Grazing dairy cows in North-West Europe

Economic farm performance and future developments with emphasis on the Dutch situation

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J.W. Reijs
C.H.G. Daatselaar
J.F.M. Helming
J. Jager
A.C.G. Beldman

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Reijs, J.W. C.H.G. Daatselaar, J.F.M. Helming, J. Jager and A.C.G. Beldman

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Orders
+31 70 3358330
publicatie.lei@wur.nl
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Preface

The dairy sector is an important contributor to food production, economic activity and land use in the European Union. Grazing has long been a traditional element of dairy farming in the EU. Current developments in the dairy sector appear to result in a decline in grazing. The World Society for the Protection of Animals (WSPA) is concerned about this decline, particularly because of consequences for animal welfare, and has commissioned this analysis. This study gives an overview of the current state-of-the-art and expected future developments with respect to grazing in six key target EU countries of WSPA. The study builds to a large extent on local expertise and focuses on economic aspects and farm management issues. We are confident that this study contributes to a better understanding of the ongoing development and that it helps various stakeholders in making sound decisions on grazing issues.

The authors are, above all, deeply indebted to the experts that were interviewed. Their knowledge has been the mainstay of this business!

Furthermore, the authors thank Jelle Zijlstra and Gertjan Holshof for the productive cooperation in the initial phase of this research. Last but not least, Sofia Parente is thanked for her patient and inspired guidance of this research project.

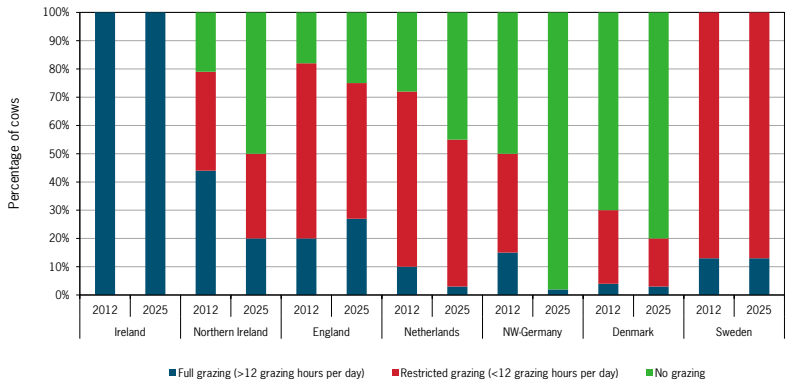
L.C. van Staalduinen MSc
Managing Director LEI Wageningen UR

Summary

S.1 Important outcomes

Grazing is declining in North-West Europe
Grazing is declining rapidly in Europe. In this study, which focused on 6 countries in North-West Europe, current estimations of grazing experts on the percentage of cows that graze, differ between 30% in Denmark and 100% in Ireland. The same experts predict that these percentages will be substantially lower in 2025 in North-West Germany, Northern Ireland, the Netherlands and Denmark. See Section 4.4.

Figure S.1 **Expected development of grazing from 2012 to 2025 (based on expert knowledge) in 6[a] different EU regions**



Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.
a) Including UK; Northern Ireland and England are shown separately in this figure

Results of economic modelling also showed a strong tendency towards a decline of grazing on Dutch dairy farms. In the absence of intervention the model predicts a reduction from two-thirds of the cows grazing 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. To some extent, some of these measures are already being introduced in the Netherlands. See Chapter 5.

Opportunities and threats for grazing in North-West Europe
This study provides an executive SWOT analysis of grazing in North-West Europe. The trend of intensification and expansion of farms has been identified as the most important threat to grazing. This trend results in the need for higher outputs (per cow and per ha) and controllability of management on the one hand and reduced availability of grazing area around the farm on the other. The largest opportunities for grazing are 1) its low cost structure, especially in times where farmers have to deal with low milk prices and high production costs, and 2) the fact that dairy industry and governments are increasingly recognising grazing as an important precondition for natural behaviour of dairy cows and for social acceptance of dairy farming. See Section 4.5.

Higher income for extended grazing large farms
An empirical analysis on Dutch farms revealed that large farms that apply extended grazing have on average higher net farm incomes than those that apply no grazing or restricted grazing. The higher income for extended grazers can be explained by a combination of:

- higher revenues from output other than milk and animals such as CAP premiums and nature conservation;
- lower feed costs;
- lower fixed costs (amongst others costs for contractwork).

On small farms this effect was not observed. These results confirm other studies that grazing can have economic benefits. The amount of fresh grass intake appears to be a crucial factor to realise these advantages. The results do not imply that grazing always results in a better economic performance. Both grazing and non-grazing can result in extremely high and low farm incomes. See Chapter 3.

S.2 Complementary outcomes

Current situation in six countries
There are large differences in farm structure, costs of production and grazing systems between the six key target countries. Differences in the current grazing situation are not only the result of differences in environmental conditions but also socio-economic factors and cultural aspects. In general, Ireland has the most favourable conditions for grazing, followed by the UK. Environmental conditions are less favourable in Sweden and Denmark but in Sweden grazing is

mandatory. The Netherlands and North-West Germany take intermediate positions but in the Netherlands several initiatives are taking place to maintain current levels of grazing. See Chapter 2.

Future price effects
Costs of production will increase over time more rapidly than milk prices, which will urge farmers to continue to search for improvement of the efficiency of management (reduce costs or increase revenues) and/or increased production volumes. Whether grazing becomes more attractive under these changed circumstances depends on the specific situation and especially price ratios of the country. In general, increased prices for concentrates will stimulate grazing. However, when this increase coincides with increased prices of other agricultural inputs, such as the land prices, it will pull the sector in the direction of no-grazing as it will stimulate further intensification. Also an increase in the milk price is expected to have a decreasing effect on the amount of grazing as it will stimulate intensification. See Chapter 5.

Maintaining grazing requires investments and strategic choices
To maintain grazing in the North-West European dairy industry, governments and other stakeholders should invest in knowledge development and technological innovation on grazing issues. Important are the development of tools and systems that simplify grazing management on large farms and assistance of farmers in their management and strategic choices. To obtain good economic results it is crucial that farmers opt for a clear strategy with respect to grazing. Grazing or no grazing should be one of the core strategic decisions. This study concludes with two main routes to maintain or extend grazing: 1) expand or introduce the (Irish) full grazing system with low housing costs, a seasonal production profile and a lower milk production per cow; 2) maximise the fresh grass intake in restricted grazing systems; 3) allow cows access to pasture in no-grazing systems to give opportunities to exhibit natural behaviour and maintaining cows visible in the landscape. See Section 6.1.

S.3 Methodology

Dairy farming in Europe has evolved considerably over the last decades. This evolution includes a decline in grazing. The World Society for the Protection of Animals (WSPA) is concerned about the consequences of this development, particularly because of consequences for animal welfare. WSPA commissioned

a study to LEI Wageningen UR to answer a number of research questions on characteristics, costs of production, profitability and future developments of different grazing models in North-West Europe. In this study three main grazing categories were distinguished: full grazing, restricted grazing and no grazing. See Chapter 1.

The study is limited to five countries in North-West Europe where WSPA runs an office: the UK, the Netherlands, Germany, Denmark and Sweden. Ireland is added to the list as the typical full grazing system of Irish dairy farming is an interesting point of comparison.

For comparison analyses of the six key target countries, the following data sources were used:

- European datasets on economic farm data (FADN (Farm Accountancy Data Networks)) were analysed to give an overview of farm structure and economic performance of the six key target countries. See Chapter 2.
- Semi-structured interviews were held with local experts to describe current and future developments in grazing. See Chapter 2 and 4.

To get more in-depth information on the Dutch situation:

- An empirical analysis on economic farm data (FADN) was carried out to get insight into the differences in economic performance of farm categories with different grazing systems. See Chapter 3.
- Economic modelling (Dutch Regionalised Agricultural Model (DRAM)) was used to model future development of the Dutch dairy sector. See Chapter 5.

In these Dutch analyses restricted grazing has been further subdivided into extended, restricted and very restricted grazing based on the total number of grazing hours. See Section 1.4.

Samenvatting

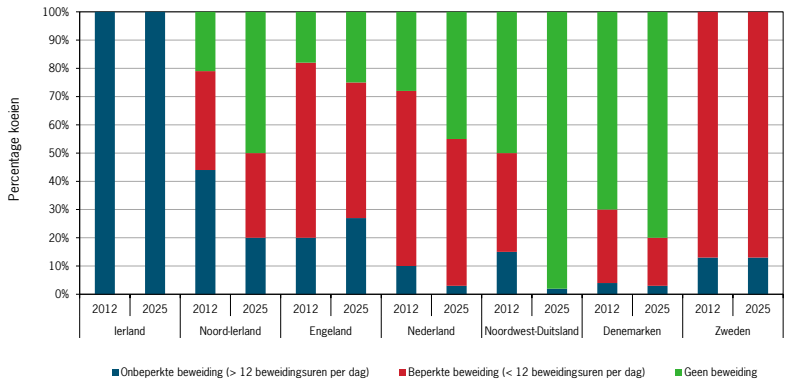
Weidegang voor melkkoeien in Noordwest-Europa; Economische bedrijfsprestaties en toekomstige ontwikkelingen met nadruk op de Nederlandse situatie

S.1 Belangrijkste uitkomsten

Beweiding in Noordwest-Europa neemt af

Het weiden van melkkoeien neemt in snel tempo af in Europa. Het geschatte percentage melkkoeien dat weidt, verschilt sterk tussen de zes landen in Noordwest-Europa waar deze studie op is gericht: van 30% in Denemarken tot 100% in Ierland. Experts verwachten dat deze percentages in 2025 aanzienlijk lager zullen liggen in Noordwest-Duitsland, Noord-Ierland, Nederland en Denemarken.

Figuur S.1 **Verwachte ontwikkeling van het beweidingspercentage tussen 2012 en 2025 (gebaseerd op specialistische kennis) in zes[a] EU-regio's**



Bron: Resultaten van semigestructureerde interviews met lokale experts. Interviews afgenomen door Wageningen UR, najaar 2012.

a) Inclusief het Verenigd koninkrijk; Noord-Ierland en Engeland worden in deze figuur apart weergegeven

Economische modelsimulaties laten ook zien dat, zonder beleid of inspanningen, het aandeel melkkoeien in Nederland dat weidt sterk zal dalen (van tweederde van de koeien op het moment van het onderzoek tot eenderde in 2025). Deze tendens kan deels worden tegengegaan door privaat en publiek beleid dat meer beweiding van melkkoeien stimuleert. Sommige van deze maatregelen zijn in Nederland deels al ingevoerd.

Kansen en bedreigingen voor beweiding in Noordwest-Europa
In deze studie is een SWOT-analyse uitgevoerd van beweiding in Noordwest-Europa. De trend van intensivering en uitbreiding van melkveebedrijven is benoemd als belangrijkste bedreiging voor beweiding. Intensivering en uitbreiding resulteert vaak in een behoefte tot een hogere productie per koe en per hectare en een betere beheersbaarheid van de bedrijfsvoering. Daarnaast leidt het doorgaans tot een afname van geschikte weideoppervlakte per koe. De belangrijkste kansen voor beweiding zijn 1) de lagere kosten, vooral als melkveehouders onder druk staan door lage melkprijzen en hoge productiekosten, en 2) het feit dat er steeds meer erkenning komt vanuit de zuivelindustrie en overheden dat weidegang een belangrijk criterium is voor de sociale acceptatie van melkveehouderij en het natuurlijk gedrag van melkkoeien.

Hogere inkomens bij grote melkveebedrijven met intensieve beweiding
Een empirische analyse van Nederlandse melkveebedrijven toont aan dat grote bedrijven die uitgebreide beweiding toepassen gemiddeld een hoger inkomen uit het bedrijf halen dan bedrijven die hun koeien niet of slechts beperkt beweiden. Dit hogere inkomen uit het bedrijf bij uitgebreide beweiding kan worden verklaard door een combinatie van factoren:

- hogere andere inkomsten dan van melk en dieren zoals toeslagen en beheersvergoeding;
- lagere voerkosten;
- lagere vaste kosten waaronder de kosten voor loonwerk.

Op kleine bedrijven werd dit effect niet waargenomen.

Deze resultaten bevestigen de conclusie van andere studies dat beweiding economische voordelen kan bieden. De hoeveelheid vers gras die wordt opgenomen lijkt een cruciale factor te zijn om deze voordelen te realiseren. De resultaten impliceren niet dat beweiding altijd voor betere economische resultaten zorgt. Zowel met als zonder beweiding kunnen extreem hoge en lage inkomens worden gegenereerd.

S.2 Overige uitkomsten

Huidige situatie in de zes geanalyseerde landen
Er zijn grote verschillen in bedrijfsstructuur, productiekosten en beweidingssystemen tussen de zes landen. De verschillen in de huidige beweidingssituatie zijn niet alleen het gevolg van verschillen in omgevingsfactoren; ook socio-economische en culturele aspecten spelen een rol. In het algemeen zijn de omstandigheden in Ierland het gunstigst, gevolgd door het Verenigd Koninkrijk. De omgevingsfactoren zijn minder gunstig in Zweden en Denemarken, maar in Zweden is weidegang verplicht. Qua omstandigheden voor beweiding vormen Nederland en Noordwest-Duitsland de middenmoot. In Nederland zijn er verschillende initiatieven om te voorkomen dat het aandeel beweiding daalt.

Prijseffecten in de toekomst
De productiekosten zullen in de loop van de tijd sneller toenemen dan de melkprijzen, waardoor melkveehouders gedwongen worden te blijven zoeken naar efficiëntere bedrijfsvoering (lagere kosten of hogere opbrengsten) en/of hogere productievolumes. Of beweiding aantrekkelijker wordt door deze veranderde omstandigheden, hangt af van de specifieke situatie en vooral prijsverhoudingen in het betreffende land. In het algemeen zullen de hogere prijzen voor krachtvoer een stimulans vormen om te gaan beweiden. Als deze hogere prijzen echter samenvallen met hogere prijzen voor andere productiemiddelen, zoals voor grond, dan kan dit eerder een stimulans vormen voor verdere intensivering, waardoor beweiding juist minder aantrekkelijk wordt. Een hogere melkprijs zal in het algemeen ook een negatief effect hebben op beweiding doordat een hogere melkprijs intensivering stimuleert.

Behoud van weidegang vereist investeringen en strategische keuzes
Als overheden en andere stakeholders beweiding in de Noordwest-Europese melkveehouderij op het huidige peil willen houden, is het verstandig om te investeren in kennisontwikkeling en technologische innovatie van beweiding. Daarbij is het van belang dat melkveehouders ondersteund worden bij het maken van strategische keuzes met betrekking tot beweiding en dat instrumenten en systemen worden ontwikkeld die het beweidingsmanagement op grote bedrijven eenvoudiger maken. Om goede economische resultaten te boeken, is het cruciaal dat bedrijven een eenduidige beweidingsstrategie hanteren. Wel of niet beweiden moet een van de belangrijkste strategische beslissingen zijn. De studie sluit af met twee belangrijke manieren om

weidegang te behouden of uit te breiden: 1) uitbreiden of introduceren van het lerse beweidingssysteem met lage huisvestingskosten, een seizoensgebonden productie en lagere melkproductie per koe; 2) maximaliseren van de opname van vers gras in systemen met beperkte weidegang; 3) koeien (beperkt) toegang geven tot weides in systemen zonder weidegang om het vertonen van natuurlijk gedrag en de zichtbaarheid van koeien in het landschap te stimuleren.

S.3 Methode

De melkveehouderij in Europa is de afgelopen decennia sterk veranderd. Hierbij vindt er steeds minder beweiding plaats. De World Society for the Protection of Animals (WSPA) maakt zich zorgen over de gevolgen van deze ontwikkeling, met name vanwege de consequenties voor het welzijn van de dieren. De WSPA heeft LEI Wageningen UR opdracht gegeven een studie uit te voeren om een aantal onderzoeksvragen te beantwoorden over de kenmerken winstgevendheid en toekomstige ontwikkelingen van verschillende beweidingsmodellen in Noordwest-Europa. In deze studie werden drie beweidingscategorieën onderscheiden: onbeperkte beweiding, beperkte beweiding en geen beweiding.

De studie is beperkt tot vijf landen in Noordwest-Europa waar de WSPA kantoor houdt: het Verenigd Koninkrijk, Nederland, Duitsland, Denemarken en Zweden. Ierland is toegevoegd aan de lijst omdat het typische intensieve beweidingssysteem van de Ierse melkveehouderij interessant vergelijkingsmateriaal is.

Voor een vergelijkende analyse van de zes landen zijn de volgende gegevensbronnen gebruikt:

- Een overzicht van de bedrijfsstructuur en de economische prestaties van de zes landen op basis van een analyse van de Europese datasets voor bedrijfseconomische gegevens van de Farm Accountancy Data Network (FADN).
- Semigestructureerde interviews met lokale experts over de huidige en toekomstige ontwikkelingen van beweiding.

Om meer gedetailleerd inzicht te krijgen in de Nederlandse situatie:

- is een empirische analyse uitgevoerd van de bedrijfseconomische gegevens van het Bedrijveninformatienet. Doel was om inzicht te krijgen in de verschillen in economische prestaties van bedrijven met verschillende beweidingssystemen;

- zijn de toekomstige ontwikkelingen van de Nederlandse zuivelsector gesimuleerd met het Dutch Regionalized Agricultural Model (DRAM).

In deze Nederlandse analyses is de categorie beperkte beweiding verder onderverdeeld in uitgebreide, beperkte en zeer beperkte beweiding op basis van het totale aantal beweidingsuren.

1 Introduction and methodology

1.1 Background

Dairy farming in Europe has evolved considerably over the last decades. As the costs increase more rapidly than the milk price, farmers have to improve their economic performance, either by improving the efficiency (reduce costs or increase revenues) or by increasing the production volume. The availability of technology and capital has allowed farmers to expand and intensify their farms relatively easily. On the other hand, many farmers decide to terminate their activities. As a consequence, the number of dairy farms decreased rapidly (Zimmerman and Heckelei, 2010). With the abolishment of the milk quota system this evolution can be expected to continue and might be amplified.

At the same time, society is becoming more aware of the negative impacts of economic activities on the planet, people and animals (now and in the future). This increased awareness is often translated into specific demands and goals for an increased sustainability on various issues. For dairy farming the main sustainability challenges have been identified as: animal health, animal welfare, economic viability, working conditions, emissions to air, water quality, water use efficiency, soil fertility and health and biodiversity conservation (SAI, 2010).

A characteristic and traditional element of dairy farming in Europe is grazing. At periods with sufficient grass growth, cows are not fed indoors but sent into the paddocks to fulfil (part of the) feed requirements by grazing. Grazing is often associated with increased animal health and welfare. Cows usually have better opportunities to perform natural behaviour compared to indoor-housing. Furthermore, grazing makes dairy farming visible in the landscape and is therefore seen as a crucial element for dairy farming to keep up a positive image within society (e.g. Convenant Weidegang, 2012). For a more elaborate overview of positive and negative aspects of grazing we refer to Van den Pol-Van Dasselaar (2005).

The current evolution of dairy farms in Europe coincides with a reduction of grazing (Van den Pol-Van Dasselaar et al., 2012). The World Society for the Protection of Animals (WSPA) is concerned about the consequences of this development on the health and welfare of dairy cows on the one hand and the economic viability of dairy farms on the other. For this reason WSPA asked LEI to conduct this study.

1.2 Aim of the research

The main aim of this research is to describe the current situation and expected future development of grazing on dairy farms in Europe. The emphasis of the study is on the economic performance of grazing vs. non-grazing systems. The specific questions that are addressed in this study are:

1. How do costs of production and profitability vary across the key target countries and different models of production? What are the key factors explaining those differences?
2. What are the strengths and weaknesses of zero-grazing and less intensive models of production where cows graze during the summer period?
3. How are costs of production expected to evolve over time and what implications does this have for different models of production?
4. What impacts will the projected rise in energy and feed prices have on different models of production over time?
5. What public policy measures would make the grazing model more attractive to farmers in the EU? What concrete examples of public policies encouraging grazing already exist and what are their effects on returns to farmers? Conversely, what policies can make the grazing model less attractive ?
6. How can dairy companies influence models of production and what concrete examples exist where producers and companies are getting returns for investing in grazing?

The study is limited to five countries in the North-West of Europe where WSPA runs an office: the UK, the Netherlands, Germany, Denmark and Sweden. Ireland is added to the list as the typical full grazing system of Irish dairy farming is an interesting point of comparison. Germany is limited to North-West Germany as South and East Germany are different with respect to farm structure, climatic conditions and grazing system. In East Germany, the former German Democratic Republic, the dairy sector is characterised by large-scale dairy farms where the cows are kept indoors. The dairy sector in the south of Germany consists mostly of small scale dairy farms. Moreover, East Germany has a more continental climate and South Germany more mountainous circumstances compared to the other countries and regions studied here.

The six selected regions are all located in North-West Europe which limits differences in climatic conditions, soil characteristics and cultural aspects. However, the study clearly shows that even within such a relatively small area regional differences are substantial.

