Developing mixed farming systems at regional level: examples from intensive dairy farming

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Abstract

Improving agricultural sustainability through innovative mixed farming systems (MFS) is the scope of the EU project CANTOGETHER. MFS may refer to activities on a single farm and/or to cooperation between farms (e.g. animal and crop production). Combining agricultural production with biodiversity and environmental goals may also be involved. To design such systems, participatory methods were used. This paper discusses two regional case studies dominated by intensive dairy farming that aim to reduce N losses. The first case study concerns the region of Winterswijk (NL), where intensive dairy farming is combined with nature conservation areas to maintain an attractive landscape and improve water quality. In cooperation with the District Water Board, practices to reduce both N and P losses have been implemented. The second case study concerns the Lieue de Grève catchment (F), where dairy farmers aim to reduce nitrate leaching by implementing, at regional and farm levels, a set of systemic indicators for N inputs and stocking rates per ha of grassland. Here the aim is to guide production systems towards better agro-ecological performance. Reduction in farm losses have been scaled up to the regional level using simple calculations for the Winterswijk region and the CASIMOD'N model for the Lieue de Grève region. For the region of Winterswijk, application of the practices to all suitable fields would reduce potential losses of N by 123 Mg and of P_2O_5 by 72 Mg, amounting to 8-9% of the N applied in the area as manure and chemical fertilisers and 19-20% of the P_2O_5 applied. In the Lieue de Grève catchment, increasing the percentage of grassland in the agricultural area (by 25 percentage points) would maintain milk production and decrease nitrate-N losses by about 30% (-8 mg $NO_3^- l^{-1}$). Conditions for implementing changes at the regional level are mentioned.

Keywords: mixed farming systems, dairy farms, N and P losses, CASIMOD'N model

Introduction

Improving agricultural sustainability through innovative mixed farming systems (MFS) is the scope of the EU project CANTOGETHER (Crops and Animals Together). Innovations in MFS are targeted at improving nutrient use and reducing nutrient losses. We studied intensive dairy farms that aim to reduce N and/or P losses, working closely with regional stakeholders to preserve the landscape. The case studies are located in the region of Winterswijk (139 km^2, the Netherlands) and in the Lieue de Grève catchment (120 km^2, France; Moreau *et al.*, 2013). For the design of MFS in CANTOGETHER, use is made of a participatory method. For both regions, the type of integration is identified as 'territorial synergy' (Moraine *et al.,* 2014).

Materials and methods

For both case studies, MFS at the regional level may result from cooperation between stakeholders and consideration of regional characteristics (Figure 1). The Winterswijk region is characterised by a 'coulissen' landscape, a mosaic of agricultural lands, hedgerows and woodlots, dominated by intensive dairy farming. The area comprises 8,000 ha of agricultural area (AA). Most dairy farms in the region have been granted a derogation (till 2013 based on 70% grass and 30% maize in each farm's AA) that gives them higher manure-application limits. Thirteen dairy farms agreed to take measures to improve water

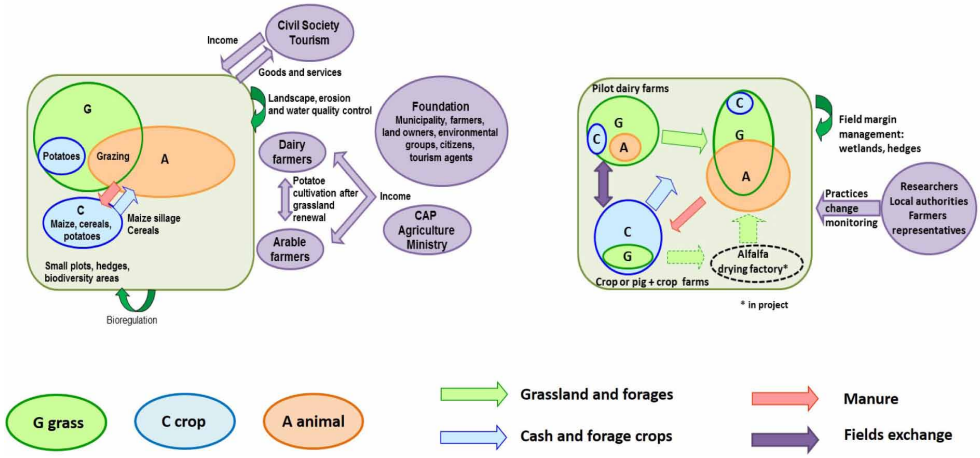

Figure 1. Regional development of mixed farming systems in the case studies Winterswijk (left) and Lieue de Grève (right).

