# Phosphate Production Reduction Decree of the Netherlands

Impact on markets, environment and dairy farm structure

Roel Jongeneel, Co Daatselaar, Myrna van Leeuwen and Huib Silvis

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# Preface

The Dutch ministry of Economic Affairs has asked Wageningen Economic Research (formerly LEI Wageningen UR) to assess the impact of its Phosphate Production Reduction Decree (PPRD). This decree is aimed at reducing phosphate production by the Dutch dairy sector in such a way that the restrictions following from the Phosphate ceiling are satisfied. The assessment focusses on the impacts of the PPRD on the dairy markets and on the structure of the dairy farming sector.

The study has been carried out by Roel Jongeneel, Co Daatselaar, Myrna van Leeuwen and Huib Silvis and was reviewed by Sabine Versteden and by Hans van Meijl.

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# 1 Introduction

## 1.1 Background

*Production increase*

The Dutch dairy sector has experienced a period of production growth, both in anticipation of the abolition of the milk quota and after the quota abolition of April 2015. The dairy cow herd expanded by 9.5% from 1.48m dairy cows in 2012 to 1.62m dairy cows in 2015. In 2016, the dairy herd further increased to an estimated 1.75m dairy cows at the end of 2016. The average farm size increased by 12.6% from 80 milk cows per dairy farm to 89 milk cows per farm. The number of farms shows a steady decline. In the period 2005-2015 the decline rate was 2.36% per year.

*Non-compliance with Phosphate ceiling*

The rapid growth of the dairy production has led to an overproduction of phosphate. The Phosphate ceiling associated with the Nitrate Directive implementation for the Netherlands as a whole is 172.9m kg. Of this total, 88m kg is allocated to the pig and poultry sectors. The reference level for the Dutch dairy sector (including breeding animals) is 84.9m kg of phosphate. In 2015 phosphate production from the dairy sector amounted to 92.9m kg. As a result, national phosphate production increased to 180.1m kg, more than 4% in excess of the national phosphate ceiling.

*Package of measures with respect to Dutch dairy sector*

The Dutch government and the dairy sector have developed a package of measures in order to make the Netherlands compliant again with the national phosphate ceiling by 2017. The package is aimed at reducing phosphate production by the Dutch dairy sector by 8.2m kg in 2017. The package consists of:

1. Measures to reduce the contents of phosphates in dairy feed
2. Measures to support the termination of dairy farming businesses and
3. The Phosphate Production Reduction Decree (PPRD).

*Phosphate Production Reduction Decree (PPRD)*

The PPR plan of ZuivelNL was a plan for the private sector, based on an agreements between milk processors and farmers. The Dutch government now proposes to implement the phosphate production reduction scheme through a Ministerial Decree (based on Article 13 of the Dutch Agricultural Act). As a consequence of this the policy is no longer dependent on concluding an agreement between all involved farmers and processors. Whereas the decree is meant to replace the PPR plan, its content is generally similar to the PPR plan with one important difference. The important difference is that the Milk Payment Scheme is not included in the Decree and therefore will not be an option for farmers. All farmers will be obliged to follow the Livestock Unit Reduction scheme.

## 1.2 Research questions

This research has been commissioned by the Ministry of Economic Affairs. Wageningen Economic Research, an independent research institute, has been asked to assess the market impacts and environmental impacts of the PPRD. The following research questions were defined:

- Assess the impacts of the PPRD on the dairy market, with special attention paid to:
    - The supply of milk and other dairy products in the Netherlands (including the possibility for imports to replace production eliminated by the PPRD);
    - The stability of markets for milk and other dairy products in the Netherlands;
    - The prices of milk and other dairy products for consumers in the Netherlands.

- Assess the effects the PPRD will have on the structure of the dairy farming sector, more specifically on the different types of farming systems (extensive vs. intensive, land-based vs. non-land-based, organic vs. non-organic farming)

## 1.3 Structure of the research

The following steps have been taken to answer the research questions:

- Modelling analysis: The market impacts of the PPRD on milk and other dairy products are assessed. To make a quantitative assessment of the relevant market impacts the partial agricultural equilibrium modelling tool, called AGMEMOD, is used. The market impacts are assessed relative to a baseline. This baseline differs from the current situation in that it includes the full impacts of the other measures either taken by the Dutch government (Measure to support the termination of dairy farming businesses) or the Dutch feed producers (Measure to reduce the contents of phosphates in dairy feed).

- Farm structure analysis: The sustainability aspects of the PPRD are assessed with a particular focus on different types of farming systems. The direct impact on the reduction of phosphate production is important to demonstrate the proportionality of the PPRD. The indirect impacts regard the impacts on farm structure and the repercussions this could have on the environment. A farm structure analysis is made, which uses information from the farm structural change literature and farm management analysis.

# 2 Impact on milk and dairy markets

## 2.1 Introduction

This chapter analyses the impact of the PPRD on the milk and dairy markets, with a special focus on milk supply, the stability of markets and the prices of dairy products for consumers.

## 2.2 Method for assessing impacts

*Analytical tool AGMEMOD*
To pursue the ex-ante market impact assessment the AGMEMOD model is used, which represents a partial equilibrium model of EU-28 agriculture (e.g. Bartova et al., 2009 and Chantreuil, Hanharan and Van Leeuwen, 2012). The model has a refined representation of the EU dairy sector and includes a representation of the milk supply and the markets for main dairy products, including both consumer products such as cheese, butter, drinking milk and cream and commodities such as skimmed milk powder (SMP) and whole milk powder (WMP). Moreover, it accounts for the fact that dairy products may be partly produced (imports) or consumed at the home market (exports). As regards trade, AGMEMOD is basically a net trade model. By its properties the AGMEMOD model enables a study of the impacts of the PPRD on the Dutch dairy sector taking into account not only the impacts on domestic markets, but also the related market effects with respect to other EU Member States (see Appendix I for more details).