This study does not aim to give a full quantitative analysis for all six regions/countries. Only for the Netherlands, where data availability allowed it, a quantitative analysis of empirical data and a quantitative modelling of future scenarios are included. For the other countries, the evaluation is limited to a qualitative analysis, based on interviews with local experts extended with some quantitative information extracted from existing databases and projects.

1.3 Methodology

This study made use of various data sources which main features are described below. More detailed information is given in the following chapters, in references and in appendices.

1.3.1 Analysis of European datasets

FADN

The Farm Accountancy Data Network (FADN) is an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy. It consists of an annual survey carried out by the Member States of the European Union. Derived from national surveys, the FADN is the only source of microeconomic data that is harmonised, i.e. the bookkeeping principles are the same in all countries. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the Union. The survey does not cover all the agricultural holdings in the Union but only those which due to their (economic) size (measured in European Size Units (ESU)) could be considered commercial. The applied threshold values vary per country (FADN, 2012).

The aim of the network is to gather accountancy data from farms for the determination of incomes and business analysis of agricultural holdings. The annual sample covers approximately 80,000 holdings. They represent a population of about 5m farms in the 27 Member States, which cover approximately 90% of the total utilised agricultural area (UAA) and account for about 90% of the total agricultural production of the Union.

Chapter 3 is based on an analysis of the Dutch FADN sample (Informatienet). In the Dutch FADN economic data are extended with technical and process information on farm management. More information on the Dutch FADN can be found at Van der Veen et al. (2012) and Binternet.

1.3.2 Interviews with local experts

For the purpose of this study and Zijlstra and Holshof (2013), LEI conducted together with partner institute Wageningen Livestock Research (WLR), semi-structured interviews on grazing with local experts. These interviews were held in the autumn of 2012. The experts were sent a questionnaire and asked to prepare the answers to the questions on paper. Afterwards a phone meeting was planned with one of the researchers of LEI or WLR to discuss and elucidate the questions and answers. The final answers were processed by the researchers and submitted for approval with the experts.

Criteria for the selection of local experts were 1) knowledge on grazing and economics and 2) practical knowledge on the dairy sector in a region, being actively involved in research and/or advice for dairy farmers on grazing.

The interviews dealt with questions on:

- Characterisation of grazing systems.
- Strengths and weaknesses of grazing systems vs. non-grazing systems.
- Socio-economic developments that will affect grazing in the future.
- Present and future instruments for dairy companies and policy makers to stimulate grazing.

Appendix 1 contains a list of the interviewed experts.

Appendix 2 gives detailed interview results. In the UK, three interviews were held in total. Only two interviews delivered quantitative characteristics: one in England and one in Northern Ireland. In tables that present quantitative data, these two interviews are presented separately as they do not represent the whole of the UK. In qualitative tables, the three UK interviews are presented as a whole (N=3) for the UK.

In the Netherlands two interviews were held. These two interviews are consistently presented as a whole (N=2). When quantitative values varied between the experts, a range is presented.

In Sweden, Denmark, Ireland and North-West Germany, only one interview was conducted.

1.3.3 Modelling future scenarios for the Dutch situation (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. For this research the selection of the eight types of dairy cows are directed to grazing systems. Input of DRAM consists of prices and quantities of inputs and economic outputs per activity. Output of DRAM is mainly the allocation of land over the different activities and the number of activities and the corresponding agricultural output (e.g. number of dairy cows and total milk production). A further description of DRAM can be found in Appendix 4.

1.3.4 Definition of grazing systems

This research uses different categorisations of grazing systems which are summarised in Table 1.1. Three main categories were used: 1) full grazing; 2) restricted grazing and 3) no grazing.

The classification of the grazing system is always based on information with respect to the grazing of the milking cows. Information on the grazing of dry cows or young stock is not taken into account.

Table 1.1	**Definition of grazing systems in different chapters**		
Chapter	**Full Grazing**	**Restricted Grazing**	**No Grazing**
Chapter 2 and Chapter 4 (interviews on six EU countries)	More than twelve grazing hours per day during the grazing season	Substantial grass intake but less than twelve grazing hours per day a)	No substantial fresh grass intake from grazing
Chapter 3 and Chapter 5 (analyses of Dutch situation)	Day and night grazing for more than 70% of days in May - Oct	All other farms, divided into: 1. **Extended Grazing**: >1220 grazing hours in May - Oct 2. **Restricted grazing**: 720-1220 grazing hours in May - Oct 3. **Very restricted grazing**[b]: 220-720 grazing hours in May - Oct	Less than 220 grazing hours in May-Oct

a) In one of the UK interviews the definition of restricted grazing was interpreted differently (see Table A2.2); b) The subdivision in restricted and very restricted grazing has only been applied in Chapter 5, not in Chapter 3.

Due to data availability reasons, there are some differences in the definition of the grazing systems between the chapters.

In Chapter 2 and Chapter 4 local experts were asked to divide dairy farms over the three main categories on the basis of grazing hours per day. In

Chapter 3 and Chapter 5 (analysis of the Dutch situation) the definition of grazing systems is based on the number of grazing hours in the period May - Oct. As in the Netherlands restricted grazing is the most common system, this category has been divided into three subcategories: extended, restricted and very restricted grazing to get more detailed insight into this large share of the population.

1.4 Reading guide

The data sources described in the previous section are used in various combinations to address the objectives of each chapter.

Chapter 2 sets the scene and gives an extensive description of the current situation with respect to farm structure, economic performance and grazing systems in the six selected regions/countries. This Chapter combines results from the analysis of the FADN datasets and the interviews with local experts. This Chapter also contains an analysis of grazing data on farms of the European Dairy Farmers (EDF). This Chapter includes an overview of the typical characteristics of the grazing systems according to the experts.

Chapter 3 presents an empirical analysis of the Dutch situation (FADN-Informatienet). This Chapter deals with differences in the economic performance between grazing and non-grazing systems in the Netherlands and how these differences relate to farm structure and farm management. This Chapter offers an illustration of the economic effect of differences between grazing and non-grazing but the results may not always be applicable to the other countries/regions.

Chapter 4 is based on the results of the interviews with local experts. It gives an overview of the strong and weak aspects of grazing, the trends these experts expect in the coming years (up to 2025) and how that might affect grazing in their countries. This Chapter finishes with a general discussion on these expected developments and the differences and similarities between the six regions/countries.

Chapter 5 describes the result of the modelling exercise. This Chapter presents the predicted development of grazing in the Netherlands in four different scenarios where grazing is stimulated compared to a situation where no stimulation of grazing takes place.

Chapter 6 offers a general discussion and answers WSPA's research questions.

2 Characterisation of dairy farming and grazing in 6 EU countries

2.1 Introduction

This Chapter characterises farm structure, economic performance and grazing systems in the six selected regions/countries. This will be done on the basis of three different data sources.

Section 2.2 gives an overview of farm structure and economic performance based on Farm Accountancy Data Network data (FADN, 2012) in the six selected countries/regions. Strong aspect of the FADN data is that they reflect a representative sample of dairy farms in the different countries/regions. However, the FADN data give no information on differences in different grazing categories and information on the years after 2009 are not (publicly) available.

Section 2.4 gives an overview of the current situation regarding differences between grazing systems on the basis of the interviews with local experts. These interviews overcome the disadvantage of not being representative in terms of dairy farms as the experts were specifically asked to give an estimation of the average farm. Disadvantage of these interviews is that the specific knowledge and opinion of single experts are very determining as, given the limited availability of time, only one or two interviews per country/region could be held.

Section 2.5 gives a qualitative sketch of dairy farming performance and grazing in the six different countries/regions based on all three data sources.

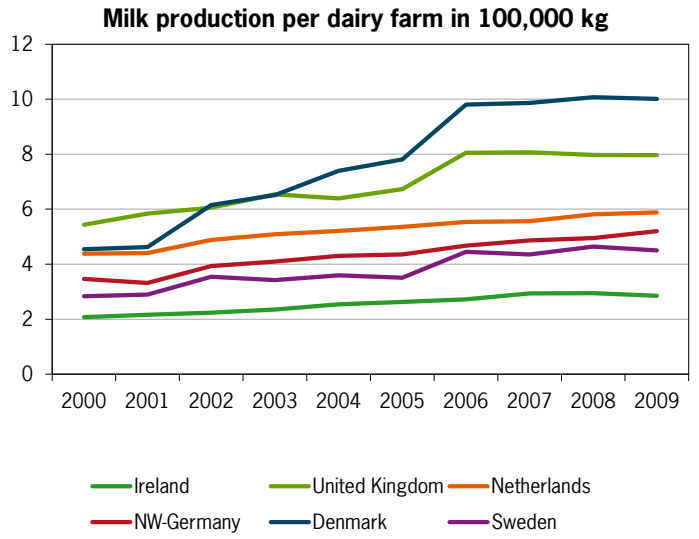
2.2 Farm Accountancy Data Network (FADN)

2.2.1 Farm structure

Farm size

The average farm size, measured in terms of volume of milk produced is lowest in Ireland (almost 300 tonnes of milk in 2009) and highest in Denmark (more than 1,000 tonnes of milk in 2009), followed by the UK (Figure 2.1). The Netherlands, Sweden and North-West Germany take intermediate positions.

Figuur 2.1 **Development of farm size in six different EU countries in the last decade (FADN)**



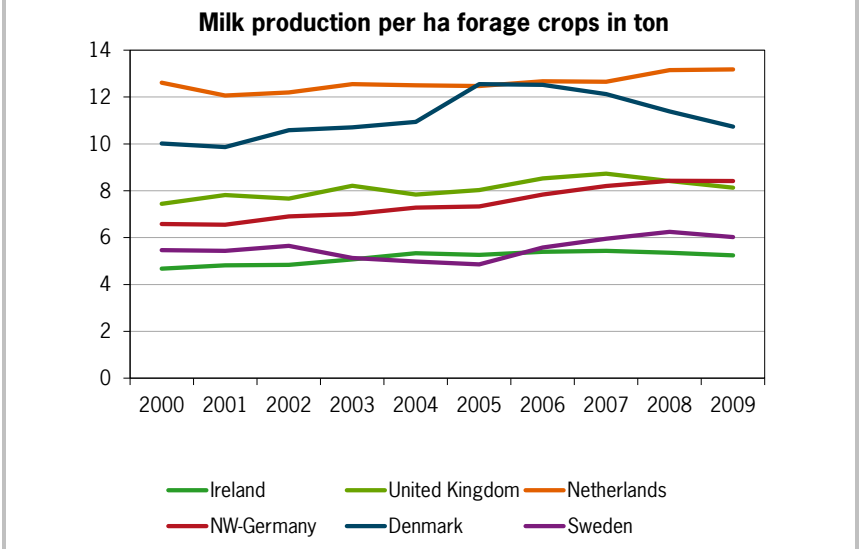
Source: FADN.

Many farmers expect to lower their fixed costs per kg of milk when increasing the total milk production on their farm. Automation and increase of productivity stimulate this development. In all countries, except for Denmark, milk production per farm has increased gradually in the period 2001-2009 (135-158%). In Denmark the average milk production per farm more than doubled (220%) in this period. In Denmark financing for farm expansion could relatively simply be obtained and, more than in the other regions, farmers left the dairy business (amongst others because of good income in other sectors).

Farm intensity

Farm intensity is expressed in this study as milk production per ha of forage crops on the own farm. This indicator gives an impression of the productivity of the land but may not be used as the sole indicator to evaluate productivity as there might be larges differences in use of purchased feed (both roughage and concentrates) between farms and countries.

Figure 2.2 **Development of farm intensity in six different EU countries in the last decade (FADN)**



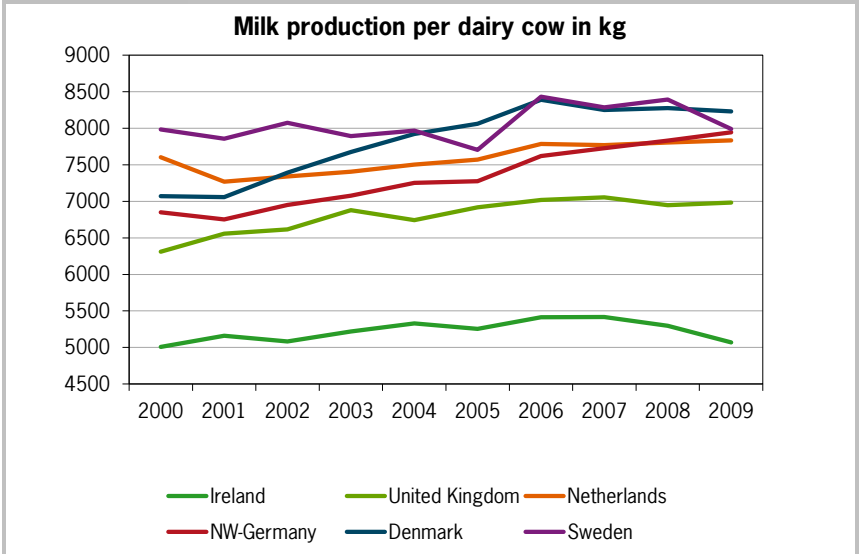
Source: FADN.

Of the six countries/regions the Netherlands has the highest milk production per hectare of fodder crops (13 tonnes of milk per ha in 2009), showing a slight increase over the years. In Denmark farm intensity has increased to 12.5 tonnes of milk per ha in 2005 and 2006 but then decreased again to 11 tonnes per ha in 2009. Sweden and Ireland have the lowest intensity: in these countries milk production per hectare of fodder crops fluctuates around 5-6 tonnes. The presence of sheep and beef cattle on dairy farms might be an important explaining factor for the low intensity in Ireland. In Sweden the short growing season probably plays a determining role. The UK and North-West Germany take intermediate positions with approximately eight tonnes per hectare. Natural conditions for good forage production in own farmland are relatively good in the Netherlands and Denmark. Furthermore, Dutch dairy farmers apply more manure and fertiliser and face lower prices per kg of concentrates than in the other regions/countries, due to lower transportation costs of overseas ingredients that arrive at the port of Rotterdam compared to other countries. Prices of purchased roughage tend to follow the prices of concentrates which eases the purchase of roughage in the Netherlands compared to other countries.

Milk production per cow

The amount of milk produced per cow is affected by the type of cow (breed and genetic potential), the diet of the cow and other farm management (quality of the stables, health management etc.). A high milk production per cow usually requires a higher share of concentrates in the diet and an increased attention for cow management.

Figure 2.3 **Development of milk production per cow in 6 different EU countries in the last decade (FADN)**



Source: FADN.

Milk production per cow is with approximately 5,000-5,500 kg per year remarkably lower in Ireland compared to the other countries. This reflects the limited input of concentrates in Ireland, where the price of concentrates is relatively high. Sweden shows the highest milk production throughout this period (8,000-8,500 kg per cow per year), most likely as a consequence of a larger share of concentrates in the diet. Denmark and North-West Germany both show quite a strong increase in milk production per cow in this period, indicating a shift towards systems with a higher productivity per cow. In the Netherlands the increase in milk production per cow is less pronounced. The UK takes an intermediate position between the Irish situation and the other countries.

2.2.2 Economic performance

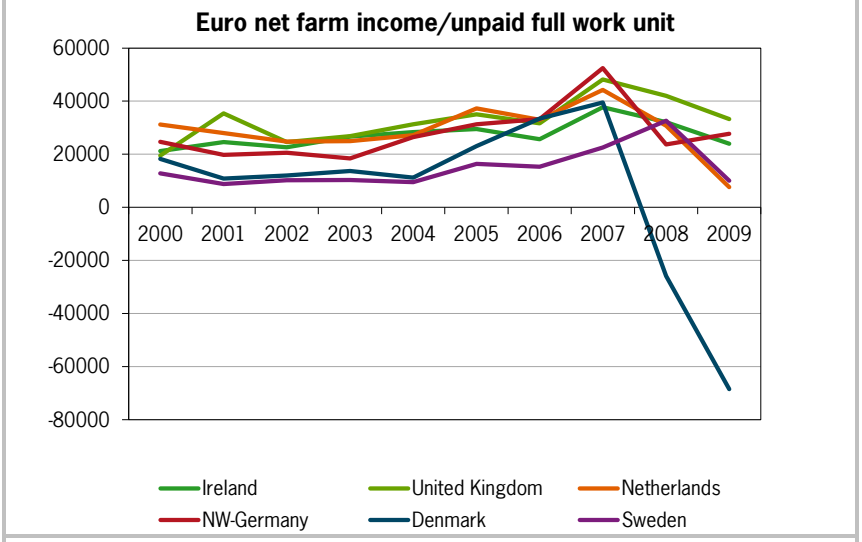
Farm income

Farm income is calculated as all revenues minus all paid costs and depreciation. The farm income per annual work unit gives an indication of the economic performance of the farm. Figure 2.4 shows the development of this indicator during the last decade. One has to be aware that calculated rent and costs for own labour are not taken into account in these figures.

The average farm income varied between approximately €10,000 and €50,000 per annual work unit. Averaged over these years (2001-2009) Sweden (€15,000) and Denmark (7,000 euro) had considerably lower farm incomes than the other countries/regions (€27,000-33,000). For most countries 2007 was a peak year, followed by an income drop in 2008 and 2009 as a consequence of low milk prices. In Denmark the income drop was very severe as the low milk prices coincided with high investments in the previous years, resulting in high interest costs (Figure 2.6).

Differences in farm income might be explained by differences in milk price, cost structure and the economic efficiency of milk production. These factors are discussed below.

Figure 2.4 **Development of farm income in six different EU countries over the last decade (FADN)**

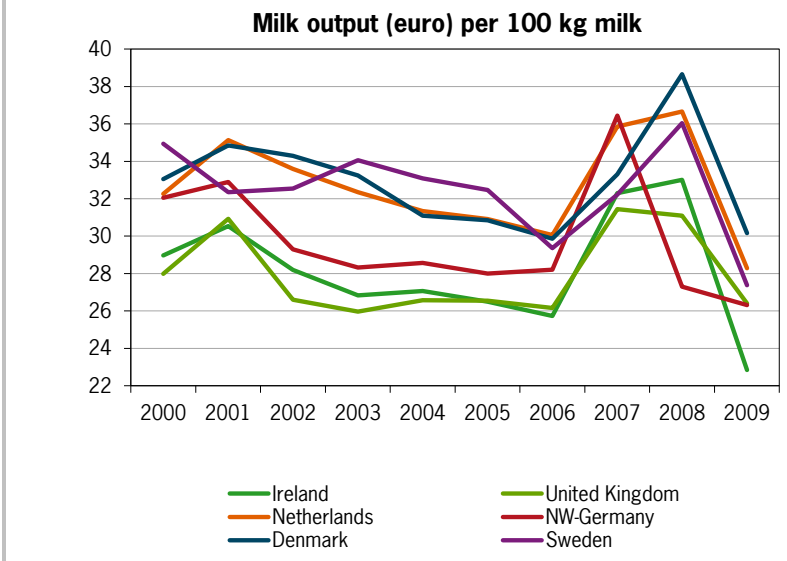


Source: FADN.

Milk price

The differences in farm income can partly be explained by differences in the revenues farmers receive for their milk. The milk price depends on the products that are produced from the milk and how well the chain is organised. Figure 2.5 shows that there are substantial differences in average milk output (measured as euro per 100 kg of milk produced) between the six countries/regions. Farmers in Ireland and the UK received on average around €28 per 100 kg of milk over the period 2001-2009, whereas the average output for farmers in Denmark, Sweden and the Netherlands amounted up to €32-33. North-West Germany took an intermediate position with €29.8. More recent data (2010-2012) extracted from the EU Agri database show the same ranking between these six countries (UK< Irl < Ger< Den< NL< Sw) (Dairy Co, 2013), though the Irish milk price seems to keep up with the German in current years.

Figure 2.5 **Development of milk output (euro per 100 kg of milk) in six different EU countries over the last decade (FADN)**



Source: FADN.

The lower milk price of Ireland can probably be explained by the fact that it produces mainly milk powder which traditionally results in lower milk prices compared with countries that focus more on added-value products like cheese. Also the seasonal production profile plays a role in the relative low milk prices in Ireland. The processing capacity has to fit with the peak in May and cannot be fully utilised the rest of the year, this leads to higher costs for this part of the chain. The system also has to fit with the market. Ireland is a big producer of milk powder. Milk powder can be stored easily so seasonality in production of milk is not a major issue. For other products e.g. cheese and especially fresh dairy products seasonality of production can be a major problem.

The situation in the UK is different with a larger share of fresh milk. In UK the debate has been on how the margins are divided within the chain. Since about 2007 DairyCo is monitoring these margins. In the report of 2009 was concluded: 'All parts of the supply chain need to generate enough profit to ensure continued improvements in efficiency (reduce cost or increase revenues) and product development. At present the DairyCo intentions survey suggests that not enough farmers have sufficient confidence to invest and this threatens the sustainability of the GB supply chain

through milk production continuing to fall. Current market volatility could worsen that confidence' (DairyCo, 2009). Currently, to increase the margins the British dairy chain is optimising production systems according to the end processor market: liquid milk or different types of manufacturing.

