Economic and environmental viability of regionally growing feed concentrate replacers

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Abstract

In an exploratory study on the impact of land use options on environment and farm income we considered closing nutrient cycles, clustering of agricultural activities and, as a combination of these two, the cooperation between dairy and arable farms. In the search for alternative feeds that can reduce the use of soybean from Brazil for feeding cattle, we investigated to what extent the growing of feed concentrate replacers by arable farmers within the region could be of interest economically. For this study our pilot area was part of the provinces of Brabant and Limburg (larger Peel region). We quantified the effect of growing up to 20, 40, 50, 60, 80 or 100% of the feed concentrate replacers within the region by replacing the least profitable arable crops by these crops (e.g. lupins, peas and beans). We found that the farm income would not be affected by replacement of up to 60% of the foreign feed concentrates by regionally grown feed concentrate replacers. However, replacement of more than 60% would reduce income. Cultivation of the new crops hardly affected nitrogen and phosphorus leaching to groundwater. But spatial optimization of land use conversion resulted in 10 to 20% reduction of nitrogen and phosphorus leaching. This means that cooperation between arable farmers growing feed concentrate replacers and dairy farmers using these products for feeding their livestock could be both economically and environmentally viable.

Keywords: land use, spatial optimization, dairy farming, regional cooperation, nutrient leaching

Introduction

Dairy farming in the Netherlands is facing many challenges, like the need to improve sustainability and of course maintain profitability. For an exploratory study on the impact of land use changes aimed at improving sustainability (for both environment and farm economy) we tried to define future land use scenarios. We decided to study the impact of land use change scenarios for a pilot area which is intensively used for agriculture. This pilot area is De Peel in the southeast of the Netherlands, covering parts of the provinces of Brabant and Limburg. We defined three scenarios: (1) business as usual; (2) closing nutrient cycles; and (3) clustering agricultural activities. The 'business as usual' scenario was characterized by larger but fewer farms with decreasing job opportunities. In the scenario 'closing nutrient cycles' all animal manure is applied within the region and this would result in less agricultural production and less employment (Cormont *et al.*, 2012). A more realistic option might be the 'clustering agricultural activities' scenario. As a combination of closing cycles and clustering we also considered cooperation between dairy and arable farms. Arable farms can use the manure produced by cattle and dairy farms can use fodder crops form arable farms. In the search for alternatives reducing the use of soybean from Brazil for feeding cattle, we then also investigated to what extent growing of feed concentrate replacers by arable farmers within the region could be of interest economically (Cormont *et al.*, 2013).

Materials and methods

For an analysis of land use change scenarios, data and tools are necessary. We used available regional data on land use, farms, cattle and grown crops from the Dutch geographical agricultural database GIAB, registered field data and data from the national statistics agency. From these data we generated information on cattle per farm, regional demand for fodder crops and feed concentrates, employment,

farm income etc. For assessing environmental impact we used the model STONE (Wolf *et al.*, 2003) and for spatial optimization we used the tool 'Waterwijs' (Van Walsum *et al.*, 2002).

The STONE-model can simulate leaching of N and P to groundwater and surface water, linked to a hydrological model which simulates water and nutrient flow within the soil and a model for deep groundwater flow. Fertilizer and manure supply are important input parameters together with meteorological data, soil characteristics, crop characteristics and regional hydrology.

Optimization within 'Waterwijs' is performed using meta models embedded in an algorithm for mathematical optimization, in this case 'Mixed Integer Linear Programming'. The meta model for our study was derived from the STONE results (Van Walsum *et al.*, 2014).

Based on the amount of cattle in the region we calculated the demand for fodder crops and feed concentrate replacers (Cormont *et al.*, 2013). From this demand the required area for these crops was determined. Considering the gross margins of currently grown crops in the region we decided for this scenario that the non-fodder crops with the lowest gross margins could be replaced by feed concentrate replacers, such as lupins, peas and beans.

The environmental and economic effects of replacing arable crops by feed concentrate replacers was quantified using the model STONE (environmental effect) and the data on gross margins within the agricultural regional database (economic effect). We varied the amount of feed concentrate replacers from 0 to 100% and thus quantified the effects of growing up to 20, 40, 60, 80 or 100% of the feed concentrate replacers within the region by replacing the least profitable arable crops by these crops.

Results and discussion

We found that the farm income for the region would not or hardly be affected by replacement of 20, 40 and even 60% of the foreign feed concentrates by regionally grown feed concentrate replacers (Cormont *et al.*, 2013). An increase to more than 60% would reduce income (Figure 1).

For the scenario where 60% of the required feed concentrates is replaced by regionally grown feed concentrate replacers, the simulated nitrate and phosphorus leaching to groundwater was only slightly affected. Only small increases of nutrient leaching were predicted. Spatial optimization of this land use

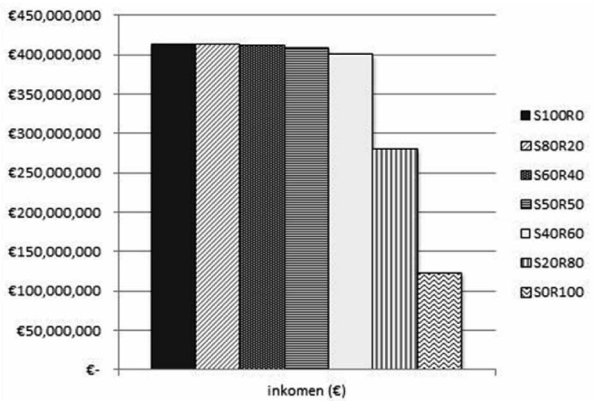

Figure 1. Regional total farm income (€) for different scenarios.
S100R0 = 100% 'standard' feed used and 0% regionally grown feed concentrate replacers; S80R20 = 80% 'standard' feed used and 20% using feed concentrate replacers (regionally grown), etc.

conversion resulted in a 10 to 20% reduction of nitrogen and phosphorus leaching (Van Walsum *et al.*, 2014). This is caused by the differences in hydrological conditions and soil characteristics.

Conclusions

The results of this exploratory study show that cooperation between arable farmers growing feed concentrate replacers and dairy farmers using these products for feeding their livestock could, potentially, be both economically and environmentally viable. The environmental benefits can be enhanced by carefully choosing where these new crops are grown. It is also worthwhile to investigate further the impact on the environmental global footprint. The footprint of feeding cattle might be reduced by regionally growing feed concentrate replacers, whilst maintaining economic profitability.

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