*Selection of products*
The analysis will focus on raw milk and dairy products, or:
1. raw milk
2. drinking milk
3. cheese
4. butter
5. cream
6. SMP
7. WMP

*Scenario*
The market impacts are assessed relative to a baseline. The baseline includes the impacts of i) Measures to reduce the contents of phosphates in dairy feed and ii) Measures to support the termination of dairy farming businesses. The PPRD scenario assesses the impact of the reduction in dairy cows implied by the Decree on milk supply and dairy product markets.

The AGMEMOD model has recently been aligned to the EU's Medium Run Market Perspectives (EU Commission, 2016). This implies that, with respect to the dairy markets (e.g. raw milk price), the prices are in line with the prices as they are expected in the EU Commission's medium-term outlook while accounting for a price transmission factor[1]. The baseline has been constructed by adding the impact of the Measure to support the termination of dairy farming businesses leading to an estimated reduction of the Dutch dairy cow herd by 60 thousand dairy cows to this medium-term outlook. Also the impact of the Measure to reduce the contents of phosphates in dairy feed is included in the baseline, but this did not have a direct effect on milk and dairy product markets.

[1] Based on the EU's medium-term market perspectives the milk price recovers in 2017, but less strongly then currently perceived by Dutch dairy farmers, who seem to orient themselves on recent monthly prices rather than on annual prices. In this chapter, following the EU's medium-term outlook, a milk price of about 31 euros per 100 kg of milk has been used. This choice has been made, because it was felt that this Commission's information is the most up-to-date and that takes into account a host of relevant factors inside and outside the EU, thus explaining the milk price and its movement.

## 2.3 Impact on milk supply

**Herd adjustment and yield shift**

The PPRD aims to reduce the cattle stock by 100,000 livestock units. Based on a farm-level analysis, which takes into account that farmers can reduce livestock units by reducing their dairy cow stock and/or their young cow stock, the composition of the animal reduction has been assessed (see Table 2.1). The reduction in livestock units[2] consists partly of dairy cows (see Table 2.1) and partly of other cattle. The dairy cow herd will be reduced by an estimated 35 thousand livestock units.

***Table 2.1*** *Reduction in dairy cattle herd due to the PPRD*

| Animal category | Animal numbers | Livestock Units |
|---|---|---|
| Dairy cows | 35,000 | 35,000 |
| Young dairy cattle 1-2 years of age | 85,605 | 45,400 |
| Young dairy cattle 0-1 years of age | 84,274 | 19,600 |
| Total | 204,879 | 100,000 |

Source: Wageningen Economic Research.

The change in the dairy cow herd will be the main driver explaining the impact the PPRD will have on the milk supply. The dairy herd at the beginning of 2017 is estimated to be 1.75m. The reduction of the Dutch dairy cow herd induced by the PPRD is thus 2%.

## 2.4 Market impacts: milk and dairy products

As a result of the reduction in the dairy herd, raw milk production and the production of dairy products will decrease in 2017 (see Table 2.2). The estimated decline in milk production is slightly lower than the percentage decline in the dairy herd (-1.7% rather than -2%). Because farmers have an incentive to discriminate low productivity dairy cows (slippage effect), there is a positive and counteracting average yield shift.

As a result of the PPRD Dutch milk production will decline by 248 thousand tonnes. When relating this to EU-28 milk production it implies an 0.15% reduction in the EU milk supply. During the last decade the average deviation of the Dutch milk supply due to different types of shocks has been 4.4%. A one year shock of -1.7% in 2017 would be well within the bounds of the normal supply variation.

***Table 2.2*** *The impact of the PPRD on the supply of dairy products*

| Thousand tonnes | Baseline | PPRD | PPRD vs Baseline | |
|---|---|---|---|---|
| | 2017 | 2017 | abs | % |
| Cow's milk collected | 14,655 | 14,407 | -248.0 | -1.7% |
| | | | | |
| Drinking milk production | 619 | 609 | -10.0 | -1.6% |
| Butter production | 253 | 249 | -4.0 | -1.6% |
| | | | | |
| Cheese production | 926 | 912 | -14.0 | -1.5% |
| Cream production | 12 | 11 | -1.0 | -3.3% |
| Skimmed milk powder (SMP) production | 60 | 59 | -1.0 | -1.7% |
| Whole milk powder (WMP) production | 159 | 156 | -3.0 | -1.9% |

Source: AGMEMOD simulation.

[2] A livestock unit (LU) is defined in this analysis as a standard dairy cow with a milk yield of 8,480 kg (2016 production level), which produced 42 kg phosphate per annum (cf. Netherlands Enterprise Agency, 2016). Young stock of class 101 has a phosphate production per animal of 9.6 kg and young stock of class 102 has a phosphate production of 21.9 kg.

As a consequence of the reduction in milk supply the supply of processed dairy products declines about proportionally. In terms of the AGMEMOD model the impacts on dairy products come from two sources:

i. the change in raw milk supply, which is the ingredient for all dairy products.
ii. changes in relative milk and dairy product prices.