Cost structure

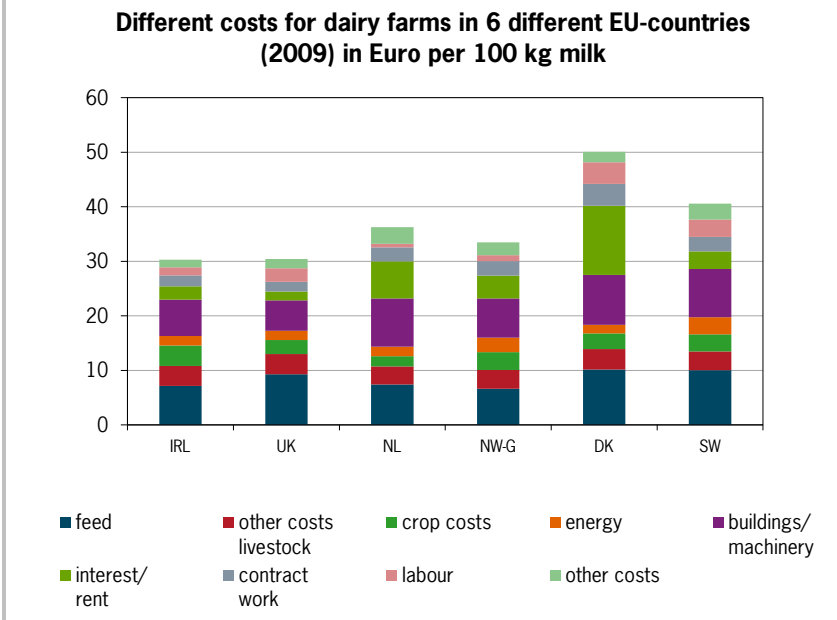
The different countries have different models of production. Different cost structures can be related to different farming systems or different strategies. There are different possibilities to achieve a high income. Some farmers mainly focus on strategies to lower the costs of production. Another possibility is to choose for a more intensive high input high output system to increase the volume of milk produced. Under a quota system, following a cost minimisation strategy is generally economically optimal. Whether a strategy is successful depends not only on country-specific factors such as prices and productivity of the land but also on farm-specific characteristics such as the allocation of the fields and the management capabilities of the farmer.

Figure 2.5 gives information on the distribution of costs over various items in 2009. In this Figure only the paid costs and depreciation are included: calculated costs for labour and rent were not taken into account.

Total costs per kg of milk are highest in Denmark and Sweden and lowest in the Ireland and the UK. The Netherlands and North-West Germany take intermediate positions. The direct costs for milk production (feed, other livestock, crop and energy costs) are highest in Sweden and Denmark and lowest in the Netherlands. Efficient management and the high productivity of Dutch soils are probably important explaining factor in this respect. However, also the relatively low prices for concentrates due to its close connection to the port of Rotterdam, which decreases lower transportation costs of overseas ingredients compared to other countries, might be an important explaining factor.

In Ireland and the UK the largest share of the costs is directly related to milk and crop production (feed, other livestock, crop and energy costs). In these countries costs for buildings and machinery are low as well as the paid interest, labour and other costs. The low costs for building and machinery can partly be explained by the full grazing systems in these countries. Less machinery is needed as cows fetch the grass themselves and the demands for cow housing are lower as the cows spend a larger share of the time outdoors. Striking is that despite the lower concentrate use, the absolute feed costs are not lower in these countries due to the high prices of concentrates as a large share of these ingredients are shipped from the port of Rotterdam to the British Isles.

Figure 2.6 **Distribution of costs for dairy farms in six different EU countries in 2009 (FADN)**



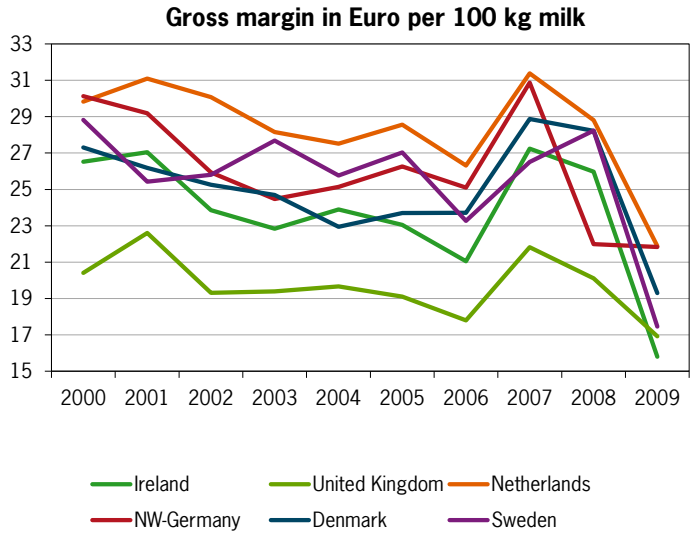
Source: FADN.

The costs for paid interest are very different between the countries. Due to the large investments in recent years these costs had gone up to 25% of the costs in 2009 in Denmark. Also in the Netherlands, 19% of the total costs consist of paid interest. In the other countries these costs are limited to 8-12% of the total costs. Costs for contract work and labour are relatively high in Denmark and Sweden and the UK. In Denmark and the UK this can be explained by the larger average farm size but not in Sweden.

Gross margin per kg of milk

The gross margin is calculated as all revenues minus the variable costs (all costs for feed, animal and crops). The gross margin per kg of milk can be used as an indicator for the economic efficiency of the milk production process (including the production of feed). Gross margin is affected both by prices of inputs and outputs levels and by the physical production efficiency.

Figure 2.7 **Average gross margin per kg of milk for dairy farms in six different EU countries in 2001-2009 (FADN)**



Source: FADN.

Gross margins varied between €16 (Ireland, 2009) and €31 per 100 kg of milk (Netherlands, North-West Germany, 2007) over the studied period. The Dutch farms reached the highest average gross margin per kg of milk in the period 2001-2009 and the British dairy farms lowest. The other countries/regions show intermediate results. The low gross margins in the UK can primarily be attributed to the low milk price in this country (Figure 2.5). The high gross margin in the Netherlands is primarily the result of the low direct cost structure (Figure 2.5).

For comparison with more recent data, the textbox on the following pages gives an analysis of the development of grazing on farms participating in the European Dairy Farmers (EDF).

Grazing on farms of European Dairy Farmers (EDF)

European Dairy Farmers (EDF)

European Dairy Farmers (EDF) is a network of leading dairy farmers to exchange experience and knowledge from farmer to farmer, founded in 1990. The Club of European Dairy Farmers serves as a forum for dairy farmers in all European countries. International members are welcome as EDF has a worldwide perspective. EDF members are dairy farmers (the statutes restrict the number of non-farmers to 30%) and people from the dairy sector who support the ideals of the club: advisors, scientists and experts. Since the mid-1990s EDF establishes a Cost of Production Comparison where all costs are taken into account. This project has grown up to a number of data sets of more than 300 single farm results. Farmers within this comparison are able to compare their results with their colleagues at the EDF congress every year.

More information can be found at the EDF website.

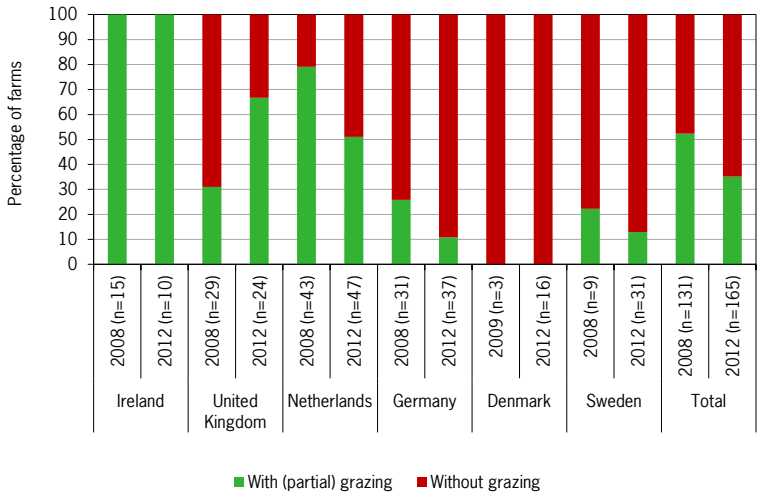
Definition of grazing in the EDF dataset

The EDF dataset is used to extract information on recent development of grazing on European dairy farms. This information adds value to this report as 1) the EDF data are very up-to-date (compared with the FADN data) and 2) might give a better estimation of future trends as it might be expected that the farmers who are participating in EDF are more progressive than the average farmer. The EDF dataset cannot be used as a representative sample as participating farms are not selected randomly but have applied voluntarily. Grazing in the EDF dataset is defined by the question whether the cows receive the majority of their feed during the grazing season from grazed grass (grazing) or from other forages (no grazing). Figure X shows the development of grazing on the EDF sample between data collection years 2008 and 2012 (N=131 in 2008, N = 165 in 2012). The data refer to the growing seasons of 2007 and 2011, respectively. The data do not refer to the exact same population in the two years: Farms that participate in 2008 do not necessarily participate in 2012.

Development of grazing in the EDF dataset

The EDF database supports a decrease in grazing over the last four years. Overall the percentage of EDF farms that applied grazing has dropped from 52% in 2008 to 35% in 2012. In Ireland all EDF farms apply grazing both in 2008 and 2012. In the UK the percentage of EDF farms that apply grazing has increased from 31% in 2008 to 67% in 2012. This increase is not the consequence of existing farms in the EDF group that

Figure 2.8 **Development of percentage of farms with and without grazing in six countries a) in the EDF sample**



Source: EDF, processed by LEI Wageningen UR.

a) The German EDF data are not restricted to the North-West but refer to the whole of Germany.

have switched to grazing but new members that joined in that already applied grazing. In Denmark none of the EDF farms applied grazing in 2008 nor in 2012. In the Netherlands (from 79% to 51%) and Germany (from 27% to 11%) the percentage of EDF farms that applied grazing dropped considerably in this period. In Sweden all farms apply grazing because it is mandatory. However, according to the definition used by EDF, the percentage of EDF farms in Sweden that apply grazing is low in both years (22% and 13% respectively) which indicates that fresh grass intake is limited.

Relation between grazing and farm structure in EDF population

Though the EDF farms are generally much larger than the values reported by FADN, the EDF data confirm that grazing farms are generally smaller and less intensive and have a lower milk production per cow compared with non-grazing farms. On the other hand it can be observed that also in this population grazing exists in all size classes. For the EDF sample as a whole, 43% of the grazing farms produce more than 1.2m kg of milk per year. With respect to intensity (milk production per ha) and milk production per cow the differences between the countries are more explicit than the differences between grazing and the non-grazing groups within the countries (data not shown).

2.3 Expert interviews

2.3.1 Farm structure

Introduction

This Section gives a quantitative estimate of the current situation in the six EU countries/regions with respect to the three distinguished grazing systems:

1. Full grazing, i.e. farms where the milking cows graze more than twelve hours per day in the grazing season.
2. Restricted grazing, i.e. farms that apply grazing to a less extent, either by restricting the number of grazing hours or keeping some milking cows indoors (usually the high-yielding cows).
3. Farms that apply no grazing (NO).

It is important to be aware of the variability within the restricted grazing group. In the UK-interview restricted grazing was defined as full grazing (as many hours as possible) for a limited number of cows. In the Dutch situation restricted grazing is a limited no. of hours (six to eight) for (mostly) all cows. The results are summarised in Table A2.2. When one of the categories was estimated to have less than 10% of the farms within a country/region the category was not considered. This was only the case for Sweden (grazing is mandatory so category NO grazing has been left out) and Ireland (only full grazing).

Results

The estimated average farm size, farm intensity and milk production per cow are in most cases higher than the figures presented in Section 2.2 based on FADN data. This can on one hand be explained by the fact that the interview data refer to the current situation and the FADN data only run up to 2009. On the other hand, there might be a slight overestimation of professional (so larger) farms by the experts as these up-to-date experts might be a bit ahead of the datasets. For the UK (England and Northern Ireland only) the estimates may not be comparable to the FADN data as they do not reflect the whole of the UK. In general, the data from the interviews reflect the same trends as the FADN data.

- *Farm size*

  The interview data confirm the general pattern of decline of grazing with the growth in size of farms and the fact that largest farms are located in the UK and Denmark and the smallest in Ireland and Sweden. Farms in the Netherlands and Germany are intermediate in size. In all countries it can be

observed that on average NO grazing farms are larger than farms that practise any form of grazing and that full grazing farms are smaller than restricted grazing farms. However, the data from England clearly show that farm size in itself is no decisive factor in grazing as also seen in the EDF sample.

- *Farm intensity*
  Milk production per hectare is lowest in Sweden and Ireland and highest in the Netherlands and the UK. There are a lot of factors that play a role in the average farm intensity of a country such as the length of the growing season, production capacity of the soil, presence of other animals, the production of own concentrates, the availability (price) of the land (competition from other sectors), the price of roughages and concentrates, milk prices and the availability of milk production quota. The farms that keep their cows indoors are in general more intensive than the farms that apply grazing. This does not automatically imply that non-grazing farms produce more feed per ha. They might also buy more feed.
- *Milk production per cow*
  In all countries/regions milk production is estimated highest at the NO grazing farms. Milk production levels below 6000 kg per cow are only reported for the full grazing systems in Ireland and England. Full grazing in the Netherlands, North-West Germany and Northern Ireland results in milk production levels between 6,000 and 7,500 kg. Restricted grazing results in intermediate milk production levels (between 7,000-9,000 kg of milk per cow) whereas the production level of NO grazing farms is in all countries estimated above 8,500 kg per cow.

The differences between grazing systems within the countries are explored in more detail in the next Sections.

2.3.2 Origin and business model of three different grazing systems

Introduction
The interviewed experts were asked to give their opinion on the origin and the business model of different grazing systems in their country. The following questions were asked:

1. How/why has the grazing system become what it is?
2. How/why does it make money?

The answers on these questions are summarised in Table A2.1.

Full grazing

Full grazing is the traditional grazing system in North-West Europe. Well-managed full grazing systems make money due to their low cost structure. This is true for fixed costs such as housing as well as variable costs of feed production due to a maximised direct intake of fresh grass. In such systems milk yield per cow is modest to obtain the best grassland utilisation while maintaining good cow health and performance.

There is a large difference in the estimated characteristics of this grazing system between the countries (Table A2.2). The length of the grazing season varies from 165 days in Sweden (even shorter in the north) up to 300 days in southern parts of Ireland and the UK. The number of grazing hours varies from >12 (Sweden) to 20-22 (Ireland and the UK) per day and the grass intake between 8 (Denmark) and 17 (England) kg dry matter per day.

Full grazing is often applied as the dominant system in regions where soil conditions do not allow arable crops (e.g. the western part of the Netherlands). In Ireland and the UK a re-invention and modernisation of these systems is currently taking place (Table A2.1). The fact that this takes place in Ireland and the UK can partly be explained by the more favourable soils and climatic conditions (especially the longer growing season) in these countries. In Sweden and Denmark, where the climate is less favourable for grazing, full grazing is mainly applied within organic farming. To qualify as 'organic' (sometimes full) grazing is compulsory. Netherlands and North-West Germany take intermediate positions. In Germany and the Netherlands full grazing is still mainly applied by and associated with smaller and more traditional farmers.

Non grazing

Non-grazing farms are often the result of the growth and intensification taking place in many farms. Except for Sweden, where grazing is mandatory, and Ireland where full grazing seems to be the only system this trend can be recognised in all regions. As a consequence the organisation of grazing becomes more complex. Often expansion is focussing on expansion in number of cows and not in hectares. Expansion in land requires even more capital. When extra land is bought or rented, this often is not situated in the direct neighbourhood of the farm. As a consequence, the grazing land available around the farm is often not big enough to allow for appropriate grazing.

Furthermore, as expansion goes together with high investments, these farmers in general have a higher need for a high output of their cows to cover their investments and therefore are keener on controlling the circumstances for the cow. Especially compared to full grazing, the controllability of non-grazing

systems is higher due to the fact that the dependence on weather conditions is much smaller. Therefore, expanding farmers more often choose for non-grazing systems.

Restricted grazing
Restricted grazing takes an intermediate position between non-grazing and full grazing and it has the advantages and the disadvantages of both. The main advantage of restricted grazing compared to the full grazing is that it allows for better balanced diets and controlled circumstances (feed availability, weather conditions) for the cattle. In all countries, except for England, this system is characterised by a shorter grazing season (150 days) and a restricted grazing time (4-9 hour) per day. This results in an average grass intake of three or less (Sweden) to nine kg dry matter per day (Northern Ireland).

The restricted grazing system allows higher milk production levels than the full grazing system. The main disadvantage of this system is that investments in housing and feed conservation are required as well as some costs for grazing (fences etc.) which increase the costs. Restricted grazing is mostly applied in the Netherlands, North-West Germany and England. Restricted grazing is recognised by different experts as a conscious strategy but is also be looked at as a transitional stage towards non-grazing or a lack of strategy.

2.4 Overview per country

This section draws a qualitative overview of the current situation in the six EU countries/regions with respect to grazing. In these overviews information on all data-sources used in the former sections is combined.

2.4.1 Ireland

In Ireland the percentage of cows grazing is estimated (by the interviewed expert) to be up to 100%. The dairy farms are relatively small (in production volume) and extensive and the vast majority of the farms practice a full grazing system and block calving in Spring. This seasonal calving pattern guarantees that the cows have the peak lactation in the period grazing conditions are most favourable. The supplemental feeding is very limited: grass silage is only fed when there is a grass deficit in the paddocks and concentrates are only fed at the peak of lactation (mostly between 0 and 4 kg but up to 8 kg per cow per

day. Irish dairy farms have a low level of milk production per cow, due to low supplemental feeding and the use of cross bread cows.

To obtain a maximum use of fresh grass Irish dairy farming has a high peak production in May and low level productions in December/January. This seasonality of production also influences the milk processing industry. The processing capacity has to fit with the peak in May and cannot be fully utilised the rest of the year, this leads to higher costs for this part of the chain. The system also has to fit with the market. Ireland is a big producer of milk powder. Milk powder can be stored easily so seasonality in production of milk is not a major issue. For other products e.g. cheese and especially fresh dairy products seasonality of production can be a major problem.

Cows grazing in Ireland

Despite the smaller farm size and the lower milk prices, the incomes of Irish dairy farms are equal to other countries. This can largely be explained by the low costs for rent, labour, contract work, machinery and buildings. Despite the low supplemental feeding, feed costs are similar to other countries. This is the result of the high prices for concentrates in Ireland. As a consequence of lower milk prices, the Irish gross margin per kg of milk is relatively low.

Typical for Irish dairy farming is that all farmers work with the full grazing system and all advice, research and education is aligned to this system. If

(technological) innovations arise they will have to be implemented within this full grazing system, so probably the innovation will be adapted and not the system.

2.4.2 United Kingdom

Dairy farms in the UK are on average large but have a relatively low milk production per cow compared to all the other countries in this study with the exception of Ireland. Dairy farms in the UK vary dramatically in size and systems used and therefore it is very hard to generalise over systems.

Low milk prices and high prices for concentrates have resulted in poor gross margins in the UK but farm income is relatively good due to the larger scale and the low fixed costs (machinery, buildings, rent, contract work and labour) compared to the other countries. The low costs for building might partly be attributed to the full grazing system that is applied in the UK.

Currently all three grazing systems occur in the UK. There are farms that apply the typical Irish full grazing system, farms that keep their cows indoors and farms where a restricted grazing is applied. In Northern Ireland, restricted grazing implies that all cows graze for a restricted time during the day, in England a restricted number of cows grazes during the whole day. Also the milk production per cow is much more variable than in Ireland. The estimations of local experts are that 85-90% of the farms still apply grazing but that this will decrease in the future. Due to the low milk prices and the high concentrate prices grazing is attractive for farmers in the UK compared to other countries. Farmers in the UK are searching for innovative ways to optimise grazing management. Unlike in Ireland there is no general consensus that full grazing is the only and most attractive system for the British farmers.

Cows grazing in the United Kingdom

2.4.3 The Netherlands

Dutch Dairy farms are very intensive compared to the other countries but have a moderate size and milk production per cow. Due to the high productivity and relatively low feed prices, gross margin of the Dutch dairy farms is high. As the fixed costs (machinery, buildings, rent, contract work and labour) are relatively high, average farm incomes are equal to the other counties.

Grazing in the Netherlands is gradually decreasing (eg. Reijs et al., 2013, Van den Pol-van Dasselaar, 2011). The traditional full grazing system is only applied at about 10-20% (depends on definition and source) of the farms. About 30% of the farms do not apply grazing for milking cows. This leaves 50-60% of the farms to apply the restricted grazing system. This system allows farmers a better control over the diet and other conditions for the animals compared to full grazing. Currently there is a strong debate in the Netherlands on grazing. A lot of parties are involved in this debate. The Dutch dairy industry actively promotes 'preservation of the current level of grazing' by signing up the 'Convenant Weidegang' and most companies pay grazing premiums up to 0.5 to 1.0 eurocent per litre of milk.