quality. For each practice, the reductions in losses of N and P_2O_5 achieved were calculated from analyses of crop and soil samples. In workshops and telephone interviews, farmers were asked to evaluate the ease of implementation and economics of the practices. Using data on the area of each land use in the region and farmers' evaluations, potential reductions in N and P losses for the Winterswijk region as a whole was quantified (Den Boer and De Haas, 2013).

The Lieue de Grève catchment, 65% of which is AA, comprises 170 farmers, mostly dairy and/or beef producers (some specialized) who aim to reduce nitrate leaching drastically by implementing at the regional and, as far as possible, farm level, a set of co-built systemic indicators of N inputs and stocking rates per ha of grassland. The aim is to guide production systems towards better agro-ecological performance. A working group of stakeholders (1) worked with eight pilot dairy farms that modified their practices or production systems to implement the indicators, and (2) extrapolated the changes to all farms in the catchment with the CASIMOD'N model, which included farmers' main decision rules concerning land use and manure management (Moreau *et al.*, 2013).

Results and discussion

In the Winterswijk region, the farms implemented over 10 agricultural practices during a 2-year period. Application of the practices to all suitable fields in the region would reduce potential losses of N by 123 Mg and of P_2O_5 by 72 Mg. This amounts to 8-9% of the N applied in the area as manure and chemical fertilisers and 19-20% of the P_2O_5 applied. Promising practices for reducing N and P are 'application of manure in the row (maize)', 'no manure if soil P is high', and 'use of a nitrification retarder (with mineral fertiliser)'. The farmers identified the practices 'green crops' and 'raising pH' as economically attractive. They considered that not applying manure if soil P is high was not economically viable, since extra mineral P_2O_5 fertiliser would be required and farmers would have to pay for manure disposal.

In the Lieue de Grève catchment, two types of results were compared: (1) observed changes in farm practices and certain N fluxes in the eight pilot dairy farms between initial (2007) and final (2011-2013) states, and (2) predicted N fluxes at the catchment level if all cattle farmers achieved target values of indicators (stocking rate: ≤1.4 livestock units (LU) ha^{-1} grassland, N input: ≤100 kg N ha^{-1}). Most dairy farms in the catchment chose to maintain or increase milk production (from a mean of 370 to 430 Mg $year^{-1}$ $farm^{-1}$ for the eight pilot farms), became more grass-based, and decreased bull fattening and maize or cereal area. The percentage of grasslands increased from 53 and 54% of AA in pilot farms

and the catchment, respectively, to 65 and 68%. Mean values of indicators moved toward target values, decreasing for the pilot farms from 2.5 to 2.0 LU ha^{-1} grassland and from 91 to 68 kg N ha^{-1}. Simulating attainment of target values by all dairy farms at the catchment level predicted a strong decrease in nitrate concentration in water at the outlet (from 28 mg NO_3^- l^{-1} in 2007 to 20 in 2020), still far from the target value of 10 mg NO_3^- l^{-1}. Results also show that soil N balances of pilot farms were higher than the mean soil N balance predicted at the catchment level.

Conclusions

Intensive dairy farms that undertake practices to maintain landscape quality and improve water quality can be regarded as a specific type of MFS. The technical results of the case studies in Winterswijk and the Lieue de Grève catchment are promising. Adjusting the management of intensive dairy farms to maintain nature values and abiotic ecosystem boundaries of the regional landscape resulted in a wide range of practices. Some of these practices were economically viable, while others were not. Payments for specific ecosystem services, regionally devised by stakeholders, could stimulate farmers to implement these practices. For further development of the MFS studied, ecological intensification applied at the regional level is advocated. For this, networks for knowledge exchange and collective design and trials of innovative practices should be organized to move towards more integrated systems.

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