The main impact explaining the changes in dairy product supply is the change in the raw milk supply. Because of the limited change in the milk supply and the well-integrated dairy product markets, the impact on dairy product prices is very limited (see also section 2.5 below). As a consequence relative prices stay more or less constant. This implies that dairy processing firms have limited incentives to further optimise their dairy product mix relative to the baseline situation.

Although the differences are marginal, the results suggest that consumer products like cheese, butter and drinking milk (cream being an exception) are less affected, whereas WMP will have a tendency to be relatively more affected. This pattern fits in with what one would expect based on a valorisation-pyramid perspective, where cheese, butter and milk-based products are often more attractive from a value added perspective than commodities such as the milk powders.

## 2.5 Impact on consumer prices

Table 2.3 illustrates the impacts on prices. The raw milk price received by farmers is expected to increase by 0.1 euro per 100 kg of milk due to the PPRD (the increase is less than 0.5%). As already expected from the minor change in the raw milk production volume, the impacts on prices of the PPRD are negligible. This also holds for the impact on the prices of consumer products such as butter, cheese and cream. An implication of these stable dairy product prices is that the consumption of dairy products by Dutch consumers is not expected to change but that Dutch net exports of dairy products are likely to adjust instead.

***Table 2.3*** *Impacts of PPRD on prices of raw milk and dairy products*

| Euro/100 kg | Baseline | PPRD | Market impact in 2017 PPRD vs Baseline | |
|---|---|---|---|---|
| | 2017 | 2017 | Abs | % |
| Raw milk price | 31.2 | 31.3 | 0.1 | 0.3% |
| | | | | |
| Butter price | 337.0 | 337.4 | 0.4 | 0.1% |
| Emmenthal cheese price | 333.2 | 334.9 | 1.7 | 0.5% |
| Cream price | 320.3 | 320.3 | 0.0 | 0.0% |
| Skim milk powder price | 207.4 | 207.4 | 0.0 | 0.0% |
| Whole milk powder price | 279.6 | 279.9 | 0.3 | 0.1% |

Source: AGMEMOD Simulation.

During the last decade the annual variation (deviations from the long-term trend) of the Dutch milk price has been 10.2 percent. In this perspective a 0.3% increase in the milk price as a result of the PPRD is of a negligible order of magnitude and not a factor affecting market stability.

## 2.6 Discussion and conclusion

This chapter assesses the impacts of the PPRD on Dutch milk supply, the stability of markets for milk and dairy products and consumer prices. From the previous analysis the following results are obtained:

- As a consequence of the limited reduction in the number of dairy cows (-2%) the impact of the PPRD on the milk supply (-1.7%) is limited.
- The impacts on the supply of dairy products are roughly proportional to the change in the milk supply and is less than 2%.
- The impact on the price of raw milk is an increase of 0.3% (equivalent with €0.1/100 kg).
- The impact on the prices of dairy products (e.g. drinking milk, cheese, butter, cream) is limited and does not exceed an increase of 0.5%.
- The impact on the prices of dairy commodities, which are highly traded and for which a deep EU and world market exists, is negligible.

From these results it can be concluded that there is a limited impact on the Dutch milk supply and an even more limited impact on the milk supply in the EU. As a result, the derived impacts on milk and dairy product markets (volumes and prices) are also limited to negligible (e.g. SMP and WMP prices). As such, market stability in Dutch, other Member States or EU dairy markets will not be changed as a result of the PPRD. This is further emphasised when the obtained volume and price changes are placed in the context of the normal variation observed for these variables due to different types of regularly occurring shocks (e.g. weather) to the system. Due to the minimal impacts found for consumer prices, the PPRD does not put consumer interests, such as access to safe and cheap food, at stake.

# 3 Impact on environment and dairy farm structure

## 3.1 Introduction

In this chapter the environmental impacts are addressed, with a strong focus on the effects of the PPRD on the different types of farming systems (extensive vs. intensive, land-based vs. non-land-based, organic vs. non-organic farming).

## 3.2 Method for assessing impacts

For the assessment of the sustainability impacts, in particular their relation to the farm structure, a four-step procedure has been used:

1) An assessment has been made of the impact on different farm types by assessing how the proposed plan has been designed and the implications this has for the ways in which farms are likely to be affected;
2) Accessing data sources which can help to quantify the impact on different farm types (e.g. in terms of the number of farms and/or number of dairy cows);
3) A literature review on which factors are driving farm structural change and how sensitive farm structural change is with respect to short-run shocks or policy changes.
4) The direct environmental and indirect environmental impacts are determined by applying established manure nutrient excretion factors (differentiated with respect to milk yields).

In order to address steps 1 and 2, a farm-level analysis has been made, which enables a comparison between the different choice options available to famers and takes into account farm heterogeneity. The technical details of the followed methodology (e.g. phosphate excretion rates, etc.) are available in a separate internal document.

The literature review on structural change includes Breustedt and Glauben (2007), Huettel and Jongeneel (2011), Zimmermann and Heckelei (2012) and Jongeneel (2014 and 2015). It indicates that important structural change drivers in the dairy sector are technology (economies of scale), productivity growth, farm household characteristics, input and output prices as well as macroeconomic drivers, such as unemployment rates. Since farm structural change involves important investment decisions, farmers' expectations about medium to long-run expected values with respect to these drivers are important. Incidental movements in markets and policies, such as the one-year PPRD, are not likely to generate significant long-run impacts on the farm structure evolution. The policy that will prevail after 2017 (a phosphate quota system) might be more important in that respect.