Cows grazing in the Netherlands

2.4.4 North-West Germany

The dairy farms in North-West Germany on average have a moderate farm size and moderate milk production per cow and per hectare compared to the other countries. Farm incomes are good compared to the other countries. Compared to the neighbouring countries the Netherlands and Denmark the fixed costs (rent, building, machinery, contract work, labour) of German farms are low.

In North-West Germany grazing is decreasing rapidly. The interview expert estimated that 50% of the cows in this region currently graze. Full grazing has been the traditional grazing system. According to the interview it is currently applied at about 25% of the farms. The rest of the farms apply restricted grazing which is mainly seen by the expert interviewed as a transitional stage towards non-grazing. Grazing mostly happens in the coastal regions in the Northwest. Further inland cows are kept indoors mainly or totally. An important historical reason is the typical land structure: the farm buildings and stables were often located in or around the village while the fields were located at some distance to the villages. Poor grassland management, leading to e.g. low grass quality, strengthens the practice of keeping the cows in the barns. Dairy companies are thinking about stimulating grazing but financial compensation is currently very limited.

Cows grazing in Germany

2.4.5 Denmark

Together with the Dutch, the Danish farms on average have a higher milk production per ha than the other countries. Denmark has faced a big growth in the scale of dairy farms in the preceding years. The average Danish dairy farm now produces more than one m kg of milk. This strong growth of dairy farming in Denmark was made possible by relatively easy access to finance in the first years of this century. Danish farms on average have relatively high costs for rent, labour and contract work. Also direct costs (feed, other livestock and crop costs) are relatively high in Denmark but due to relatively high milk prices, the gross margin of Danish dairy farms is average compared to the other countries.

The combination of high direct and indirect costs and increased interest rates has resulted in a severe income drop from 2008 onwards. As a consequence an important share of the farmers has faced financial problems and land prices have decreased dramatically again.

Cows grazing in Denmark

In Denmark grazing is often associated with lower profits and yields per cow and per hectare. There has been a strong decrease in grazing in recent years in Denmark. Van den Pol-Van Dasselaar (2011) reports a decline from 85% in 2001 to 35-45% in 2010. The current study delivers an estimate of 35% of the farms currently still applying grazing in Denmark. A large share of the farmers that apply grazing is organic: for organic dairy farmers a minimum of six hours grazing per day over 150 days a year is mandatory. Many Danish dairy farmers state that cow comfort in the barns is very good: at such a level that it could compete with keeping the cows grazing.

2.4.6 Sweden

In Sweden a considerable share (47% in 2012) of the cows is still tethered. Swedish dairy farms are relatively small and extensive compared to the other countries. The average milk production per cow is high. Swedish dairy farms realise lower incomes compared to the other countries due to the small farm size, high direct costs (feed, other livestock and crop costs) and relatively high costs for labour and contract work. Due to relatively high milk prices the gross margin is average compared to the other countries.

Cows grazing in Sweden

Sweden has a very short grazing season compared to the other countries. Grazing is mandatory for six hours a day during three months in central regions and four months in the southern part of Sweden. Fresh grass intake on the Swedish grazing farms is limited (on average three kg dry matter per day). Sweden is an exception in the case of grazing because grazing is mandatory by law, for already 25 years. Some dairy farmers started complaining about this law because in their view it hampers necessary farm expansion. But there are no signs that the law will be changed soon or considerably.

2.5 Conclusions

The six studied countries/regions differ considerably in farm structure, grazing systems and costs of production. These differences have their origin in natural (soils and climate), economic and cultural circumstances. Natural conditions (mild climates, long growing seasons and soils not suitable for arable production) are most favourable for grazing in Ireland and the UK and less favourable in Sweden and Denmark. The Netherlands and North-West Germany take intermediate positions.

Dairy farms are on average largest in the UK and Denmark and smallest in Ireland and Sweden. Dutch farms have the highest milk production per hectare (they produce and/or buy more feed), followed by the Danish. Milk production per cow is lowest in Ireland and highest in Sweden. Denmark and North-West Germany show a more rapid increase in milk production than the other countries.

In general, grazing farms are smaller and produce less milk per cow and per hectare. However, grazing exists in all size classes.

Grazing is rapidly declining in Denmark and North-West Germany and to a lesser extent in the Netherlands and the UK. In Sweden grazing is mandatory but grazing time and fresh grass intake is very limited. The Irish dairy sector is expected to completely maintain the full grazing system.

Despite the differences in natural conditions and farm structure, average net farm incomes (euro per annual work unit) are quite similar for the UK, Ireland, North-West Germany and the Netherlands. The factors behind these incomes differ between countries. Ireland and the UK have a relatively low milk price. The share of costs directly related to milk production (feed and animal costs) is large due to high concentrate prices and as a result gross margins are low. Costs for buildings and machinery and contract work on the other hand, are low as well as the paid interest, labour and other costs. These low fixed costs can

partly be explained by the full grazing systems in these countries. The other countries, where grazing time is much shorter, realise a higher milk price and better gross margins per kg of milk but on average higher indirect costs (costs for buildings and machinery, contract work, paid interest, labour and other).

The average net farm income in Sweden and Denmark are somewhat lower than in the other countries. Both countries have high direct and indirect costs compared to the other countries. The low income of Danish farms can primarily be attributed to the high interest costs. In Sweden the combination of high cost per litre of milk and small production volumes results in lower incomes.

3 Economic performance of grazing systems in the Netherlands

3.1 Introduction

This Chapter handles more into detail the relationship between the grazing system, farm structure, farm management and the economic performance of dairy farms in the Netherlands. This Chapter gives a comparison between farms with different grazing systems using empirical data of the Dutch FADN sample (Informatienet). The FADN data for the Netherlands contains detailed information on grazing in a way that is not available in the FADN database for other countries. The Dutch FADN data allow a much more in-depth analysis of the situation in this country.

In this analysis different grazing systems are classified on the basis of the percentage of time in summer (May-October) milking cows are grazing. For this analysis all specialised dairy farms (N=210) in the Dutch FADN sample are divided in four different grazing categories:

1. Full grazing: day and night grazing of milking cows for more than 70% of summer months (May-October).
2. Extended Grazing: milking cows graze more than 28% of the time in summer months but do not fulfil the criteria of full grazing.
3. Restricted grazing: milking cows graze between 5% and 28% of the time in summer months.
4. No grazing: milking cows graze less than 5% of the time in summer months.

Furthermore, farms are divided in two different size classes on the basis of milk production (smaller or larger than 600,000 kg of milk equating to approximately 75 cows) to avoid comparing economic performance of farms with very different farm sizes. The data refer to the average for the years 2009 and 2010. Differences between groups were tested on significance using a Student's T test.

When reading this Chapter it should be noted that the absolute income levels are low compared to other years due to the inclusion of the year 2009 in which the average net farm income was -€2,000. In all other years in the period 2001-2011 the average net farm income per unpaid work unit was above €25,000 in the Netherlands (Duurzaamheidlandbouw.nl, 2013).

3.2 Results for small dairy farms

3.2.1 Introduction

As seen in Chapter 2, small dairy farms tend to apply more grazing than large farms. Of the 85 specialised farms in the sample smaller than 600,000 kg of milk, only eight did not apply grazing ('no-grazing' category). Because of the small group size these farms are not included in Table 3.1 and Table 3.2 that present farm structure, farm management and economic performance of the small farms.

Table 3.1 **Differences in farm structure and farm management between small dairy farms (<600,000 kg of milk) with different grazing systems in the Netherlands**

Farm structure and management	**Full grazing (1)**	**Extended grazing (2)**	**Restricted grazing (3)**			
No. of farms	33	24	20	confidence of the differences[b]		
Characteristics[a]				*1-2*	*1-3*	*2-3*
No. of cows	45	54	54	**	**	
No. of ha	32	35	31			
Milk production (* 1,000 kg of milk)	334	422	447	***	***	
Intensity (*1,000 kg of milk per ha)	10	12	15	**	***	***
Milk per cow per year (*1,000 kg)	7,4	7,8	8,3	*	***	*
% grazing hours in summer period	83	48	23	***	***	***
Percentage grassland (% of area)	90	84	81	***	***	
% of farms with AMS	1	9	6			
% of organic farms	5	2	1			
Annual work units (unpaid)	1,2	1,3	1,4	*	***	

a) Appendix 1 gives a technical description of all indicators; b) * 90%; ** 95% ;*** 99%.
Source: Informatienet.

Table 3.2	Differences in economic performance between small dairy farms (<600,000 kg of milk) with different grazing systems in the Netherlands					
	Full grazing (1)	**Extended grazing (2)**	**Restricted grazing (3)**			
No. of farms	33	24	20	confidence of the differences[b]		
Economic performance				*1-2*	*1-3*	*2-3*
Gross Margin (euro/100 kg of milk)	29,2	30,4	29,1			*
Gross margin (euro/cow)	2,161	2,373	2,412	**	***	
Cost price milk (euro/100 kg of milk)	49,7	48,6	50,3			
Modernity of total farm (%)	27	34	37	***	**	
Net Farm Income (euro/annual work unit)	*10.300*	*12.200*	*12.600*			

a) Appendix 1 gives a technical description of all indicators; b) * 90%; ** 95% ;*** 99%.
Source: Informatienet.

3.2.2 Full grazing small farms

Small farms that apply full grazing (33 of 85) have a higher percentage of grassland, less cows and produce less milk than farms with other grazing regimes. Both milk production per hectare and per cow increase with the decline in grazing on small farms. Furthermore, small farms that apply full grazing have a lower modernity compared to the others grazing regimes: these farms have made less investment in buildings and machinery during recent years compared to the other groups. It might be the case that more of these farmers are focused on a low cost strategy due to the absence of a successor but this is not analysed.

The differences in farm structure and management compared to the other groups result in lower gross margins (total revenues minus feed, animal and crop costs, Appendix 2) per cow. When expressed per kg of milk no significant difference in the gross margin could be observed between the full grazing group and the others. However, the lower gross margin does not result in a lower net farm income or higher cost price for the full grazing group as the fixed costs (that are approximately twice as a high as the variable costs) do not differ between the groups (Appendix 3).

3.2.3 Extended versus restricted grazing small farms

extended grazing small farms produce more milk, have more cows, more hectares and more milk per hectare than full grazing small farms. Compared to the restricted grazing group, extended grazers produce less milk per hectare and less milk per cow.

The lower milk production per hectare and the higher grazing percentage of the extended grazers compared to the restricted grazing group, result in a higher gross margin per kg of milk. This difference can, to a large extend, be explained by the lower feed costs on the extended grazing farms (Appendix 3). Given the fact that the restricted grazers produce more milk per hectare, these lower feed costs could be expected. When expressed per cow, there is no difference in gross margin between extended and restricted grazing small farms.

The higher gross margin of the extended grazers per kg of milk compared to the restricted grazers does not result in a higher farm income or a lower costprice of the milk due to the fact that the fixed costs (energy, buildings, machinery, interest, rent, paid labour, contract work and other, Appendix 3) are numerically (not significantly) lower for the restricted grazing group.

Also the modernity[1] does not differ between the two groups indicating that there have not been more investments in recent years, in one of the groups.

3.3 Results for large dairy farms

3.3.1 Introduction

Compared to the small farms, full and extended grazing is applied less frequently at large dairy farms. Full grazing is applied at only 6% (8 of 125) of the farms and due to the small group size these farms are not considered in the analysis. Most of the large dairy farms in the sample (70%) continued to apply grazing to some extent. Extended grazing is applied at 29 of 125 (23%) of the large dairy farms and restricted grazing at 50 out of 125 (40%).

[1] Modernity is calculated as the balance sheet value of the total farm divided by the replacement value of the total farm.

3.3.2 Non-grazing large farms

At 30% (38 out of 125) of all the large dairy farms no grazing is applied. These farms have more cows and produce more milk per farm, per cow and per hectare than the grazing farms. Furthermore, a larger share of these farms has an automatic milking system (AMS) and the average percentage of grassland is lower. Compared to the extended grazers, the no-grazers have a higher modernity, indicating that they have made more investments in recent years, most likely indicating recent farm expansion and/or intensification.

Table 3.3 **Differences in farm structure and farm management between large dairy farms (>600,000 kg of milk) with different grazing systems in the Netherlands**

Farm structure and management	**Extended grazing (2)**	**Restricted grazing (3)**	**No grazing (4)**	confidence of the differences[b]		
No. of farms	29	50	38			
Characteristics[a]				*2-3*	*2-4*	*3-4*
No. of cows	111	107	127			*
No. of ha	70	58	63	**		
Milk production (* 1,000 kg of milk)	904	885	1.129		*	**
Intensity (*1,000 kg of milk per ha)	13	15	18	**	***	**
Milk per cow per year (*1,000 kg)	8,1	8,3	8,9		***	***
% grazing hours in summer period	44	20	1	***	***	***
Percentage grassland (% of area)	84	81	74	*	***	**
% of farms with AMS	6	15	31		**	*
% of organic farms	1	1	0			
Annual work units (unpaid)	1,8	1,6	1,7	**		

a) Appendix 1 gives a technical description of all indicators; b) * 90%; ** 95% ;*** 99%.
Source: Informatienet.

Appendix 3 shows that the non-grazing group realises lower animal costs (veterinary and artificial insemination) compared to the restricted grazing group. However, both total variable and total fixed costs are not significantly different compared to the restricted grazers. Furthermore, there is not any significant

difference in economic indicators presented in Table 3.4 between the no grazing group and the restricted grazing group.

Table 3.4 **Differences in economic performance between large dairy farms (>600,000 kg of milk) with different grazing systems in the Netherlands**

	Extended grazing (2)	Restricted grazing (3)	No grazing (4)	confidence of the differences[b]		
No. of farms	29	50	38			
Economic performance				*2-3*	*2-4*	*3-4*
Gross Margin (euro/100 kg of milk)	29,7	27,2	26,5	**	*	
Gross margin (euro/cow)	2,413	2,256	2,358	*		
Cost price milk (euro/100 kg of milk)	43,2	44,7	43,0			
Modernity of total farm (%)	36	42	47		**	
Net farm Income (euro/annual work unit)	*29,000*	*5,500*	*2,000*	***	**	

a) Appendix 1 gives a technical description of all indicators; b) * 90%; ** 95% ;*** 99%.
Source: Informatienet.

Compared to the extended grazers, the net farm income per annual work unit of the non-grazing group is significantly lower (2,000 versus 29,000 euro). Appendix 2 shows that these differences can be attributed to lower revenues from other output (such as the CAP premium, nature conservation, farm activities for others), higher costs for contract work and higher total fixed costs (energy, buildings, machinery, interest, rent, paid labour, contract work and other). The higher other output results also in a higher gross margin expressed per kg of milk. When expressed per cow there is no difference in gross margin between the non-grazing and the two grazing groups.

Appendix 3 shows highly significant lower unpaid costs for labour and capital for the non-grazing group compared to the extended grazing group. Due to these higher unpaid costs, the cost price of milk appears to be equal between these groups.

3.3.3 Extended versus restricted grazing large farms

Compared to the restricted grazers, the extended grazers have more hectares, a lower milk production per hectare and a higher percentage of grassland. Furthermore, these farms have a significantly higher number of unpaid annual work units (Table 3.3).

The extended grazers clearly realise a higher net farm income than the restricted grazing farms (€29,000 versus €5,500). This can be attributed to 1) higher revenues from other output (such as the CAP premium, nature conservation, farm activities for others), 2) lower feed costs (which can partly be explained by the lower production per hectare) and 3) lower costs for contract work and 4) lower total fixed costs (energy, buildings, machinery, interest, rent, paid labour, contract work and other). Due to the higher revenues and lower feed costs, the extended grazers also realise a higher gross margin, both per kg of milk and per cow, compared to the restricted grazing group.

Furthermore, Appendix 3 shows significant higher unpaid costs for labour and capital for the extended grazing group compared to the restricted grazing group. Due to these higher unpaid costs, there is no significant difference in the cost price of milk between the two groups.

Cows grazing in the Netherlands

3.4 Discussion and comparison with other research results

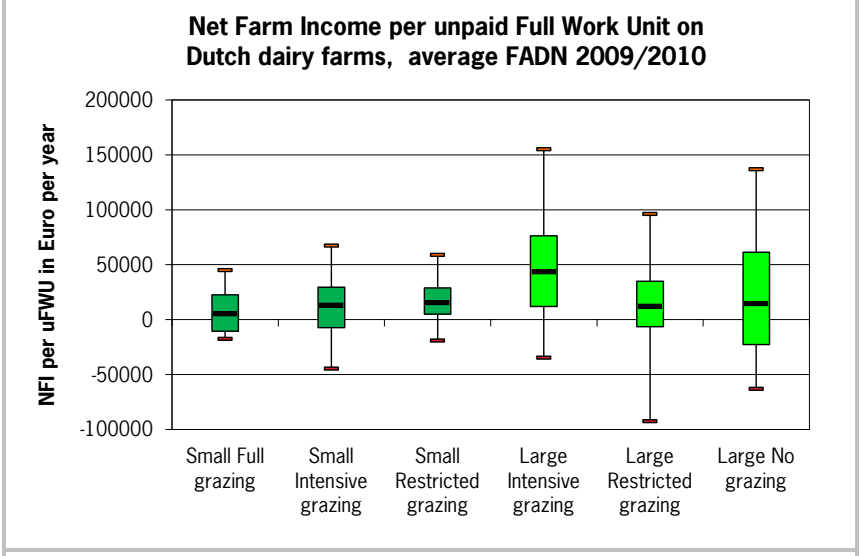
This study shows that on farms that produce more than 600,000 kg of milk per year, the farms that apply extended grazing on average have higher net farm incomes than the farms that apply no grazing or restricted grazing. The higher income for extended grazers can be explained by a combination of: 1) a higher revenue from output other than milk and animals, 2) lower feed costs, 3) lower costs for contract work and 4) lower total fixed costs (costs for energy, buildings, machinery, interest, rent, paid labour, contract work and other).

On farms that produce less than 600,000 kg per year, no significant differences in farm income between different grazing groups could be observed. It should be noted that within this category, the group that did not apply grazing was too small to take into account. So, all included farms applied grazing to a certain extent. The grazing system used (full, extended or restricted) appeared not to be a decisive factor in the net farm income. Apparently, other aspects of farm management or structure play a more important role.

Although the net farm income for the extended grazing farms compared to the other groups is significant and substantial, it does not imply that grazing always results in a better economic performance. Figure 3.1 shows that the variation within the groups is large and that both high and low levels of income are present in all groups. In all six analysed groups, the 25% farms with the lowest income, had an average income below or close to zero in these years. In all six groups the difference between the 25% best and 25% worst performing farms is more than €23,000 per annual work unit. The variation in income between 25% best and worst performing farms is largest on the extended grazing large farms (more than €60,000). The variation in income between the 5% best and worst performing farms is in all groups even more than €60,000. The group of non-grazing large farms shows the largest extremes: the difference between the 5% best and 5% worst performing farms amounts up to €170,000 per annual work unit.

The results clearly show that both, grazing and non-grazing can, when properly managed, result in high farm incomes. This confirms statements from accountants (Van den Pol-van Dasselaar and Den Boer, 2012) that income differences are larger between different type of farmers than between grazing systems.

Figure 3.1 **Variation in farm income per annual work unit**



Source: Informatienet.

Positive effects of grazing on economic performance of dairy farms has been reported by several authors (Tozer et al., 2003; Evers et al., 2008; Van den Pol-Van Dasselaar et al., 2013). Model studies from Evers et al. (2008) showed that in general farm income was higher with grazing compared to non-grazing. The advantage of grazing depends on the farm structure. In Evers et al. (2008) grazing appeared to have an income advantage ranging from €0.00 to €2.00 per 100 kg of milk in most situations. Only when there is too little grazing paddock available for sufficient grass intake, grazing shows poorer results than non-grazing. Evers et al. (2008) showed a clear relation between fresh grass intake and the economic advantage of grazing. The modelling results of Evers et al. (2008) were recently confirmed by Van den Pol-Van Dasselaar et al. (2013). They state that also with the expected future trends (regulation, expansion, intensification and more AMS) in the Netherlands grazing will remain economically attractive and that an important key indicator for the economic success of grazing will be the daily fresh grass intake per cow.

Model studies such have the disadvantage that they contain assumptions on farm relations. There is no guarantee that these assumptions are reflecting consistent real farm situations. To overcome drawing false conclusions it seems wise to also look at empirical farm data as is done in this chapter. However, also such comparisons of group averages of on-farm data have their

shortcomings. Effects of other aspects of farm management (or structure) are not taken into account nor interactions between these factors. Van den Pol-Van Dasselaar et al. (2013) recently also used statistical techniques that take effects of other farm aspects into account to analyse the effect of grazing on farm income and technical efficiency. They also concluded that both economic efficiency and farm income on average are higher with grazing but that this positive relation decreases with farm size and the use of an AMS. For larger farms and farms with an AMS the economic benefits of grazing appear to be more difficult to realise. The results of the current study (no difference on small farms, significant difference on large farms) might seem to contradict with their conclusion that it is more difficult to realise economic benefits of grazing for larger farms. This is, however not a real contradiction because we did not compare grazing with non-grazing but different categories of grazing. In fact, assuming that grazing hours are closely related to the fresh grass intake, our results on the large farms are in line with the conclusion that substantial fresh grass intake is a crucial factor to realise the economic benefits of grazing. It might be assumed that extended grazers realise a higher grass intake compared to the restricted grazing group.

Appendix 3 showed that the higher farm income can partly be attributed to higher revenues from output other than milk and animals. Such differences will not be taken into account by the modelling study of Van den Pol-Van Dasselaar et al. (2013) as they probably only compare situations with the same output. Whether this higher other output is a typical characteristic of the grazing system or coincidental economic benefit that farmers that apply extended grazing appear to realise, is an interesting question for additional research.

3.5 Conclusions

- On large farms, those that apply extended grazing have on average a higher net farm income than those that apply no grazing or restricted grazing.
- The higher income for extended grazers can be explained by a combination of: 1) higher revenues from output other than milk and animals, 2) lower feed costs, 3) lower costs for contractwork and 4) lower total fixed costs.
- Compared to the extended grazers, the no-grazers have a higher modernity, indicating that they have made more investments in recent years, most likely indicating recent farm expansion and/or intensification.
- On small farms, no significant differences in farm income between different grazing groups could be observed. All included farms applied grazing to a

certain extent. Apparently, other aspects of farm management or structure than the grazing system play a more decisive role in the net farm income in this category.

- Although the net farm income for the extended grazing farms compared to the other groups is significantly and substantially larger, it does not imply that grazing always results in a better economic performance. Figure 3.1 shows that the variation within the groups is large and that both high and low levels of income are present in all groups. Both, grazing and non-grazing can, when properly managed, result in high farm incomes.
- The findings in this study confirm the findings of Van den Pol-Van Dasselaar et al. (2013) that also for large farms grazing can have economic benefits and that the amount of fresh grass intake is a crucial factor to realise these advantages.
- Whether this higher revenue from output other than milk and animals is a typical characteristic of the extended grazing system or coincidental economic benefit that farmers that apply extended grazing appear to realise, is an interesting question for additional research.

4 Future developments in grazing

4.1 Introduction

This Chapter is based on the results of the interviews with local experts of the six selected regions/countries. The experts were asked for:
1. Strengths and weaknesses of grazing on various topics.
2. Expected trends and their effect on grazing on various topics
3. Instruments to stimulate grazing

The answers given by the experts are summarised in tables in Appendix 2. The results are discussed in this chapter. This Chapter ends with a summary of strengths, weaknesses, threats and opportunities (SWOT) of grazing in North-West Europe.

4.2 Strengths and weaknesses of grazing

Economic farm performance (Table A2.3)
With respect to economic farm performance, two main advantages of grazing compared to non-grazing can be extracted from the interviews:
- Higher profits due to lower costs for feed production;
- Higher profits due to lower costs for housing.

The extent of the latter advantage depends largely on the potential length of the grazing season. When the potential length of the grazing season is short (e.g. Denmark and Sweden) the second advantage loses importance as the period where cows need good housing increases. The first advantage has been corroborated by a number of research studies (eg. Evers et al., 2008; Hoving et al., 2013).

The main disadvantages of grazing, mentioned by the experts, can be summarised as:
- Lower milk prices due to seasonality of production and reliance on export markets.
- Lower yields and profits per cow and per hectare.
- Not enough controllability of the production volume.
- Too laborious.

The first disadvantage is typical for the situation in Ireland and partly the UK where the seasonal calving pattern implies that no year round milk production can be guaranteed. The other three are mainly mentioned in the regions where less grazing is applied (Denmark, Sweden, Germany).

Animal health and welfare (Table A2.4)

Advantages of grazing compared to non-grazing on animal health and welfare can be summarised as: 1) A higher expression of natural behaviour; 2) Fitter cows due to more exercise; 3) Better hoof health and wound healing; 4) Higher fertility and 5) Lower infection risks (Table A2.4). Some of these aspects eventually depend on the quality of the housing for all housing systems. Though innovations in modern housing systems might overcome some of the disadvantages of no grazing and restricted grazing systems rapidly, good opportunities to express natural behaviour (grazing, fleeing, playing, unrestricted lying and standing etc.), will always be better and easier to achieve in the field compared to the stables.

The mentioned disadvantages (not enough energy intake in peak lactation, weight loss in autumn, unbalanced diets, heat stress in summer) are valid indicators of exposure to natural conditions and variability when grazing. In the Irish full grazing system these disadvantages are successfully addressed by breeding cows with a low genetic potential for milk production and by a full adaptation of the seasonal calving profile, making sure that cows have their peak lactation during the most favourable grazing conditions in spring. In the restricted grazing system (e.g. the Netherlands) these disadvantages are addressed not by changing the cows and calving pattern but by supplemental energy feeding and giving cows shelter in a good barn in harsh weather conditions.

Farm organisation and labour (Table A2.5)

Table A2.5 is probably an important one in explaining the trend of decreased grazing in Europe. In the countries where grazing is decreasing (Netherlands, Germany, Denmark) the experts hardly mention any advantages of grazing with respect to farm labour and organisation. On the other hand, the disadvantages of grazing with respect to farm organisation and labour are clearly shared among the experts. They can be summarised as:

- grazing management requires higher management (planning) skills;
- grazing reduces controllability;
- grazing is more laborious (when poorly planned) and

- it's more difficult to implement an AMS with grazing (though opinions vary on this one also within this group of experts).

Expanding and intensifying the milk production increases the pressure on the dairy farmer to manage his/her farm more economically efficient. Grazing management is one of the tasks that is relatively easy excluded compared to other tasks. One of the Dutch experts phrased this perfectly: 'the non-grazing system is just prolonging the winter management'. When a farmer decides to keep his cows inside, the summer cow management is very similar to the winter management. With grazing an extra dimension is added to the management in summer.

The advantages mentioned in the grazing countries (Ireland, UK) mostly relate to the seasonal calving pattern. The only mentioned advantage not directly related to the seasonal calving pattern is the fact that less work is required in the barns (bedding, feeding and scraping).

Other social aspects (Table A2.6)

The last topic dealt with was other strong or weak social aspects of grazing. The Irish answers refer mainly to dairy as a whole instead of grazing per se. Most of the experts recognised grazing as either an important tradition or important for a good image/perception of dairy farming by society. Consumers and citizens claim that cows should be allowed to graze to exploit natural behaviour. The Danish expert added that this value is not recognised by a large share of the farmers. The Dutch experts mentioned that personal values and preferences of farmers are very decisive in the choice whether to graze or not. Farmers that decide to graze usually get more satisfaction out of working in the field whereas non-grazers usually get their satisfaction from good cow records (high production per cow) and having control over the situation.

4.3 Instruments to stimulate grazing

Instruments and initiatives to stimulate grazing mentioned by the experts are presented in Table A2.7 and can be divided into the following categories:

Milk price incentives

Dairy companies in the Netherlands are stimulating grazing by grazing premiums. In the Netherlands a grazing premium has been applied by CONO since 2002. Friesland Campina (75% of the milk) introduced the grazing premium in 2009. In that year the premium amounted up 0.05 eurocent per

litre. In 2012 the premium was increased to 0.50 eurocent per litre for farms that apply grazing for at least six hours per day during 120 days. CONO increases the premium to one eurocent per litre in 2013. Most other dairy companies are following these examples and introduce a grazing premium for their members in 2013 or 2014. All dairy companies are putting effort to realise the goal of the Convenant Weidegang to maintain the current level of grazing in the Netherlands. For more information we refer to *Voortgangsrapportage Convenant Weidegang* (in Dutch).

In North-West Germany, the company Ammerland-Oldenburg also provides a grazing premium for farms that apply grazing for more than more than six hours a day during 120 days. This premium is still limited to €200 per farm per year.

In Denmark and Sweden additional payments apply only to organic concepts with grazing as one of the criteria.

Regulation on grazing

In Sweden grazing is mandatory for all dairy farms. This is regulated via the Swedish Animal Welfare Law since 1987. Furthermore, grazing is mandatory for organic farms in Sweden and Denmark. The latter is probably also the case for the other countries but was not mentioned by the experts.

Other regulations

In the Netherlands legislation on ammonia emission and subsidies for new housing are more favourable for dairy farms that apply grazing compared to non-grazers. Such regulations are not recognised as crucial by the experts in the other countries.

Knowledge development

In Ireland, England and the Netherlands research programmes have been started to stimulate knowledge development on grazing. Projects are focused on technological improvement such as better nutritional analysis of fresh grass, predictive tools grassland yield, improved yield estimation, automatic grass supply estimation but also on supporting farmers to improve their grazing management either by providing benchmark data or by stimulating knowledge exchange between farmers and advisors.

CAP reform

A topic that was not asked for in the interviews nor mentioned by the experts, but maybe interesting enough to mention here, is the current CAP reform. Part of the European Commission's 2011 proposal on the CAP towards 2020, is the

requirement that 30% of direct payments (the CAP's so-called first pillar) be linked to farmers' environmental performance - such as diversifying crops, leaving up to 7% of land uncultivated to promote biodiversity, and creating permanent pastures. At the writing of this report discussion and negotiations are still going on. It is likely that the greening requirements will be made more flexible than in the Commission's original plan. Small farms might be exempted and 'medium'-sized farmers (e.g. farmers having 10-30 hectares of pasture) might be also given a different treatment. An option to consider is that well-defined alternative measures, given that they are 'equivalent' and certified, might provide alternative options to fulfil the greening requirement. As part of such an arrangement a grazing requirement for specific groups of dairy farmers might be an option. Although further research is necessary, there is some evidence that grazing will affect biodiversity in a positive way as compared to pasture where the grass will be removed after mowing. Moreover, given the interest of the public and the private sector that is already existing in some (regions of) member states, further development of such a requirement might be attractive. Such a grazing option might be particularly interesting for medium sized dairy farms.

4.4 Expected developments towards 2025

4.4.1 Expected trends and effect on grazing

This Section presents, on a number of topics, the trends that local experts expect to happen towards 2025 and how they think this will influence grazing in their country/region. The results are summarised in Table A2.8 and discussed for each (group of) topic(s) below.

Milk prices

Most experts expect a relative decrease of the milk price compared to the cost level and more fluctuation in the milk price. In all countries except for Denmark this trend is expected to increase grazing as farmers search for low cost strategies such as grazing. The Danish expert expects that this trend will decrease grazing as it will stimulate growth in size and intensification of dairy farms.

Feed prices
With regard to the prices of feed, all experts expect that they will increase more rapidly than inflation. Increased feed prices are expected to increase grazing in countries with lower productivity per hectare (IRL, UK, NW-G, SW). In the countries with higher productivity per hectare (Netherlands, Denmark) the opposite trend is expected. The latter experts reason that prices for roughage and concentrates are strongly connected and that non-grazing systems realise higher grassland yields.

Costs for labour, capital and technology
Except for Sweden and Ireland, the experts expect that the costs for labour, capital and technology will go up towards 2025 and that this will decrease the amount of grazing. The underlying mechanism must be that increased costs for land, capital and technology will further encourage scale enlargement and intensification.

Technological innovation
Two major trends are recognised by the experts: 1) increased technology in housing systems will decrease the amount of grazing (UK, NL, Germany) and 2) further development or introduction of the Automatic Milking System (AMS). This second trend is expected to decrease grazing in the UK, Netherlands and Denmark as it might be difficult to combine grazing with an AMS. In Sweden where a percentage of cows are still tethered, the introduction of AMS is expected to increase grazing. This is because AMS is simultaneously installed with the introduction of free barns which simplify grazing management in comparison with tethering. The Irish expert expects no effect of the introduction of the AMS on grazing. He reasons that it will only be introduced in Ireland when it fits the current grazing system.

Farm expansion
Most experts expect an on-going trend in farm-expansion. The general effect of increased farm expansion on grazing is negative. Decisive factors in this are the decreasing availability of grazing area per cow around the farm, the higher complexity of the management on grazing farms and the larger labour requirements for grazing. In the UK and the Netherlands also some interesting positive effects of farm expansion on grazing are mentioned. In the UK it is observed that expanding farmers buy more farm locations per farmer to maintain enough grazing fields. In the Netherlands it is also expected that farm expansion will result in more specialisation: dairy farmers could contract out the feed

production to arable farmers or the feeding of the cows to contract workers and then specialise themselves in grazing and cow management. On farms where the feeding is contracted out, restricted grazing will become more interesting.

Public debate

The public debate is only mentioned as a determining future trend on grazing in England and the Netherlands. In the Netherlands this debate is quite strong and many parties are involved. Several companies have launched large commercials to boost the image of dairy products with grazing as one of the trump cards. Stichting Weidegang actively promotes 'preservation of the current level of grazing'. The largest share of the dairy industry has joined in by signing up the 'Convenant Weidegang'. The debate amongst dairy farmers about this 'Convenant' is very strong. The Dutch experts expect that this development will have a restraining influence on the decrease of grazing in the future. In England grazing is not a major issue in the public debate. In England there is also a debate recognised about the negative side of grazing cows. For example during heavy rain periods: is it acceptable to have large herds of dairy cows standing with their feet in the mud? In the UK the scale of dairy farms sometimes is a point of discussion like in the case of a proposed large-scale farm (8,000 cows) to be established in Nocton. Grazing was however only one among other points in this discussion (http://en.wikipedia.org/wiki/Nocton_Dairies_controversy)

Environmental issues

The experts agree upon the fact that environmental issues will demand a continuously improvement of the nutrient management efficiency. Whether this will have a negative or a positive effect on grazing is difficult to predict. Some grazing aspects are positive (ammonia), some negative (utilisation of manure, nitrate), some unknown or difficult to unravel (greenhouse gas emissions).

Animal health and welfare

Some experts mention that cows are perceived to be healthier when grazing and that this perception might increase grazing in the future as there will be an increased awareness on these issues. Most of the experts add to this that grazing does not result in reduced veterinarian costs.

Competing claims

In countries with an extended production where soils can also be used for other purposes than grassland (NL, DK), the experts recognise that competing claims might increase the demand for land and therefore reduce grazing. In Ireland it is

stated that grazing is and will be the most profitable system given the circumstances.

Attitude dairy sector towards grazing
Three arguments are used here: 1) grazing will become a popular strategy for dairy farmers to survive in the coming periods with low milk prices (see milk price) and this will increase grazing; 2) more extreme weather conditions will change the positive attitude of farmers towards grazing which will decrease grazing and 3) a large part of the new generation of farmers is not educated with grazing as the traditional system. They lack knowledge and traditional values on grazing management which will decrease grazing.

Knowledge on grazing management
The experts in the UK and the Netherlands mentioned development of knowledge on grazing management as a crucial factor in the future of grazing. They could not tell if this would turn out positive or negative. The German expert believed that knowledge on grazing management is declining and that will result in a decrease of grazing.

Organisation of the dairy chain
In Ireland and the UK, the experts recognise the attempts of the dairy industry to search for new products and markets for dairy products from pasture which might increase grazing. In the Netherlands and to a minimal extent in North-West Germany, dairy industry is giving a grazing premium to stimulate grazing. The experts expect that this will restrain the decline in grazing. In the UK such a premium does not exist but if it did, the experts believed it should make a difference in the decision of the farmer to graze.

Other issues
In North-West Germany salination of surface water is recognised as a threat to grazing.

4.4.2 Expected development of grazing towards 2025

After giving their opinion on the expected trends towards 2025, the experts were asked to make an estimate on how the distribution of milk and cows over the three grazing systems would look like in their region/country in 2025. These figures are presented compared to their estimate of the current situation.

The Irish expert expects that in 2025 all farmers are still working with the current full grazing system. There is a general consensus that this is the most profitable system and the whole infrastructure is organised according to it. The estimate is that in 2025 100% of the cows will still graze in Ireland. In the UK the experts expect that the three different systems will remain. The expert in Northern Ireland thinks that the number of farmers with full grazing will decrease in favour of the number of non-grazing farms. The English expert predicts a decrease of the restricted grazing system in favour of the two extremes. The estimate is that 50% of the cows in Northern Ireland and 75% of the cows in England will still graze in 2025.

Table 4.1 **Expected development of grazing from 2012 to 2025 (based on expert knowledge) in 6 different EU countries**

Country/ Region	Characteristics	Full or extended grazing	Restricted grazing	No grazing
Ireland	% of farms	100 -> 100		
(N=1)	% of dairy cows	100 -> 100		
Northern Ireland	% of farms	58 -> 30	30 -> 30	12 -> 40
(N=1)	% of dairy cows	44 -> 20	35 -> 30	21 -> 50
England	% of farms	28 -> 35	60 -> 45	12 -> 20
(N=1)	% of dairy cows	20 -> 27	62 -> 48	18 -> 25
Netherlands	% of farms	14 -> 8	66 -> 60	20 -> 32
(N=2)	% of dairy cows	10 -> 3	62 -> 52	28 -> 45
North-West Germany	% of farms	25 -> 5	35-> 0	40 -> 95
(N=1)	% of dairy cows	15-> 2	35 -> 0	50 -> 98
Denmark	% of farms	5 -> 5	30 -> 20	65 -> 75
(N=1)	% of dairy cows	4 -> 3	26 -> 17	70 -> 80
Sweden	% of farms	12 -> ?	88 -> ?	0 -> ?
(N=1)	% of dairy cows	13 -> ?	87 -> ?	0 -> ?

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

The Dutch experts expect that the number of grazing farms (both full and restricted grazing) will show a limited decline in favour of the non-grazing farms. The average estimate is that 55% of the cows will still graze in the Netherlands in 2025, mostly in the restricted grazing system. The German expert expects an almost complete disappearance of grazing. He thinks that in 2025 less than 5% of the cows will be grazing in North-West Germany. The Danish expert expects that there will be a further decline in grazing (both full and restricted

grazing) in Denmark. His estimate is that in 2025 20% of the cows in Denmark will still graze. The Swedish expert did not predict the percentage of grazing cows in 2025. Whether grazing will decrease in Sweden will mainly depend on the development of the legislation on this topic.

4.5 Summary of the SWOT analysis

Table 4.2 summarises strengths, weaknesses, threats and opportunities that have been presented in the previous sections of this Chapter. Strengths and weaknesses in this table are derived from Section 4.2 whereas the threats and opportunities were presented in Section 4.4.

Table 4.2	**Summary of strengths, weaknesses, threats and opportunities of grazing in North-West Europe (based on expert judgement) insix EU countries)**
STRENGTHS - Low costs for feed production - Low costs for housing (when grazing season is long) - Better opportunities for cows to express natural behaviour - Better image of dairy farming through visibility in the landscape - Improved cow health and fertility through lower production (depends on conditions) - Farmer is working more in the field (depends on farmer preference)	**WEAKNESSES** - Grazing requires additional management and organisational skills - Grazing reduces controllability of management due to greater dependence on weather conditions - Lower grassland yields per ha and less efficient feed production (depends on conditions) - Animal health problems due to unbalanced diets and harsh weather conditions (depends on conditions) - Lower yields per cow. Usually not popular amongst farmers

Table 4.2 (continued)	Summary of strengths, weaknesses, threats and opportunities of grazing in North-West Europe (based on expert judgement) insix EU countries)
OPPORTUNITIES	**THREATS**
- Grazing as a low cost survival strategy in times where farmers have to deal with low milk prices and high costs - Dairy industry is introducing or considering price premiums - New ways of specialisation that creates new opportunities for grazing. - Technological innovation and education on grazing - Part of the farmers have more fun and get more satisfaction out of working in the fields	- Intensification and expansion of farms - Poor field allocation - Lack of knowledge and skills for efficient management on large farms - Technological innovation on housing systems - In some countries competition over land - Climate change will result in more extreme weather conditions - Young farmers lack knowledge, support and traditional values to maintain grazing
Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.	

Strengths of grazing

The key strength of grazing lies in its lower costs structure and therefore potentially higher profits per litre of milk. This consists of two aspects. Firstly, feed costs of production can be lower because cows harvest the grass in the field themselves. Secondly, costs for housing can be lower because cows spend less time inside, especially when the grazing season is long.

Grazing is often associated with a positive image and better perception of dairy farming from citizens and consumers as cows are visible in the landscape, Whether this is also an advantage for the farmers and the dairy industry is an interesting subject of debate with many different ways of thinking. As the cows are more outside, also the labour for the farmer is more out in the field. Whether this is a strong aspect depends on the personal preferences of the farmer.

Another important strength of grazing is that cows have more opportunity to express natural behaviour grazing in the fields and might be fitter as they have more exercise. These effects might also improve the health of the cows but that depends on the conditions in the stables. Cows in (full) grazing systems often are bred to produce less milk per animal. This can improve fertility and reduce disease incidence (negative energy balance, mastitis, hoof health).

Weaknesses of grazing

The key weakness of grazing lies in the lower controllability of the management. Grazing management is often an extra organisational dimension and more

difficult to plan because it is dependent on weather conditions. In the rapidly changing industry new knowledge and skills are required to manage grazing systems efficiently. In most of the countries, this knowledge development seems to lag behind. Therefore, the economic advantages that grazing offers are not always realised in practice.