## 3.3 Estimated phosphate production reduction

The reduction in phosphate production follows from the changes in animal numbers. Using the dairy cattle reduction numbers as these are provided in Table 3.1 below and the phosphate-excretion numbers for specific animal categories as well as milk yield levels, it follows that the estimated phosphate output reduction associated with the PPRD is 4 million kg of which 1.32 (one third) is due to a reduction of dairy cow livestock units.

***Table 3.1*** *Estimated phosphate production reduction of PPRD*

| | PPRD | | |
|---|---|---|---|
| | # animals (x1000) | change in # animals | change m kg of phosphate |
| Dairy cows | 1,773 | -35,000 | -1.32 |
| Young stock 0-1 year | 633 | -19,600 | -0.81 |
| Young stock >1 year | 643 | -45,400 | -1.87 |
| | | | -4.00 |

Source: authors calculations using forfait excretion factors.

Note that the environmental impacts of phosphate are directly related to the manure application on land. This application is constrained by the application standards directly or indirectly following from the Nitrate Directive including the derogation provision. These hold irrespective of farm structure issues such as farm size and production intensity. As such the reduction in manure production induced by the PPRD is not likely to lead to a change in the application of manure on land. It is more likely that manure processing will be affected and that less manure will have to be processed.

## 3.4 Dairy herd growth and herd size

As regards the impact of the PPRD on the dairy farm structure Table 3.2 provides further information about the dairy herd sizes corresponding to the different growth size classes for both the middle of 2015 (the reference moment) as well as at the start of 2017. Note that these are average herd sizes for each growth size class. This Table has been central in the calculations made with respect to the number of dairy cows that have to be reduced for different growth categories. Table 3.2 is based on 2016 end of year data and already accounts for the reduction of the number of dairy farms by 1000 aimed for by the Measures to support the termination of dairy farming businesses and an associated reduction of 60 thousand dairy cows.

***Table 3.2*** *Classification of Dutch dairy farms according to their growth in dairy cow herd*

| Classification according to growth rate in period 1-7-2015/1-11-2016 | Number of dairy farms 1-1-2017 | Number of dairy cows 1-7-2015 | Number of dairy cows per farm 1-7-2015 | Number of dairy cows 1-1-2017 | Number of dairy cows per farm 1-1-2017 | LU to be reduced per farm |
|---|---|---|---|---|---|---|
| No dairy cows anymore | 0 | 1,990 | 60.3 | | | |
| A. < - 4 | 1919 | 216,668 | 88.1 | 191,489 | 77.9 | 0.0 |
| B. >= - 4 < 0 | 1821 | 186,772 | 99.2 | 181,752 | 96.5 | 1.3 |
| C. >= 0 < 5 | 3493 | 349,921 | 98.4 | 355,916 | 100.1 | 5.6 |
| D. >= 5 < 10 | 3166 | 322,752 | 101.4 | 344,183 | 108.1 | 10.8 |
| E1. >= 10 < 15 | 2335 | 237,231 | 101.0 | 264,306 | 112.6 | 15.6 |
| E2. >= 15 < 20 | 1438 | 141,876 | 98.1 | 165,206 | 114.3 | 20.1 |
| E3. >= 20 < 25 | 851 | 79,911 | 93.4 | 96,894 | 113.2 | 23.6 |
| E4. >= 25 < 30 | 477 | 41,385 | 86.3 | 52,340 | 109.1 | 26.3 |
| E5. >= 30 < 35 | 267 | 23,625 | 88.0 | 31,026 | 115.5 | 31.1 |
| E6. >= 35 < 40 | 174 | 14,288 | 81.6 | 19,487 | 111.3 | 33.0 |
| E7. >= 40 < 45 | 126 | 10,005 | 79.1 | 14,132 | 111.7 | 35.8 |
| E8. >= 45 < 50 | 83 | 7,262 | 87.0 | 10,625 | 127.3 | 43.8 |
| E9. >= 50 < 75 | 160 | 11,687 | 72.6 | 18,445 | 114.5 | 44.9 |
| E10. >= 75 | 132 | 6,627 | 50.0 | 15,855 | 119.7 | 47.9 |
| Dairy cows new | 120 | | 0.0 | 11,344 | 94.0 | 37.6 |
| | | | | | | |
| Total | 16562 | 1,652,000 | 95.7 | 1,777,300 | 103.4 | |

Source: ZuivelNL, adapted by Wageningen Economic Research, based on figures of Van Bruggen (to be published).

## 3.5 Farm size: large versus small dairy farms

Figure 3.1 (bars and left axis) shows the distribution of the average herd size over the different size classes for the reference which is the middle of 2015. The distribution over classes A to E10 seems rather uniform at first sight with an exception being the right tail. Figure 3.1 also shows the growth rates (dots, right axis), which increases over the classes A to E10 as expected, since the classes are developed according to farm growth rates over the period 2015-2017. It demonstrates that a negative correlation exists between observed growth rates and the herd size. This correlation is -0.93, implying that dairy farms with a smaller herd size have expanded relatively more strongly than farms with large herd sizes. This is further confirmed in Figure 3.2, which shows the herd size distribution after the growth has been realised (at 1 January 2017) which, as a result of this, is now more equal (except for class A). However, one should be careful in drawing too strong conclusions from that. A large part of the observed expansion in dairy herds has already taken place before July 2015, as farmers anticipated the milk quota abolition. When extending the period of analysis (e.g. from 2015-2017 to 2013-2017) it is possible that an opposite relation could be found.