Grazing often results in lower yields per hectare. In general, feed production will be less efficient as manure cannot be distributed evenly. Due to more complicated grassland management time and money required for feed production per kg dry matter is sometimes higher than in the no-grazing situation. Whether the lack of controllability is also perceived by the farmer as a weakness depends on personal preferences. Grazing often results in lower yields per cow which is not popular among some farmers.

In full grazing systems, it is difficult to make sure that cows receive balanced diets and enough energy intake to maintain high milk production levels, especially during harsh weather conditions. When the cows are not adapted to this situation and/or not managed properly, this can result in serious animal health problems.

Threats to grazing

The trend of intensification and expansion of farms is probably the most important threat to grazing, mainly due to two mechanisms: 1) the fact that there is often not enough land available near the farm where cows can graze and 2) grazing requires additional management and organisational skills and reduces the controllability of the management.

In most countries the new generation of farmers has not been educated with the tradition of grazing. Young farmers might lack knowledge, support and traditional values to maintain grazing. Furthermore, technological innovation, especially improvements in housing that will reduce the disadvantages of the non-grazing system with respect to animal health and welfare.

In countries with intensive production and possibilities for the production of crops other than grassland, competition over land will drive up prices for land which will stimulate further intensification. This might be a threat to grazing as yields per ha are often higher with non-grazing systems

Climate change will result in more extreme weather conditions. This is a threat to grazing as it can result in damage to soil and grass swards. Farmers might be more willing to switch to the non-grazing system. More extreme weather conditions might also result in poorer conditions for the cows in field.

Opportunities for grazing

An important opportunity for grazing is its low cost structure, especially in times where farmers have to deal with low milk prices and high prices. Grazing might be used by farmers as a low cost survival strategy.

Furthermore dairy industry and governments are increasingly recognising grazing as an important precondition for natural behaviour of dairy cows and for social acceptance of dairy farming and are introducing or considering price premiums.

Expanding farms are finding out new ways of specialisation that creates new opportunities for grazing. Examples are to contract out all crop production and feeding so that the dairy farmer can focus on cow management and grazing.

Part of the farmers have more fun and get more satisfaction out of working in the fields. Technological innovation and education on grazing, for instance large projects on the implementation of robots in Ireland, cow separation techniques, sophisticated planning tools with weather forecasts, better estimation of nutritional value of fresh grass might help farmers with the development of time-efficient grazing systems.

5 Modelling the Dutch situation in 2025

5.1 Introduction

The objective of this chapter is to study in more detail developments in grazing in the Netherlands under different scenarios towards 2025. More precisely the goals of this Chapter are:

- 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 Chapter 4, literature search and statistics.
- Study the sensitivity of milk production and grazing to increases in milk and feed prices.
- 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 dairy sector, by dividing dairy farms in different types (or technologies). A general description of DRAM and some technical details and assumptions can be found in Appendix 3.

Section 5.2 describes the current situation in the dairy sector in the Netherlands, entitled for the purpose of this report as the baseline. In Section 5.3 the situation for 2025 is projected based on a scenario where policies remain unaltered.

Section 5.4 explores the effects of four different policy options and scenarios on grazing towards 2025 on the structure of the Dutch dairy sector and grazing. These scenarios are presented as 'grazing scenarios' and use input of Section 4.3 (instruments to stimulate grazing).

Section 5.5 presents a discussion and conclusions.

5.2 Current situation in the Dutch dairy sector - Baseline

5.2.1 Methodology

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.

Technical economic variables per cow per type are based on individual farm data from the Dutch Farm Accountancy Data Network (FADN), accounting year 2010. It should be noted that in Chapter 3 the average of 2009 and 2010 was used. Individual FADN data from specialised dairy farms are aggregated to eight farm types. The number of dairy cows per type are taken from the agricultural census data for 2011. Shares found in FADN are used as the key to distribute the total number of dairy cows to the different types in DRAM.

These two sources of data, FADN and agricultural census, are combined to express the current situation entitled in this study as the baseline scenario 2010/2011. Note, that DRAM does not calculate number of farms of a certain type, but number of cows per type.

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. See Appendix A3.2 for further elaboration on this. For the purpose of a clear presentation the eight categories are combined to four different grazing regimes:

- Full or extended 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).

Compared to Chapter 3 the category restricted grazing is split into two categories: restricted and very restricted grazing. 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 (Section 5.4). Table 5.1 shows some selected data used in DRAM for the baseline 2010/2011.

Average gross margin per cow per type - calculated subtracting specific costs from the total revenue - is an indicator for farm profitability in DRAM. In this Chapter we will not look further into the differences in economic performance between different farm types than gross margin. Differences in fixed costs will not be taken into account.

5.2.2 Results

Table 5.1 shows that, in line with the data presented in the previous chapters, 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.

Table 5.1 Characteristics of the Dutch Dairy sector in the DRAM baseline (2010/2011)

Characteristics of dairy sector	Full or Extended 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: Informatienet, Agricultural census, processed by LEI Wageningen UR.

As seen also in Chapter 2 and Chapter 3, 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 extended grazing (4.1m tonnes). Roughly two-thirds of the cows ((540 + 402)/1469) graze more than 720 hours.[1]

[1] 720 hours corresponds to at least six hours during 120 days which is the definition of grazing according to the Dutch Convenant Weidegang.

5.3 Standard scenario 2025

5.3.1 Assumptions

To project a standard scenario for the year 2025 we assume a set of technical and economic developments in the Dutch agricultural and dairy sectors as given by Berkhout et al. (2011), with some adjustments. In our study the milk production per cow increases 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). The distribution of the total milk production over the different types of dairy cows in 2025 is determined following a set of steps described in detail in Appendix 4.

5.3.2 Results

Structural changes

Results with respect to the structure of the Dutch dairy sector and technical variables per type of dairy cow in the standard scenario 2025 are presented in Table 5.2. 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 (see Appendix 5). 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 increases from about 1.7 to 1.8 cow per ha.

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. Gross margins per kg of milk decrease sharply compared to the baseline scenario.[1]

[1] Note that results of the standard scenario 2025 is based on assumptions related to current developments and model calibration techniques (Appendix 3), not on model simulation with DRAM. Average gross margin per dairy cow in the standard scenario 2025 is not the driving factor, but the result of assumptions and model calibration.

Table 5.2	Characteristics of the Dutch Dairy sector per grazing regime in the standard scenario (2025)				
Characteristics of dairy sector	**Full or extended grazing**	**Restricted grazing**	**Very restricted grazing**	**No grazing**	**Total dairy sector**
Milk per cow (*1,000 kg)	8.5	9.1	9.5	9.6	9.4
Dairy cows per ha (# cows per ha)	1.5	1.8	1.8	1.9	1.8
Milk per hectare (*1,000 kg)	12.6	15.9	16.9	17.7	16.6
Total Milk Production (*1,000 tonnes)	1153	2931	2124	7043	13250
No. of cows (*1,000)	135	323	223	731	1412
Grassland and forage crops (*1,000 ha)	92	185	126	397	799
Grazing time in May-Oct (hours)	2587	1037	518	18	575
Gross Margin per cow	2174	2229	2137	2243	2216
Gross Margin per 100 kg of milk	25.5	24.6	22.5	23.3	23.6

Source: Informatienet, Agricultural census, processed by LEI Wageningen UR.

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.

Changes in grazing

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 (Table 5.2). 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 5.3).

Average grazing time in May-Oct in the Netherlands decrease from 1282 hours in the baseline 2010/2011 to 575 hours in 2025. The percentage of milk from cows that graze to a certain extent will drop from 71% to 47%. When the current grazing definition of Stichting Weidegang is used, the percentage of grazing cows will drop from 64.1% to 32.6%.

Table 5.3 **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 extended grazing	Restricted grazing	Very restricted grazing	No grazing	Total dairy secto
% 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: Informatienet, Agricultural census, processed by LEI Wageningen UR.

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).

It should be noticed that 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.

5.3.3 Sensitivity analysis on milk and feed prices

The future structure and production of the Dutch dairy sector is of course difficult to predict. Two sensitivity analyses are applied. First the impact of a 5% increase in the milk price is analysed. Next the impact of a 5% increase in feed prices is analysed. Results are compared to the standard scenario 2025. The results of the sensitivity analyses are obtained from simulations with DRAM. Results are presented in Table 5.4. All other exogenous variables are assumed constant (e.g. prices of cereals and other arable crops, milk production per cow per type).

Increased milk prices

An increase in the milk price with 5% will increase total milk production and number of dairy cows in the Netherlands with about 6.3% compared to the standard scenario for 2025. Gross margins per cow will increase for all grazing categories with 7-8%. Number of dairy cows will increase for all categories (Table 5.4). The higher milk price and increased production will result in higher (shadow) prices of land indicating increased demand for land. Land will become scarcer and will be used more intensively in the Dutch dairy sector. As a result there will be a tendency to increase milk production per ha. Given data and features of DRAM this will result in a further concentration of milk production in the category no-grazing.

However, the impact of the increased milk price on the distribution of cows over the categories and the shares of the total milk production per category is limited. Hence, the effect on average grazing time is very limited, namely from about 575 hours in the standard scenario to about 567 hours with increased milk prices. The percentage of cows that graze according to the definition of Stichting Weidegang slightly decreases (from 32.6 to 32.0%). It should be noted that a decrease in the milk price compared to the standard scenario works the other way around.

Table 5.4	Development of share in milk production and number of dairy cows in the Dutch dairy sector in the standard scenario 2025 and with different assumptions on milk and feed prices					
	Scenario	**Full or extended grazing**	**Restricted grazing**	**Very restricted grazing**	**No grazing**	**Total dairy sector**
% of milk	Baseline	35%	27%	9%	29%	100%
	Standard scen. 2025	9%	22%	16%	53%	100%
	Increased milk price	8%	22%	16%	53%	100%
	Increased feed prices	9%	22%	16%	53%	100%
No. of cows	Baseline	540	402	122	406	1,469
	Standard scen. 2025	136	324	223	728	1,411
	Increased milk price	140	341	239	779	1,499
	Increased feed prices	134	318	218	714	1,384
Gross margin per cow	Baseline	2,264	2,397	2,368	2,431	2,355
	Standard scen. 2025	2,174	2,229	2,137	2,243	2,216
	Increased milk price	2,327	2,392	2,308	2,409	2,381
	Increased feed prices	2,139	2,192	2,091	2,208	2,179

Source: Informatienet, Agricultural census, processed by LEI Wageningen UR.

Increased feed prices

An increase of prices of concentrates and roughage with 5% results in a decline in total milk production and number of dairy cows with about 2%. Milk production and number of dairy cows will decrease for all categories (see Table 5.4). Gross margins per cow will decrease in all grazing categories with approximately 2%.

According to the DRAM database in the standard scenario for 2025, the costs of concentrates and purchased roughage per 100 kg of milk ranges from an average of about €7.0 per 100 kg of milk in the category extended grazing to about €8.9 per 100 kg of milk in the category very restricted grazing. Average feeding costs are about equal in the categories restricted grazing and no-grazing, namely about €7.5 per 100 kg of milk. Given the data and grazing categories in the model it can be expected that in relative terms increased feed

prices pushes the farmer away from the category very restricted grazing. At the same time there is a tendency to choose for extended grazing and the share of the category extended grazing in total number of dairy cows and milk production increases.

The above mentioned tendencies also show up in Table 5.4. However, compared to the standard scenario for 2025 the differences in feeding costs between categories are not so big that large changes in the development of the shares of the different categories in numbers of dairy cows and milk production will occur. The percentage of cows that graze according to the definition of Stichting Weidegang remains 32.6% and the average grazing time in May-Oct summer increases only slightly (from 575 to 580 hours).

For the purpose of this sensitivity analysis we have chosen for a limited increase of the feed prices (5%). A large increase in the feed price would be inconsistent with the assumption that all other prices are constant compared to the standard scenario for 2025. If all prices of agricultural inputs and outputs would increase, including the land prices, on average this would pull the sector in the direction of no-grazing.

5.4 Different grazing scenarios towards 2025

5.4.1 Definition of four scenarios on grazing regime

The different scenarios that will be analysed are presented in Table 5.5. They reflect the introduction of various public and private policies and measures to support grazing and were decided after consultation within the project team and analysis of existing literature.

Tabel 5.5 Definition of 4 different scenarios on grazing regimes

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

Source: Wageningen UR.

Appendix A3.3 presents in detail how the decision to choose between grazing and no-grazing is modelled per type of dairy cow. The alternative technology for the categories no grazing and very restricted grazing 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 720 hours, corresponding to 120 day and six hours grazing per day (Stichting Weidegang). It is assumed that these extra costs to switch from to the new technology that qualifies for the grazing premium, are relatively low for the category very restricted grazing and relatively high for the category no-grazing. This is simply explained by the fact that rather limited management changes are required in the former category, while more management changes and investments are required in the latter category. The model outcomes are driven by the assumption that farmers maximise their gross margin.[1] If the extra revenue from the grazing scenario exceeds the extra costs to comply with the scenario restrictions, the farmer will switch to grazing. Of course there can be other reasons to choose for grazing or no grazing besides economic optimisation which will be explored in the discussion.

5.4.2 Results

Table 5.6 shows the impact of the different scenarios regarding grazing on selected variables per category compared to the standard scenario 2025.

[1] Note that DRAM is not driven by average gross margin or farm profitability in the initial situation, but by changes in costs and revenues components, depending on scenario specifications. These changes trigger a reaction of the model until marginal costs and marginal revenues are in equilibrium again. The resulting gross margin is an indicator for economic winners and losers of a certain scenario.

Table 5.6	Development of share in milk production and number of dairy cows in the Dutch dairy sector in 2025 under different grazing scenarios					
	Scenario	**Extended grazing**	**Restricted grazing**	**Very restricted grazing**	**No grazing**	**Total dairy sector**
% of milk	Grazing premium	+10%	+68%	-37%	-19%	
	Greening condition CAP	+9%	+40%	-25%	-11%	
	Innovative management	+9%	+14%	-9%	-5%	
	Combination	+28%	+123%	-72%	-34%	
No. of cows (*1,000)	Grazing premium	+15	+218	-83	-133	+17
	Greening condition CAP	+9	+120	-58	-91	-20
	Innovative management	+12	+44	-20	-33	+3
	Combination	+37	+384	-160	-255	+6
Gross margin (euro/cow)	Grazing premium	+3.5%	+3.6%	-0.5%	-0.8%	+1.5%
	Greening condition CAP	+0.8%	+0.9%	-1.7%	-1.7%	-0.5%
	Innovative management	+2.3%	+0.8%	-0.1%	-0.1%	+0.4%
	Combination	+6.7%	+5.4%	-2.1%	-2.7%	+2.8%

Source: Informatienet, Agricultural census, processed by LEI Wageningen UR.

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, extended or full grazing. Rather limited farm management changes are necessary to switch from very restricted to restricted grazing; the premium exceeds the extra costs. To switch to the category full or extended grazing, costs are relatively high. Moreover, to switch from no-grazing to a category that qualifies for the grazing premium, also requires relatively high extra costs. Table 5.6 shows that 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 also be limited, namely from 575 hours in the standard scenario to 712 hours in 2025 under the scenario with a grazing premium.

Gross margin increases in the categories above 720 grazing hours. This is of course explained by the top up on the milk price of €0.01 per kg of milk in these categories. The decrease in gross margin in the categories below 720 grazing hours is especially explained by lower milk prices in these categories due to extra milk supply at national level. At national level average gross margin per dairy cow, including the grazing premium, increases.

Table 5.7 **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
Milk per cow	9.4	9.3	9.3	9.4	9.3
(*1,000 kg)		-0.70%	-0.40%	-0.20%	-1.30%
Dairy cows per ha	1.8	1.8	1.8	1.8	1.8
(# cows per ha)		-0.50%	-0.30%	-0.20%	-1.10%
Milk per hectare	16.6	16.4	16.4	16.5	16.2
(*1,000 kg)		-1.20%	-0.80%	-0.50%	-2.40%
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 Calculalions with DRAM, LEI Wageningen UR.

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 5.7 shows that the average grazing time in 2025 equals 663 hours compared to 575 hours in the standard scenario.

Gross margin decreases in the categories below 720 grazing hours. This is explained by the larger decrease in the CAP premium (€100 per ha) compared to the farms that do apply more than 720 grazing hours. The overall decrease in the gross margin is dampened by a limited increase in milk price due to a decrease in milk supply at national level (Table 5.7). This increase in milk price explains the increase in gross margin in the categories above 720 grazing hours.

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 and number of dairy cows in total milk production and total number of dairy cows decrease with about 5% in the category no-grazing and about 9% in the category very restricted grazing (Table 5.6). 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. This is especially the case in the category restricted grazing.

Gross margin increases most in the category full or extended grazing as the highest increase in grassland yield is assumed in this category. The average grazing time in this scenario increases only limited in this scenario compared to the standard scenario (from 575 to 619 hours).

Innovation is defined as increased uptake of grass by the dairy cows, while the milk production per cow and quality of the milk is assumed unchanged. This increased uptake of grass provokes a decrease of the costs of purchased concentrates and roughage. The financial gain therefore depends on the initial grass uptake by the dairy cows and the value of the energy content of the grass in the standard scenario for 2025. If the later value is higher than assumed here, the impact of scenario innovative grazing management could be higher.

A sensitivity analysis shows that in that case the impact could be comparable to the impact of the 'grazing as a greening condition in CAP' scenario.

Combination

All measures combined result in the largest impact in the shares of production and number of dairy cows in the different categories. Looking at the different categories, the number of dairy cows in the categories no-grazing and very restricted grazing decreases 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 5.6).

Table 5.7 shows that only a combination of measures will substantially dampen the decrease in grazing time in the Netherlands. Compared to the standard scenario 2025 the average grazing time increases from 575 to 848 hours. This is still far below the average grazing time in the baseline 2010/2011 of 1282 hours (Table 5.9).

Overall effects

Table 5.7 shows further 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. All scenarios lead to lower average milk production per cow, number of dairy cows per ha and milk production per hectare.

In Table 5.7, development of the average percentage grazing under the different scenarios is given. 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 extended grazing is much larger in the initial situation. 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).

5.5 Discussion and interpretation in relation to other chapters

5.5.1 General scope of modelling results

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 the scope of this approach is limited:

- 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 extended 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. Chapter 3 already 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 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. Furthermore it should be noted that indirect costs are not taken into account in this modelling exercise. To evaluate the differences in economic performance between grazing and no-grazing we refer to Chapter 3.

5.5.2 Development of grazing under different scenarios

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 2025 projections of the model (32-62% of the cows) are roughly in line with the predictions from the Dutch experts (55% of the cows) presented in Chapter 4. As these experts reason from the idea that grazing premiums are already introduced in the Netherlands, it is reasonable that their prediction is somewhat higher than the model prediction with unaltered policies. Still, the interviewed experts seem rather optimistic about the future level of grazing.

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. Chapter 2 shows that in different countries different trajectories on grazing are being developed. In Denmark and North-West Germany, for example, grazing gets comparatively little attention and seems to be disappearing. In Ireland and the 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.

5.5.3 Economic effects

The model results indicate that gross margins per cow will decrease with 6% from €2,355 per cow in the initial situation (2011) to €2,216 per cow in 2025 in a situation with unaltered policies. This average development is mainly the result of the assumptions on price development that have been made, mostly derived from Berkhout et al. (2011). This predicted decrease of the gross margin per cow, reflects the ongoing growth in scale in the dairy sector. Gross margins between groups are different but the model results show no straightforward relation between the grazing category and the gross margins per cow or per kg of milk. This is in line with Chapter 3, where an increased gross margin for extended grazing large farms could not be confirmed for small

farms or restricted grazing large farms. Other factors than grazing are apparently interfering.

Cows grazing in the Netherlands

The grazing scenarios have a beneficial effect on the gross margin of the whole sector but the effect is limited to less than 3% (Table 5.9). Per grazing category the effect of the different scenarios on gross margin are however 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 extended 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 extended grazing, the grazing premium will have a positive impact on continuation of small farms.

In Chapter 2 and Chapter 4 we refer to the fact that high prices of concentrates might increase grazing. The sensitivity analysis of this Chapter shows that also in the Netherlands increased feed prices will stimulate (extended) grazing. However, this will only be the case if increased feed prices do not coincide with increased prices of other agricultural inputs, including the land prices. Such a development would on average pull the sector in the direction of no-grazing as it will stimulate further intensification. Also an increase in the milk price is expected to have a decreasing effect on the amount of

grazing as it will stimulate intensification. The result of this modelling exercise indicate only a limited effect of an overall 5% increase in the milk price: the percentage of cows that graze in 2025 in the standard scenario was only marginally reduced. However, in a situation with premiums on top of the milk price, depending on number of grazing hours, (such as the defined scenarios where grazing is stimulated) this effect might be larger as a result of the premium.

5.6 Conclusions

In this Chapter 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. To some extent, some of these measures are already being introduced in the Netherlands. Increased feed prices will stimulate (extended) grazing. However, when increased feed prices coincide with increased prices of other agricultural inputs and outputs (including the milk price), this will pull the Dutch dairy sector in the direction of no-grazing as it will stimulate further intensification.

6 Discussion and general conclusions

6.1 General discussion: impact and implications of this research

The challenge

Dairy farming is changing drastically in North-West Europe. As the costs increase more rapidly than the milk price, farmers have to improve their economic performance, either by improving the efficiency (reduce costs or increase revenues) or by increasing the production volume. The availability of technology and capital has allowed farmers to expand and intensify their farms relatively easily in recent decades. With the abolishment of the milk quota system from 2015 onwards this evolution can be expected to continue and might even be amplified.

This study contains an overview of trends that local experts expect to happen in dairy farming towards 2025. There is a general agreement that dairy farming will face:

- Feed prices that will increase more rapidly than inflation.
- Increased costs for labour, capital and technology.
- Milk prices that will not keep up with the increase of the cost level;
- More fluctuation in the milk price.
- Increased technology in housing systems and a further development or introduction of the Automatic Milking System (AMS).
- An on-going trend in farm-expansion, resulting in limited availability of grazing fields around the farm to graze properly and the need for more time-efficient management.
- Increased awareness on environmental issues that will demand a continuously improvement of the nutrient management efficiency.
- Increased awareness on animal health and welfare.
- More extreme weather conditions due to climatic changes.

These developments will urge farmers to continue to search for improvement of the efficiency (both technically and economically) of management and/or increased production volumes.

Current situation

These developments will affect grazing differently in the six countries/regions included in this study. Differences in the current grazing situation between

countries/regions are not only the result of differences in environmental conditions such as soil type (e.g. the potential to cultivate other crops than grass) and length of the growing season but also socio-economic factors such as the prices of concentrates and fertilisers, organisation of the dairy chain, interest rates, presence of other economic activities etc. Also cultural aspects play a role in how dairy farming and grazing has become what it currently is.

In general it can be concluded that Ireland has the most favourable conditions for grazing environmentally, economically and culturally, followed by the UK. Environmental conditions are less favourable in Sweden and Denmark but in Sweden, grazing is mandatory in national legislation. The Netherlands and North-West Germany take intermediate positions but in the Netherlands several initiatives and a national debate are taking place to maintain current levels of grazing.

Decline in grazing

Grazing is declining rapidly in some parts of Europe (Van Den Pol- Van Dasselaar, 2012), which is confirmed by the experts' opinions in this study as well as the modelling of the situation for the Netherlands in 2025. The decline in grazing is happening very rapidly in Denmark and North-West Germany, and to a lesser extent in the Netherlands and the UK. Results of economic modelling showed that also in the Netherlands 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).

Farmers in some countries currently automatically seem to choose for the non-grazing system as the most attractive and future-proof dairy system. This automatic choice is not supported by economic farm performance data. Properly managed grazing systems are economically sound and attractive. This study confirms the results of other studies that grazing has economic benefits compared to non-grazing. This does not imply that economic performance of all non-grazing farms is inferior. Both systems can result in high incomes when properly managed but also very poor results when the management is not optimal. Grazing systems have the advantage of lower costs for feed production and housing while non-grazing systems often have the advantage of higher yields per cow and per hectare. From a farmer point of view, arguments on farm organisation and labour are probably more decisive in the decline in grazing than pure economic arguments.

Reversing the decline in grazing

What can be done to maintain grazing in North-West Europe? To obtain good economic results it is crucial that farmers opt for a clear strategy with respect to grazing. Grazing or no grazing should be one of the core strategic decisions in the farming strategy and the whole farm management plan should be arranged accordingly. Farmers should be assisted in such decisions and the implementation there off. In such decisions personal values, capabilities and preferences should be play an important role. To optimise grazing, the following aspects seem crucial:

1. *Full grazing*

   The full grazing system is the predominant system in Ireland and there has been some uptake in parts of the UK. The strategy lies on a seasonal production profile, maximum intake of grass, very long growing season, very low supplemental feeding, low milk production per cow, the use of cross breads, low investments in housing and machinery. The strategy might also be adapted and applied in other regions such as the Netherlands and Germany but there is limited research and experience to ascertain whether the growing season in these countries is long enough to fully utilise the advantage of low feed and housing costs. Furthermore, the question should be asked what the consequences would be if this system is applied on a large scale? Will there be complaints from consumers or citizens about cows standing outside in harsh weather conditions? Can dairy companies still guarantee enough market opportunities if the production profile changes drastically? For a more elaborate discussion of the potential of this strategy in the Netherlands we refer to Zijlstra and Holshof (2013).

2. *Restricted grazing*

   This strategy requires an optimisation of the traditional Dutch system with summer grazing. Considerable grass intake and long grazing season should be realised (>8 kg dry matter per cow per day) to fully utilise the economic benefit of grazing. On the other hand considerable supplemental feeding should be available when weather conditions require it. With this system moderate to high milk productions per cow can be achieved. As cows need good conditions also in the barns considerable investments in housing remain a necessity. This strategy allows for a better control of nutrients from manure than the full grazing system. Besides increased grass intake, optimisation is required mainly with respect to time-efficient management of such systems on large farms. Another issue that requires attention is how to structurally improve field allocations. To obtain a convenient farm organisation and management feeding and crop production might be

contracted out on large specialised farms. For an example of an innovative research project on grazing we refer to Vrolijk and Gosselink, 2013 and Amazing Grazing (http://www.amazinggrazing.eu/)

Furthermore, development might be stimulated of new systems that allow cows free access to pasture in a limited area around the buildings in no grazing systems. This system does not focus on fresh grass intake from pasture and therefore does not realise the economic benefits of cheaper feed production nor the decreased housing costs. However, the system does have the advantages of grazing with respect to: 1) animal welfare issues (access to a soft loafing area, expression of natural behaviour, etc.), 2) keeping cows visible in the landscape while maintaining the controllability of the system, both in terms of nutrients and farm organisation. See the free choice system (www.vrijekeuzestal.nl) for a Dutch example.

6.2 Answers to research questions of WSPA

6.2.1 Variation in costs of production and profitability across the countries

Original question of WSPA: 'How do costs of production and profitability vary across the key target countries and different models of production?'

The six studied countries/regions differ considerably in farm structure, grazing systems and costs of production. These differences have their origin in natural, economic and cultural circumstances. Albeit these differences, average net farm incomes (euro per annual work unit) are quite similar. In summary:

- Ireland and the UK have the most favourable climatic conditions for grazing and a relatively low milk price. The share of costs directly related to milk production (feed and animal costs) is large due to high concentrate prices and as a result gross margins are low. Costs for buildings and machinery, on the other hand, are low as well as the paid interest, labour and other costs. These low fixed costs can partly be explained by the full grazing systems in these countries.
- The Netherlands and North-West Germany, where the grazing time is usually much shorter, realise a higher milk price and better gross margins per kg of milk but on average higher indirect costs (costs for buildings and machinery, paid interest, labour and other) and therefore comparable farm incomes. Dutch dairy farms are on average more intensive compared to German, both in terms of capital and milk production and have a higher milk price.

- Sweden and Denmark, where the grazing season is short and grazing is limited, have high direct and indirect costs resulting in somewhat lower incomes. In Denmark this can primarily be attributed to the high interest costs in recent years, following a (too) rapid scale enlargement. In Sweden the combination of high cost per litre of milk and small production volumes results in lower incomes.

Original question of WSPA: *What are the key factors explaining those differences between grazing models?*

In general can be said that grazing reduces costs for feed production (because the cows fetch the grass themselves) and housing (only with full grazing in a long grazing season). Negatively, grazing is usually related to lower production levels per cow and per ha. Furthermore, when grazing is combined with a seasonal production profile, it is more difficult to obtain high milk prices because a larger share of the milk is processed to milk powder. How these effects will turn out depends largely on the specific circumstances of the country. In general can be said that a long growing season and relatively high prices for concentrates compared to land will increase the economic benefits of grazing. On the other hand, increased price levels (including land prices), competing land claims and intensification will reduce the economic benefits of grazing.

6.2.2 Strengths, weaknesses, opportunities and threats of grazing

Original question of WSPA: *What are the strengths and weaknesses, opportunities and threats of zero-grazing and less intensive models of production where cows graze during the summer period?*

Section 4.5 gives an executive summary of the SWOT analysis on grazing in North-West Europe. The trend of intensification and expansion of farms has been identified as the most important threat to grazing. This trend results in the need for higher outputs and controllability of management on the one hand and reduced availability of grazing area around the farm on the other. Largest opportunities for grazing are 1) its low cost structure, especially in times where farmers have to deal with low milk prices and high prices and 2) the fact that dairy industry and governments are increasingly recognising grazing as an important precondition for natural behaviour of dairy cows and for social

acceptance of dairy farming. The results of the SWOT analysis are summarised in Table 6.1 which is a copy of Table 4.2.

Table 6.1	**Summary of strengths, weaknesses, threats and opportunities of grazing in North-West Europe (based on expert judgement) in six EU countries)**
STRENGTHS - Low costs for feed production - Low costs for housing (when grazing season is long) - Better opportunities for cows to express natural behaviour - Better image of dairy farming through visibility in the landscape - Improved cow health and fertility through lower production and more natural behaviour (depends on conditions) - Farmer is working more in the field (depends on farmer preference)	**WEAKNESSES** - Grazing requires additional management and organisational skills - Grazing reduces controllability of management due to greater dependence on weather conditions - Lower grassland yields per ha and less efficient feed production (depends on conditions) - Animal health problems due to unbalanced diets and harsh weather conditions (depends on conditions) - Lower yields per cow. Usually not popular amongst farmers
OPPORTUNITIES - Grazing as a low cost survival strategy in times where farmers have to deal with low milk prices and high costs - Dairy industry is introducing or considering price premiums - New ways of specialisation that creates new opportunities for grazing - Technological innovation and education on grazing - Part of the farmers have more fun and get more satisfaction out of working in the fields	**THREATS** - Intensification and expansion of farms - Poor field allocation - Lack of knowledge and skills for efficient management on large farms - Technological innovation on housing systems - In some countries competition over land - Climate change will result in more extreme weather conditions - Young farmers lack knowledge, support and traditional values to maintain grazing
Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.	

6.2.3 Evolution of costs of production over time

Original question of WSPA: *How are costs of production expected to evolve over time and what implications does this have for different models of production?*

For all countries, costs of production will increase over time more rapidly than milk price which will urge farmers to continue to search for improvement of the efficiency (both technically and economically) of management and/or increased production volumes. This will result in a further scale enlargement and intensification and, without actions, a further decline in grazing. In the Dutch situation grazing farms realise better farm incomes compared to non-grazing farms but only in a situation where the feed intake from fresh grass is substantial (extended grazing). Model simulations (Chapter 5) indicate that these differences are not big enough to reduce the trend of decline in grazing in the Netherlands.

In other countries the effects will be different. In Ireland and the UK where direct costs make up a large share of the total costs, concentrate prices are high and grazing conditions good, grazing will be more readily economically attractive. In countries with less favourable grazing conditions like Denmark and North-West Germany grazing will decline even more rapidly.

Original question of WSPA: What impacts will the projected rise in energy and feed prices have on different models of production over time?

Increased prices for concentrates will stimulate grazing. However, this will only be the case if increased feed prices do not coincide with increased prices of other agricultural inputs, including the land prices. Such a development would on average pull the sector in the direction of no-grazing as it will stimulate further intensification. Also an increases in the milk price is expected to have a decreasing effect on the amount of grazing as it will stimulate intensification.

6.2.4 Policies that affect grazing and influence of dairy companies

Original question of WSPA: How can dairy companies influence models of production and what concrete examples exist where producers and companies are getting returns for investing in grazing?

In Ireland and the UK, the experts recognise the attempts of the dairy industry to search for new products and markets for dairy products from pasture which

might increase grazing. In the Netherlands and to a minimal extent in North-West Germany, dairy industry is giving a grazing premium to stimulate grazing. Dutch dairy companies have embraced the goal of maintaining the current level of grazing in the Netherlands (Convenant Weidegang, 2012) and most companies introduced grazing premiums of 0.5 to 1.0 eurocent per litre of milk. In the 'Convenant Weidegang' a large share of the relevant stakeholders of the Dutch dairy industry are participating and have agreed on actions to stimulate grazing. In Denmark and Sweden additional payments apply only to organic concepts with grazing as one of the criteria.

Furthermore, especially in Ireland, the UK and the Netherlands, dairy companies are investing in knowledge development on grazing management.

Whether there is evidence for return on investments of the dairy industry has not been investigated in this study.

Original question of WSPA: What public policy measures would make the grazing model more attractive to farmers in the EU? What concrete examples of public policies encouraging grazing already exist and what are their effects on returns to farmers? Conversely, what policies can make the grazing model less attractive (e.g. environmental policies).

In consultation with WSPA this question has not been investigated.

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Appendix 1

List of interviewed experts

Table B1.1	List of interviewed experts	
Name	**Organisation**	**Country/region**
James Humphreys	Teagasc	Ireland
Albert Johnston	College of Agriculture, Food and Rural Enterprise (CAFRE)	Northern Ireland
Ian Browne	Farm Consultancy Group	Middle England
Kathryn George	Livestock Improvement Corporation UK	United Kingdom
Ton Derks	DLV Adviesgroep	Netherlands
Rene van den Oord	FLYNTH adviseurs en accountants	Netherlands
Hans Witbaard	Beratungsring Wesermarsch	North-West Germany
Rudolf Thøgersen	Knowledge Centre for Agriculture	Denmark
Susanna Berg	Växa Sverige	Sweden

Appendix 2

Results of semi-structured interviews with local experts

In the UK, three interviews were held in total. Only two interviews delivered quantitative characteristics: one in England and one in Northern Ireland. In tables that present quantitative data, these two interviews are presented separately as they do not represent the whole of the UK. In qualitative tables, the three UK interviews are presented as a whole (N=3) for the UK.

In the Netherlands two interviews were held. These two interviews are consistently presented as a whole (N=2). When quantitative values varied between the experts, a range is presented.

In Sweden, Denmark, Ireland and North-West Germany, only 1 interview was conducted.

Table A2.1	**Origin and business model of current grazing systems (based on expert judgement) in six EU countries**	
Country/region	**Origin (how/why has it become what it is)**	**Business model (how/why does it make money)**
Ireland (N=1)	- Low value commodities result in a low milk price for farmers which necessitate a low cost structure - Climate and soils support this approach	- Maximise the intake of grazed grass: grazed grass is between 2.5 and 5.0 times cheaper than other feedstuffs - Seasonal grazing system: low capital investment in housing and machinery
Northern Ireland (N=1)	- Traditional herds apply full grazing - Expanding herds grow out of grazing platform and house cows at night or graze a proportion of the herd day and night - Non-grazers usually have large herds with limited grazing platforms. They target at high yields from high input levels	- Full grazing: moderate yield and low costs, no major reliance on paid labour or rented land - Restricted grazing: increased yield through increased concentrate feeding - Non-grazing farms have high costs of production (concentrates, labour, building, machinery, land) and target at a high yield per cow

England (N=1)	- Full grazing: consciously taken over from New Zealand and Irish specialists. Needs excellent management. - Restricted grazing: these farmers use the older English system, starting to learn but will not change the complete system - Non grazing: Learning from US system. Large-scale farms: requires high competency for management	- Full grazing makes more money because it is a low cost system - Restricted grazing is the least profitable because it is a mix of systems (lower output with higher input) - Non grazing farms have a high output per man and per cow and high cost structure. Can be profitable if run well
Netherlands (N=2)	- Full grazing is the traditional system. Currently mostly in the western part with wetter soils. Easier because lower demands for housing - Restricted grazing: not enough grazing platform and need for more stable diet and production - No grazing: not enough grazing platform and easier to organise and manage. Farmers in a region often copy the system from neighbours	- Full grazing: low costs - Restricted grazing: stable diet and production in summer, use costs advantages - No grazing: high yields per hectare - No grazing is more easy. It is just prolonging the winter management
North-West Germany (N=1)	- Full grazing was the traditional system until early 1990's. Decreased due to farm expansion and limited availability of grazing platform. Often older farmers - Restricted grazing is a transitional stage towards non-grazing or 'young and dynamic' farmers - Non-grazing: Expanding farms that lack enough grazing platform and labour. Often father/son farms	- Full grazing: advantage is low costs - Restricted grazing: try to find the balance between the two - Large farms need high output to get enough return on investment

Denmark (N=1)	- Many organic farmers that graze - Non grazing: Large farms, not sufficient land for grazing, many traffic roads and long distances to grazing land	- Full grazing: organic production and lower costs. Land is not suitable for grain production - Non-grazing: higher yields per cow and per ha
Sweden (N=1)	- Organic farmers have to apply grazing > 12.5 hours per day - Grazing >6 hours per day in summer is mandatory by law - Non-grazing is not allowed	- Grazing gives better utilisation of pasture

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.2	Current situation with respect to grazing in six EU countries/regions (based on expert judgement)																	
Region	**Ireland (N=1)**	**Northern-Ireland (N=1)**			**England (N=1)**			**Netherlands (N=2)**			**North-West Germany (N=1)**			**Denmark (N=1)**			**Sweden (N=1)**	
Grazing system	**INT**	**INT**	**RESTR**	**NO**	**INT**	**RESTR**	**NO**	**INT**	**RESTR**	**NO**	**INT**	**RESTR**	**NO**	**INT**	**RESTR**	**NO**	**INT**	**RESTR**
% of farms	100	58	30	12	25-30	60	10-15	5-20	60-75	20	25	35	40	5	30	65	13	87
% of cows	100	44	35	21	20	60-65	15-20	5-15	60-65	25-30	15	35	50	4	26	70	12	88
Farm size (tonnes of milk)	285	500	840	1530	1500	1250	2250	500	750	950	500	650	>800	900	1100	1350	500	550
Milk per ha (tonnes)	6	12.5	14	12.5	15	16	24	9-12	15-16	17-20	7	8.5	10	8	9	11	6	7
Milk per cow (tonnes)	5.2	6.5	7.0	>8.5	5.1	6.7	9.5	7.5	8.5	9.0	6-7.5	7.5-9.5	>9.5	8.7	8.9	9.0	8.0	8.3
Length of grazing season (days)	270-300	200	150	Na	240-270	200	Na	180	150	Na	180	150	Na	180	150	Na	60-165	60-165
Grazing hours/day	20-22	18	8	Na	20-22	20[a]	Na	16	7	Na	20	9	Na	18	6	Na	>12	>6
Fresh grass intake (kg dm/day)	15-16	15	9	Na	16-17	10	Na	13	6-8	Na	13	8	Na	8	5	Na	9	0-3

A This is the grazing time for the cows that go outside. High yielding cows are kept inside.
Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.3	Strengths and weaknesses of grazing with respect to (economic) farm performance (based on expert judgement) in 6 EU countries	
Country/ region	**Strong aspects of grazing**	**Weak aspects of grazing**
Ireland (N=1)	- Low costs, incomes relatively high - Income resistant to fluctuating milk prices	- Reliance on export markets - Seasonal production profile
United Kingdom (N=3)	- Higher net profit/litre - Lower costs for concentrates and feed production - Need lower investments on sheds and machinery	- Limitations to expansion (land availability) - Seasonal production profile
Netherlands (N=2)	- Lower costs for concentrates and feed production (contract work, feed storage) - Higher profit (when situation allows it)	- More fertiliser - More roughage purchase - Lower production per cow
North-West Germany (N=1)	- For farms up to 100 cows good economic and technical results	- For large farms too laborious - Variability of production: every day enough milk
Denmark (N=1)	- Cheaper feed production when grain prices are low	- Lower profit per cow because of lower milk yield
Sweden (N=1)	- Decrease feeding and harvest costs	- Decrease milk yield - Fencing costs - New working routine?

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.4	Strengths and weaknesses of grazing with respect to animal health and welfare (based on expert judgement) in 6 EU countries	
Country/ region	**Strong aspects of grazing**	**Weak aspects of grazing**
Ireland (N=1)	- Breeding cows with a balance on characteristics	- Long walking distances?
United Kingdom (N=3)	- Modest yields per cow - Crossbreads - Optimising genetic potential for yields from forage - Low replacement rate (with right cow and right system) - Higher expression of natural behaviour - Fitter cows due to exercise	- Not suited for high yielding cows: not being able to achieve required energy intake in peak lactation - Weight loss in autumn - Unbalanced diets
Netherlands (N=2)	- Fitter cows due to exercise - Softer floor (depends on quality stable) - Better fertility and hoof health (depends on quality stable) - Lower infection risk in stable (depends on quality stable) - Higher expression of natural behavior	- More abomasum dislocations - More heat stress at high temperatures
North-West Germany (N=1)	- Better welfare - Better health? (Not to be extracted from vet costs)	- High yielding cows difficult to manage
Denmark (N=1)	-	- Lower milk yield
Sweden (N=1)	- Better hoof health and wound healing - Easier calving	- Lower milk yield - Higher cell counts - Grazing sickness (gnats)
Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.		