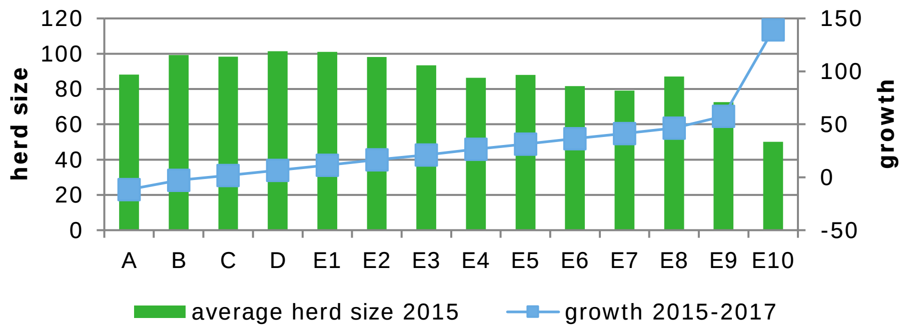


**Figure 3.1** *Average herd size in reference year 2015 and growth achieved in the 2015-2017 period*

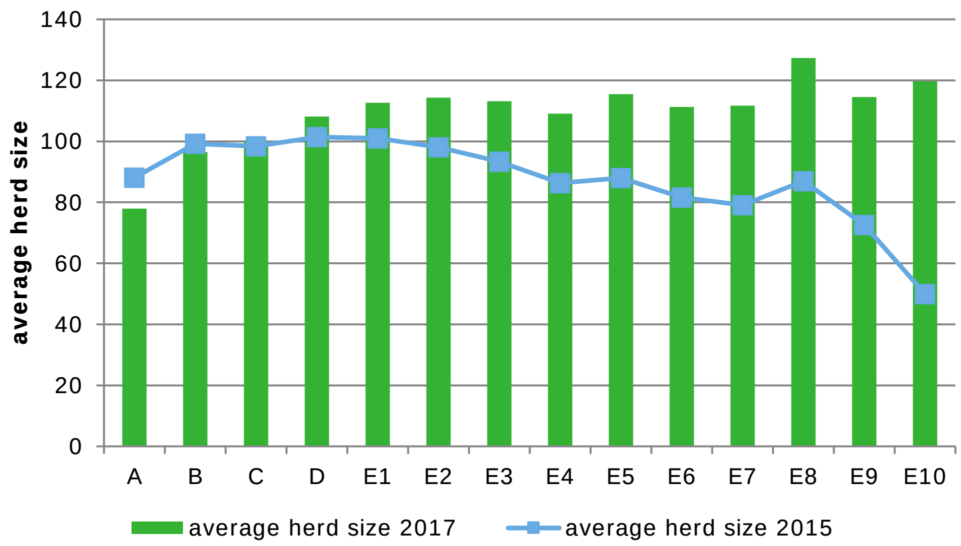


**Figure 3.2** *Average herd size in 2017 for different growth-size classes*

Figure 3.3 (based on FADN data) shows the relationship between farm size and herd size growth for the 2013-2015 period during which farmers already anticipated that the milk quota would be abolished in 2015. The left axis of this figure denotes the herd size, whereas the right axis shows the growth achieved up until 2015 measured as an index (e.g. 110 means a 10 percent herd size increase). Dairy farms are not only categorised by their scale (herd size), but also by their phosphate surplus per hectare (three size classes: <0, 0-20, >50 kg/ha). Note that farms with a herd size of 80-120 dairy cows showed a relative strong growth, while both relatively small farms (<80 dairy cows) and relatively large farms (>180 dairy cows) showed lower and even negative growth rates.