Table A2.5	Strengths and weaknesses of grazing with respect to farm labour and organisation (based on expert judgement) in 6 EU countries	
Country/ region	**Strong aspects of grazing**	**Weak aspects of grazing**
Ireland (N=1)	- Perceived as less labour intensive - Holiday in December/January - Plenty of free time during summer and autumn	- Very busy calving season - Not suitable for robots? - Variable grass production: need good (grassland) management skills
United Kingdom (N=3)	- With good infrastructure less labour input: If system is wright than it is simple - More time off during summer - Additional labour at calving season allows specialisation - Reduced labour for bedding, feeding and scraping	- Reliance on management skills (adopt to weather) - Poorly planned grazing systems are complex and hard to manage
Netherlands (N=2)	- Less machinery necessary	- Better organisational skills required (difficult to transfer to others) - Relatively more time required for fertilisation and silage making - Reliance on management skills (adopt to weather)
North-West Germany (N=1)	-	- Higher skills and education required
Denmark (N=1)	-	- More laborious - Higher management skills required
Sweden (N=1)	- Less barn work	- More labour for fetching cows for milking - Farm organisation more difficult with AMS - Farm organisation more difficult with expanding farms

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.6	Strengths and weaknesses of grazing with respect to other (social) aspects (based on expert judgement) in 6 different EU countries	
Country / region	**Strong aspects of grazing**	**Weak aspects of grazing**
Ireland (N=1)	- Farmers feel they work less hard for a better return - Important part of society and rural communities - Important for employment and national income	- Education is a major challenge - Milk quota perceived as a major hindrance - Volatility of milk prices and variable weather conditions are major headaches - Physically demanding (not suitable >60) - Young people less inclined towards dairy farming
United Kingdom (N=3)	- Might be considered more natural - Desire to look after the land and the animal - Perception that it is good to see grazing cows in the countryside	- Farmer must be able to deal with worse cow performance (yield per cow)
Netherlands (N=2)	- Higher satisfaction: cow belongs outside (personal) - Grazers do not aim for cow records - Grazers have fun in working in the field - Citizens want cows outside: farmers are sensitive to this and want to avoid extra policy and image intensive husbandry	- Non-grazers aim at high yields per cow - Non-grazers often like controllability
North-West Germany (N=1)	- Grazing farmers often not active outside farm	- Non-grazing farmers often active outside farm
Denmark (N=1)	- Mandatory for organic farms - Positive image form the perspective of consumers	- Many farmers do not find grazing better than no grazing (image and animal health) - No governmental subsidy for grazing
Sweden (N=1)	- Long tradition to keep animals grazing - Higher social value for the consumer	- Consumers do not understand difference between organic and traditional

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.7	Existing and potential instruments to stimulate grazing (based on expert judgement) in 6 different EU countries
Country/region	**Instruments to stimulate grazing**
Ireland (N=1)	- Economic circumstances favour grazing is the simple answer. Producing milk using high cost concentrates and silage is not an attractive proposition for dairy farmers at the prices that are available. In the past two decades there has been a steady decline in farms producing 'year-round' milk matched by the growth of the seasonal production
United Kingdom (N=3)	- There are no initiatives on financial support - Figures from CFP (Comparative Farm Profits = free benchmarking programme) show a link between Gross Margin and Net Profit and the level of milk achieved from forage - Dairy co-operative 'First milk' has launched a sustainability initiative: amongst others they work on improved grassland management capabilities - Dairy Co and British Grassland Society assist farmers who wish to have support from other farmers in terms of grazing management (Grazing Partners)
Netherlands (N=2)	- Grazing premium is introduced by various dairy companies (0.5 eurocent per litre), a.o. Friesland Campina (85% of milk) when cows graze at least 6 hours a day during 120 days - Stichting Weidegang facilitates the availability of knowledge for farmers to support grazing decisions. The aim is to make grazing more easy by improved labour organisation and economic performance - Various projects on improved technology by dairy industry: nutritional analysis fresh grass, predictive tools grassland yield, improved yield estimation, automatic grass supply estimation. - Local governments set lower demands for ammonia reduction when grazing is applied - National government sets lower demands for subsidies on new sustainable housing when grazing is applied - What is the role of feed suppliers and veterinarians?

North-West Germany (N=1)	- Ammerland-Oldenburg introduced a grazing premium of €200 per farm per year when cows graze at least 6 hours a day during 120 days - DMK is thinking about introducing a sustainability concept - Government has various regulation for financial compensation of dairy farmers to implement environmental measures but grazing is not included
Denmark (N=1)	- Organic farmers have to let the cows graze at least 6 hours a day during 150 days. They get paid up about 20% extra for the milk and a government subsidy per hectare
Sweden (N=1)	- The Swedish animal welfare law says that cows need to graze at least 6 hours per day in the grazing season

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.

Table A2.8	Expected trends towards 2025 and expected effects of these trends on grazing (based on expert judgement) in 6 different EU countries						
Topic	**Expected trend**	**Expected trend on grazing**					
		IRL	**UK**	**NL**	**NW-G**	**DK**	**SW**
Milk price	Relative decrease milk price and more fluctuation	+	+	+	+	-	
Feed price	Increased feed prices (more competition and increased global demand)	+	+	+/-	+	-	+
Costs labour, capital, technology	Costs for labour, capital and technology will go up		+/-	-	-	-	
Technological innovation	More technology on housing systems: Innovative housing improves animal health and welfare for non-grazing systems		+/-	-	-		
	Introduction of the Automatic Milking System	0	-	-		-	+
Farm expansion	Post quota: intensification of existing farms and start-up of new farms	+					
	Land being the limiting factor with expansion		-	-	-		
	Large farms easier to manage without grazing			-		-	-
	More external labour			-			
	More farms per farmer		+				
	Specialisation: Feeding by contract worker			+			
	Specialisation: Co-operation with arable farms			+			
Public debate	Increasing pressure from NGO's on food production methods		+	+			
	Public debate on cows in the mud with full NZL grazing systems?		-				
Environmental issues	Environmental issues will demand for more efficient management		+	+/-	-	+/-	

Animal health and welfare	Grazed herds are perceived to be healthier		+	+		+	
	Introduction of free barns						+
Competing claims	Less land available and higher prices due to competing claims?		+/-	-		-	-
	Grazed grass is most profitable use of land resources given climate and soils	+					
Attitude dairy sector towards grazing	General agreement in the industry that grazing is most profitable system	+					
	Grazing will be more popular for farmers as a survival strategy		+	+			
	More extreme weather will change farmers attitude		-				
	New generation farmers have less knowledge on grazing			-		-	
Knowledge grazing management	Future developments in the availability of knowledge on grazing management		+/-	+/-		-	
Organisation of dairy chain	Improving dairy chain organisation and market	+	+/-				
	(No) price encouragement		-	+	0		
	Development of organic milk a.o. concepts					+	
Other issues	Salination of surface water				-		

Source: Results of semi-structured interviews with local grazing experts. Interviews conducted by Wageningen UR, autumn 2012.
+ : Expert(s) expect a positive effect on grazing of dairy cows in his/her country/region
+/-: Experts expect opposite effects on grazing of dairy cows in his/her country/region
-: Expert(s) expect a negative effect on grazing of dairy cows in his/her country/region
0: Experts expect that this trend is irrelevant on grazing of dairy cows in his/her country/region
Empty cells indicate that this trend was not mentioned in the interview

Appendix 3

Detailed results of Chapter 3
Costs and returns per 100 kg of milk in different grazing groups in the Netherlands (Informatienet)

Table A3.1 **Differences in costs and returns per 100 kg of milk between small dairy farms (<600,000 kg of milk) with different grazing systems a) in the Netherlands**

SMALL FARMS (>600,000 kg of milk)	**Full grazing (1)**	**Extended grazing (2)**	**Restricted grazing (3)**	confidence of the differences[b]		
No. of farms	33	24	20			
Costs and returns per 100 kg of milk				*1-2*	*1-3*	*2-3*
Revenues from milk and milk products (A)	31.3	31.8	32.8		**	**
Revenues from turnover and growth of cattle (B)	7.8	7.5	6.8			
Revenues from other output (C)	7.7	7.9	7.1			
of which single payments	3.6	3.7	3.8			
Total revenues (D=A+B+C)	46.7	47.1	46.7			
Feed costs (E)	7.3	6.7	7.8	**		***
Veterinary costs and artificial insemination (F)	2.3	2.4	2.5			
Other costs animals and crops (G)	3.4	3.4	3.4			
Total variable costs (H)	13.0	12.5	13.7			***
Gross margin (I=E-H)	**29.2**	**30.4**	**29.1**			*
Buildings and machinery (J)	11.0	12.0	11.3			
Energy (K)	2.2	2.0	2.1	**		
Interest and rent (L)	5.3	5.5	5.3			
Contract work (M)	2.5	2.5	2.6			
Paid labour (N)	0.5	0.4	0.1		*	
Other fixed costs paid (O)	4.0	4.1	3.6			
Total fixed costs paid (P=J+K+L+M+N+O)	25.7	26.4	25.0			
Farm income (Q=D-H-P)	**8.0**	**8.2**	**7.9**			
Unpaid costs labour and capital (R)	29.8	27.6	27.0			
Total costs (T=H+P+R)	68.5	66.6	65.7			
Cost price (U= T * (A/(D-C1)	**49.7**	**48.6**	**50.3**			

a) Full grazing: day and night grazing for more than 120 days in May-Oct; Extended grazing: grazing time > 1,220 hours in May-Oct; Restricted grazing: grazing time between 220 and 1,220 hours in May-Oct; No grazing: grazing time < 220 hours in May-Oct b) * 90%; ** 95% ;*** 99%,
Source: Informatienet.

Table A3.2	Differences in costs and returns per 100 kg of milk between large dairy farms (>600,000 kg of milk) with different grazing systems a) in the Netherlands					
LARGE FARMS (>600,000 kg of milk)	**Extended grazing (2)**	**Restricted grazing (3)**	**No grazing (4)**	confidence of the differences[b]		
No. of farms	29	50	38			
Costs and returns per 100 kg of milk				*2-3*	*2-4*	*3-4*
Revenues from milk and milk products (A)	32.5	32.6	31.6			
Revenues from turnover and growth of cattle (B)	6.4	7.2	6.7			
Revenues from other output (C)	7.4	5.8	5.7	**	**	
of which single payment (C1)	3.8	3.4	3.3	***	***	
Total revenues (D=A+B+C)	*46.3*	*45.6*	*44.1*			
Feed costs (E)	7.5	8.3	7.7	**		
Veterinary costs and artificial insemination (F)	2.0	2.3	2.0			*
Other costs animals and crops (G)	3.4	3.6	3.8			
Total variable costs (H = E+F+G)	*12.9*	*14.2*	*13.5*	**		
Gross margin (I=E-H)	**29.7**	**27.2**	**26.5**	**	*	
Buildings and machinery (J)	9.9	10.7	11.3			
Energy (K)	1.9	1.9	1.9			
Interest and rent (L)	5.6	6.4	5.8			
Contract work (M)	1.8	2.5	2.2	***	**	
Paid labour (N)	0.6	0.5	0.7			
Other fixed costs paid (O)	4.0	4.3	4.4			
Total fixed costs paid (P=J+K+L+M+N+O)	*23.8*	*26.2*	*26.3*	*	*	
Farm income (Q=D-H-P)	**9.6**	**5.2**	**4.2**	***	**	
Unpaid costs labour and capital (R)	19.6	17.6	15.7	***	***	
Total costs (T=H+P+R+S)	56.3	58.0	55.6	**	*	
Cost price (U= T * (A/(D-C1)	**43.2**	**44.7**	**43.0**			

a) Full grazing: day and night grazing for more than 120 days in May-Oct; Extended grazing: grazing time > 1,220 hours in May-Oct; Restricted grazing: grazing time between 220 and 1,220 hours in May-Oct; No grazing: grazing time < 220 hours in May-Oct b) * 90%; ** 95% ;*** 99%,
Source: Informatienet.

Appendix 4

General description DRAM

A4.1 General description

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 and 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. 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 e.g. cows per type) 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.

A4.2 Selection of cow types

The model is flexible to select the distribution key from the individual farm data to get to the above mentioned eight types of dairy cows. Selection criteria can be different depending on the question at hand. In this research we use 'percentage grazing' as the only selection key. The advantage of this is that the standard deviation of the average percentage grazing per type is relatively small. This way impact of policy options and scenarios on percentage grazing determined by the distribution of dairy cows over the different types of dairy cows (or technologies) can be studied in detail, while minimising the aggregation error. Further distribution including e.g. farm size could be possible as the mean percentage grazing is quite different between large farms and small farms (see Chapter 2). From the other hand the standard deviation of percentage grazing per farm is quite large, both within the group of small dairy farms and large dairy farms. With farm size included as distribution key we would need to cut the number of grazing classes. This would increase the standard deviation of the average percentage grazing per class. For the model analysis this is considered more important than further distribution to large and small farms.

A4.3 Modelling the trade of between grazing and no grazing in DRAM

In this section we present data and methodology to model the trade of between technologies per cow type in DRAM. Given the grazing scenarios presented in Section 5.4 the focus is on the switch from no grazing or limited grazing to a technology with grazing.

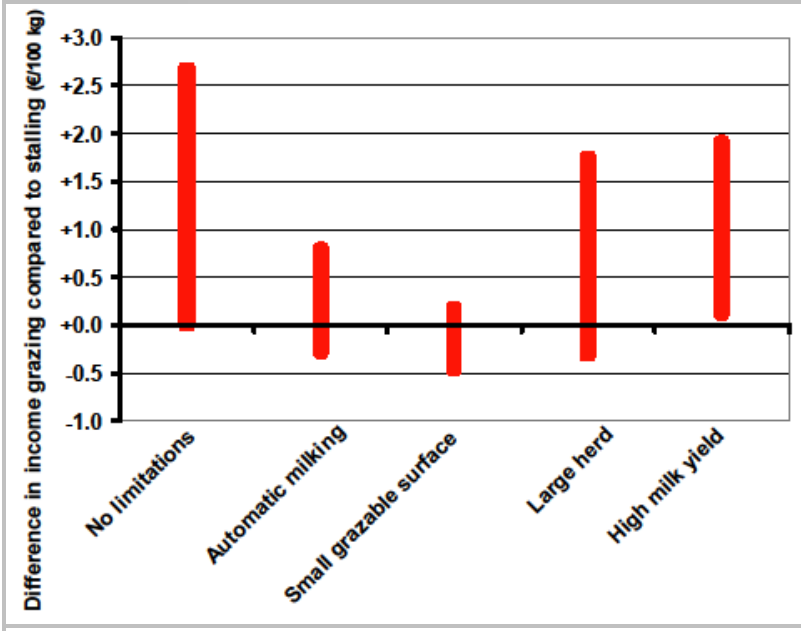
Evers et al. (2008) use a detailed budget model of Dutch dairy farms (BBPR) for an economic comparison between grazing and no grazing technologies. The

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

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 is at 20,000 kg of milk/ha €0.00 to €1.75/100 kg of milk.' (Evers et al., 2008)

Results are summarised in Figure A4.1. The figure 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 A4.1 **Difference in income between grazing and no grazing in difficult circumstances summarised. Amounts in € per 100 kg of milk. A positive figure indicates that income is higher with grazing than with housing**



Source: Evers et al., 2008.

Aggregated average farm income per type of dairy cow in DRAM is presented in Table A4.2. An important difference with Evers et al. (2008) is that these figures are obtained from observed figures from real farms. Table A342 distinguishes between farm income under observed technology and alternative technology. 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.

Table A4.2	**Assumptions on family farm income under grazing and no grazing (€/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 extended grazing	>28%	***5.3***	1.3	4
Source: own assumptions LEI Wageningen UR, based on Evers et al., 2008				

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 difference between farm income under observed and alternative technology should be positive. Following indications found in Evers et al. (2008), we assume a difference in farm income between observed technology and alternative technology (about 16.7% grazing) of €1,2 per 100 kg of milk in favour of the observed technology for cow type no-grazing. For cow type 5-16.7% grazing 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.

Finally, we assume symmetry in the sense that marginal costs of a switch from full or extended grazing to no grazing is equal to the marginal costs of a switch from no grazing to full or extended grazing.

A4.4 Model calibration and modelling continuous and flexible adjustments

To reproduce the observed situation 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.

Sensitivity analysis

For the sensitivity analysis described in Section 5.3.3 initial marginal costs (or PMP terms) are obtained from the first step of the PMP, namely solving the constrained optimisation model (Howitt, 1995). Elasticities between the above mentioned PMP terms and the number of dairy cows range from about 1.5 for cow types 0-5% grazing to about one for cow types 85-100% grazing. The latter elasticity means that marginal costs increases with 1% as the number of dairy cows in that category increases with 1%.

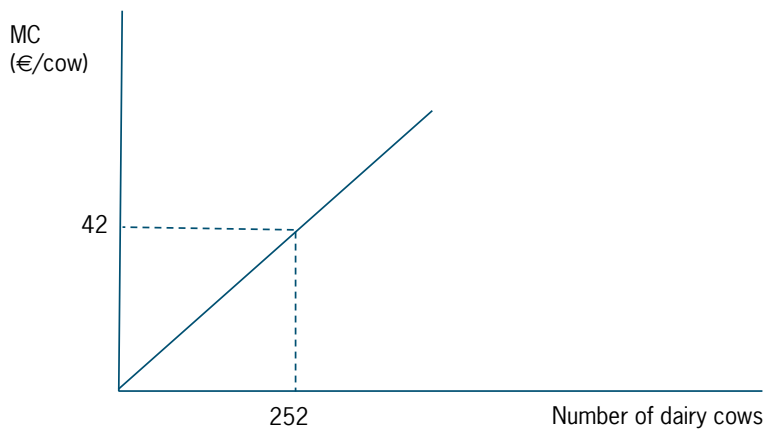
Scenarios

For the analysis of the scenarios the simulation behaviour of the model is considered rather different as the focus is now on the trade-off between technologies.

Marginal revenue (MR) is now considered equal to the difference in farm income between the observed technology and the alternative technology (see Table A4.2 above). These differences are assumed constant in real terms for 2025. In the initial situation we assume that markets are in equilibrium and marginal revenue are equal to marginal costs (MC) per type of dairy cow per region. MC are again written as equation (1). The elasticity between marginal costs and number of dairy cows per type is assumed equal to 1 for all types of dairy cows and regions. As the focus is on technology switch the elasticity should be interpreted as fifty per cent of the number of dairy cows per type of cow have a MR (equal to MC) of fifty per cent of the MR in the initial situation (is calibration point).

A graphical example of equation (1) under scenario analysis for the category 16.7-25% grazing is given in figure A4.2 below.

Figure A4.2 **Relationship between marginal costs and number of dairy cows for category 16.7% and 25%**



Source: Evers et al., 2008.

Next, to reproduce the observed situation with respect to number of dairy cows per type per region, the marginal costs per type of dairy cow per region are subtracted from the so-called PMP term. As mentioned above the PMP term

is obtained from the first step of the PMP, namely solving the constrained optimisation model (Howitt, 1995). Equation (1) is included as a quadratic 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.

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 will increase. More farmers will choose for grazing and the number of dairy cows in the category above 16.7% grazing will increase. Part of marginal costs modelled as equation (1) will increase. MC increases also because the grazing premium will be at least partly incorporated in the land prices. This process continues until MR and MC are in equilibrium again for all cow types. The change in number of dairy cows per category will be relatively large if the grazing premium or land prices changes are large in comparison to the marginal revenue.

Appendix 5

Structural changes in the Dutch dairy sector in the standard scenario 2025

The distribution of the total milk production over the different types of dairy cows in the standard scenario for 2025 is determined following different steps. First the growth rates per type of dairy cow as found in the Dutch FADN over the period 2005 to 2010 are calculated. This is the first column in Table A5.1. Yearly growth rates are especially large for cow types 0-5% and 5-16.7% grazing.

Table A5.1 **Yearly growth rates of total milk production per type of dairy cow (%)**

Grazing system	Farm/cow type (% grazing)	Growth rate FADN	After correction with 50%	After lining up with given total milk production
No grazing	0-5	13.7	6.8	3.9
Restricted grazing	5-16.7	13.7	6.8	3.9
	16.7-25	4.4	2.2	-0.6
	25-28	4.4	2.2	-0.6
Full or extended Grazing	28-39.3	-4.8	-2.4	-5.0
	39.3-70	-4.8	-2.4	-5.0
	70-85	-4.8	-2.4	-5.0
	85-100	-4.8	-2.4	-5.0

Source: Informatienet, processed by LEI Wageningen UR.

If we would apply growth rates of Table A5.1 over the period 2010 until 2025, milk production in the Netherlands would increase with about 300%. This is of course not realistic. To solve this problem it is assumed that the FADN growth rates should be corrected with 50%. This correction also reflects that the growth rate is extended over a much longer period (2010-2025) than that it is calculated (2005-2010). As a third and final step the growth rates are lined up in such a way that they correspond to the expected total milk production in the Netherlands in the standard scenario 2025.

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