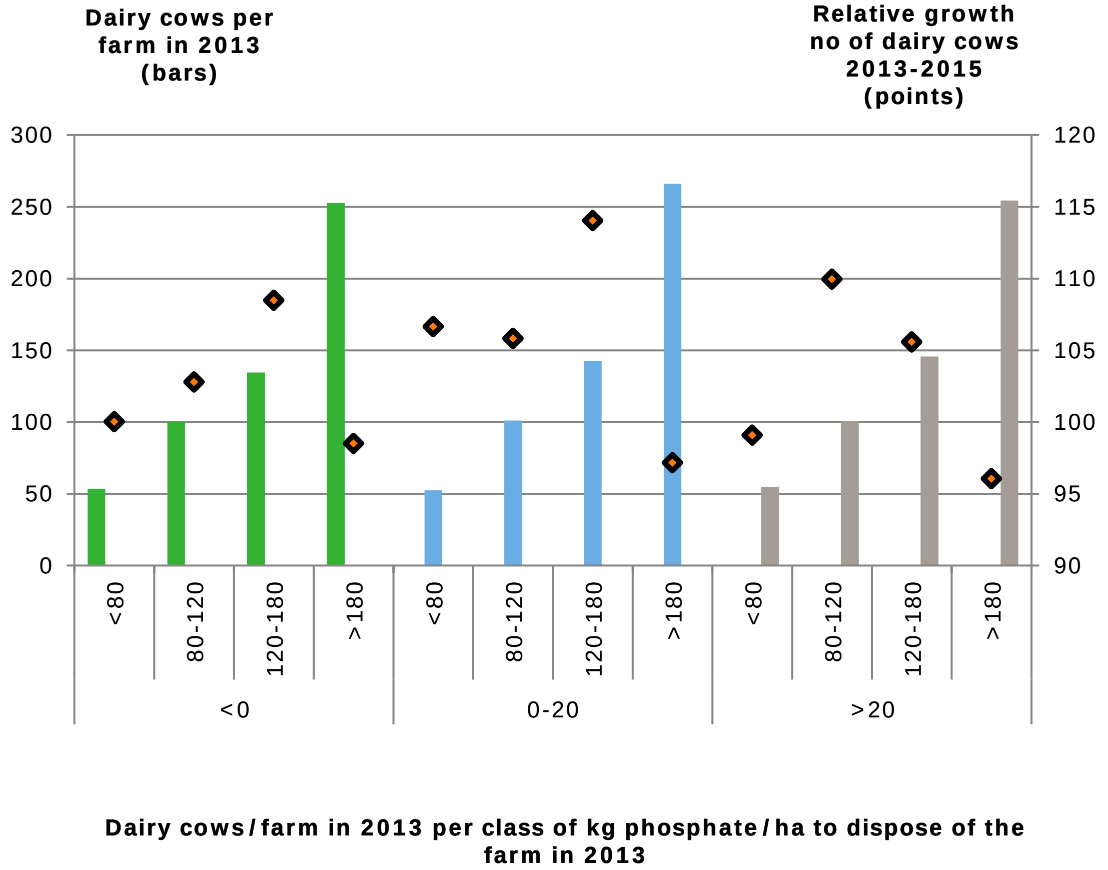


**Figure 3.3** *Farm size and growth in period 2013-2015*

As regards the impact of the PPRD on the dairy farm size structure evolution in general it should be recognised that the PPRD, when implemented, will hold for only one year, after which another policy regime (a phosphate quota system) will be implemented. As such the plan is likely to lead to a one year suspension of the farm scale increase. The longer run evolution of the dairy farm size structure (e.g. farm size evolution) is, however, not likely to be changed in a significant way due to a one year constraint on production and/or herds. When a phosphate quota system is implemented from 2018 onward, farms showing a relative strong growth will have to acquire sufficient phosphate quota rights in order to sustain their high production level. Therefore a phosphate quota system will probably slow down and restrict the increase. It is possible that the difficulty in acquiring such rights will induce them to also reduce their herd size after 2017.

## 3.6 Intensive vs. extensive farms

For the years 2013 and 2015 estimates about the milk production per hectare could be made using the FADN data. It shows that for the 2013-2015 period the growth rates were highest for dairy farms already producing more than fifteen thousand kg of milk per hectare (see Figure 3.4).[3] Although there are large differences between individual farms, the fifteen thousand kg milk per hectare-indicator can be argued to be a reasonable proxy for the Netherlands to determine to what extent milk production is land-based (in Dutch this is called *grondgebonden*).[4] In any case, the growth rate in the number of dairy cows has exceeded the growth in land per farm. As can be seen from Figure 3.3, during the period 2013-2015 relative intensive dairy farms (see farms with a phosphate surplus of more than 20 kg per hectare) did not differ that much in their expansion path from that of farms with a lower intensity of production. However, since then regulation has been imposed which links farm growth to land (see below).

It might be assumed that for the period middle of 2015 to the beginning of 2017 a similar pattern holds, as has been observed for the period 2013-2015. However, according to a recent Order in Council (Algemene Maatregel van Bestuur), expansion in milk production is no longer possible for farms with higher phosphate productions per hectare without at the same time extending the land base.[5] This implies that, in general, landless growth of milk production is no longer possible. Since this constraint only holds for a part of the production growth it is still the case that additional production growth will lead to additional mandatory manure processing. An exemption are those farms (about one third of the total number of farms) which currently have no manure surplus: they can expand their production without facing the need to increase their land base up until a phosphate surplus of 20 kg per hectare. However, The Order in Council will generally further limit intensification of production relative to a situation without this constraint.

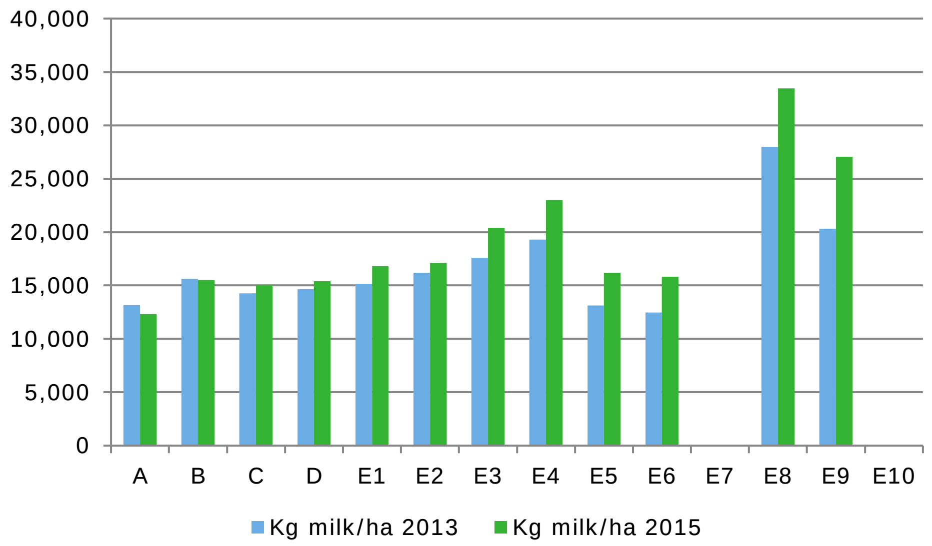


**Figure 3.4** *Milk production per hectare for 2013 and 2015 as estimated based on FADN data*

## 3.7 Land-based vs. non-land-based farms

The PPRD includes a general reduction of 4% in the number of Livestock Units (relative to the reference level of July 2015) which is applicable to all dairy farms. However, during the design phase of the plan, an exemption has been made for farms that are satisfying the criteria of *grondgebondenheid* (as requested by the Parliament). Dairy farms that are labelled as land-based (*grondgebonden*[6]) are defined as those farms that have no manure surplus and can place all the manure produced by their dairy herd on their own land. Based on 2015 data it is estimated that this exemption applies to about 38% of the dairy farms and 23% of the dairy herd. So in the PPRD these

[3] For growth-size classes E7 and E10 there were insufficient observations from the FADN to be able to report a reliable number.

[4] A popular understanding of 'land-based' is that a farmer is self-sufficient with respect to roughage. Note that here 'land-based' refers to the ability of farmers to place all the manure that is produced by their dairy herd on their land (no manure surplus) taking into account the application standards as they are defined in the applicable regulation.

[5] This measure became effective 1 January 2016.

[6] See also the reference in the previous section to this category.

land-based dairy farms enjoy preferred treatment in that they get a lower livestock unit reduction obligation. Note that, given that the PPRD aims for a fixed absolute reduction in phosphate production, this exemption for *grondgebonden*-dairy farms implies that dairy farms not satisfying this criterion have to reduce their livestock units more strongly than otherwise would have been the case. Note also that these *grondgebonden* dairy farms will generally be dairy farms that have a less intensive system of production (lower milk production per hectare of pasture and fodder area) than the average dairy farm.

Dairy farms which have strongly expanded their herd size since July 2015 (see growth classes E10 and New in Table 2.1 above) also implicitly receive favourable treatment. It is highly unlikely that dairy farms have to reduce their livestock units by more than 40% (a reduction of 20% or less seems more likely; see Jongeneel et al, 2016). This implies that all dairy farms which in the recent past have expanded their herd with more than 40% do not have to remove the full percentage amount. However, in absolute terms, they still have to make significant livestock unit reductions per farm (e.g. Table 3.2, right column). As can be seen from Table 3.2 this group concerns at maximum about 250 dairy farms, which is a relatively small group.

## 3.8 Organic vs. non-organic farms

About 2% of the Dutch dairy farms are organic farms. These organic farms all classify as land-based dairy farms, implying that these are also exempt from the 4% general livestock unit reduction requirement (see previous section). Moreover, due to their zero or negative phosphate surplus, these farms are allowed to grow to an average level of 20 kg phosphate per hectare, before they are required to buy additional land.

## 3.9 Discussion and conclusion

In the previous sections the impacts of the PPRD are analysed with respect to different types of farming systems. The aim of this assessment is to provide insight into the short-run impacts as well as into the longer-run repercussions to the sustainability performance of the Dutch dairy sector.

The PPRD implies a reduction of 100 thousand livestock units. Taking into account optimised dairy farmer choices, this will lead to a reduction of 35 thousand dairy cows. The remainder (65 thousand livestock units) will be realised by reducing young stock (86.6 thousand young dairy cattle 1-2 yrs of age and 84.2 thousand young dairy cattle 0-1 yrs of age). The aggregate impact of this is a reduction of phosphate production by 4 million kg. In combination with the other measures that are foreseen the obtained phosphate reduction should be sufficient to bring Dutch national phosphate production back within the constraints of the agreed phosphate ceiling. The reduction in livestock units induced by the PPRD will lead to a decline in the emissions of ammonia and greenhouse gasses (indirect environmental effect).

There exists a negative correlation between the observed growth rate during the2015-2017 period and the herd size, implying that farms with a low herd size have expanded relatively more than farms with already large herd sizes. In general dairy farms with small and very large herd sizes showed below average herd size growth rates which is a finding that is in line with the farm structural change literature.

The PPRD is minimally expected to lead to a one year suspension in 2017 of the farm scale increase which is a temporary deviation from the long-run trend. However, their increase will depend on their ability to acquire phosphate quota rights.

Extensive farms (land-based; milk production tied to land and no phosphate surplus) face a lower livestock reduction requirement than more intensive farms. Furthermore, farms that show an 'extreme' growth in the recent past (including new entrants) enjoy a certain extent of preferential treatment since there is a cap on the maximum livestock reduction rate. Land-based farms (defined as *grondgebonden*-dairy farms) are exempted from the general 4% livestock reduction rate (see also above). Organic farms normally all qualify as land-based dairy farms and thus face a lower than average livestock reduction rate (4 percentage points). Usually organic farms will have some room for landless growth.

As a result of the exemption made for land-based dairy farms (including organic farms), non-land-based dairy farms face higher livestock reduction rates than would have otherwise been the case.

# 4 Conclusions

The aim of this research is to answer questions with respect to market impacts and sustainability aspects of the Phosphate Production Reduction Decree. Table 4.1 summarises the main findings.

***Table 4.1*** *Summary of impacts of the PPRD*

| Question | Answer | Reference |
|---|---|---|
| | *Market impacts* | |
| Milk supply | The milk supply is expected to decline by 1.7% due to a 2% decline in the 2017 Dutch dairy cow herd | Section 2.3 |
| Stability of milk and dairy product markets | The obtained reduction in production volumes of dairy products are proportional to the projected milk supply decline and in general less than 2%. | Section 2.4 |
| Consumer prices of milk and dairy products | The impact on the prices of dairy products (e.g. drinking milk, cheese, butter, cream) is limited and in all cases does not exceed an increase of 0.5%.<br>The impact on the prices of dairy commodities is negligible.<br>The impact on the farm gate price of raw milk is an increase of 0.3% (equivalent with €0,1/100kg). | Section 2.5 |
| | *Environmental impact for different types of farming systems* | |
| General impact | The PPRD will lead to a targeted reduction of 4 million kg phosphate.<br>As the application of manure is constrained by application standards, no major environmental impacts are expected.<br>The reduction in livestock units induced by the PPRD will lead to a decline in the emissions of ammonia and greenhouse gasses (indirect environmental effect). | Section 3.3 |
| Farm structure | A negative correlation exists between the observed growth rate in the recent period and the herd size, implying that farms with a low herd size have expanded relatively more than farms with already large herd sizes.<br>The PPRD is minimally expected to lead to a one year suspension of the farm scale increase in 2017 (temporary deviation from the long-run trend). | Sections 3.3, 3.4 and 3.5 |
| Extensive vs. intensive dairy farms | Extensive farms (*grondgebonden*; land-based milk production and no phosphate surplus) face a lower livestock reduction requirement than more intensive farms.<br>Also farms that show recent extreme growth(including new entrants) receive a certain extent of preferential treatment since there is a cap on the maximum livestock reduction rate, though in absolute terms they have to reduce the largest number of livestock units per farm. | Section 3.6 |
| Land-based vs. non-land-based dairy farms | Land-based farms (defined as *grondgebonden*-dairy farms) are exempted from the general 4% livestock reduction rate (see also above). As a result of this exemption non-land-based dairy farms face higher livestock reduction rates than would have otherwise been the case. | Section 3.7 |
| Organic vs. non-organic dairy farms | Organic farms normally all qualify as *grondgebonden*-dairy farms and thus face a lower than average livestock reduction rate(4 percentage points). Usually organic farms will have some room for landless growth. | Section 3.8 |

The general picture emerging from this assessment is that the impacts of the Phosphate Production Reduction Decree of the Netherlands with respect to milk and dairy product markets is very limited. This is because the PPRD leads to an estimated 2% reduction of the dairy cow herd and an even more limited decline of Dutch milk production (-1.7%). Moreover, dairy product markets are highly integrated in the EU and also in the rest of world (e.g. SMP and WMP), which limits the impacts on prices (competition/arbitrage).

As regards the environmental and sustainability impacts, especially those related to the different types of farming systems, the PPRD tried to find a balance in which land-based milk production farms (*grondgebonden*-dairy farms) including organic farms, face a lower livestock unit reduction rate and in which farms that have shown a high herd size growth rate and made large investments during the 2015-2017 period do not have to reduce their herd for the full percentage amount of their past growth.

*Limitations of the analysis*
With respect to the sector level analysis (Chapter 2) it should be noted that the AGMEMOD model has an annual periodicity, implying that annual impacts and annual average price changes are reported. The PPRD implies that cows and young stock will be reduced on a weekly basis. These within-year dynamics are not covered by AGMEMOD. In determining their output mix, the dairy processing industry is also likely to take into account the availability and constraints with respect to production capacity which are not directly included in AGMEMOD. For this analysis this is not expected to have created any problems since the observed changes are relatively small.

With respect to the farm structure analysis (Chapter 3), it is difficult to make an estimate about the longer-term consequences of a one year phosphate reduction programme like that of the PPRD, because structural change has to do with longer-term expectations about the profitability of dairying (e.g. the milk price) and costs of production including the impacts of environmental regulation.

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# Appendix 1 AGMEMOD - modelling tool

The AGMEMOD EU Member State model is a dynamic and multi-product partial equilibrium model in which a bottom-up approach is used (Chantreuil, Hanharan and Van Leeuwen, 2012). Based on a common model template, individual country models reflect the specific situation of the agriculture market in individual Member States, the EU as a whole and the rest of the world. This bottom-up approach allows for the inherent heterogeneity of EU agro-food commodities to be captured, while simultaneously maintaining analytical consistency across all the individual country models. The incorporation of EU and national policy instruments and macroeconomic driving factors in each of the country models allows AGMEMOD to provide market outlooks up to 2030 (year-by-year projections) in terms of supply, demand, trade and market prices of agro-food commodities. Moreover, it allows for analysing the impacts of issues like new supportive policy instruments, changes in macroeconomic circumstances and changes in world prices for oil and biomass.

In addition to the crop sector AGMEMOD covers the livestock and dairy commodity markets in the EU member states:

- raw milk and dairy products, drinking milk, fresh dairy products, cream, butter, cheese, skimmed milk powder and whole milk powder;
- beef & veal, pork, poultry and eggs
- cereals and oilseeds input for feed

Elements of these commodity markets for which AGMEMOD provides results up to 2026 are:

- dairy and cattle herd, land use, production, consumption, imports, exports, food processing, feed (all measured in volumes);
- EU and national prices per commodity (euro/100 kg).

The AGMEMOD-model has been used in various policy impact analyses and market impact studies. For a recent application to the EU dairy sector see European Commission (2016).

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