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Sustainable meat and milk production from grasslands

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Dairy farming and biodiversity: seeking for a better balance

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Abstract

Sustainable agriculture is an important component of many of the 17 Sustainable Development Goals agreed upon by the UN in 2015. However, the trend in agriculture is moving in a non-sustainable direction. Agriculture is one of the major drivers of biodiversity loss. Next to biodiversity loss due to habitat destruction by conversion of natural lands into agriculture, intensification of agriculture has led to a strong decline of specific farmland biodiversity. Furthermore, many agricultural landscapes face pollution by pesticides and fertilisers and encounter depleted soils and erosion due to unsustainable farming practices. This is threatening biodiversity, complete ecosystems and the ecosystem services on which agriculture itself depends. Moreover, the pressure of feeding an increasing number of people in combination with a change in diets towards more animal protein puts a lot of additional pressure on the current available agricultural lands and nature areas. We propose an holistic approach for sustainable agriculture that contributes to the development and implementation of sustainable practices in dairy production that make use and support biodiversity and ecosystem services. A dairy production system based on the full potential of (functional agro) biodiversity provides opportunities to create a resilient system.

Keywords: agriculture, biodiversity, sustainability, ecosystem services, conceptual framework

Introduction

Biodiversity can be described as the richness and diversity of all life on earth. Biodiversity is not just about the individual species, but also about the diversity of ecosystems, species and genes and the relationship between them (Convention on Biological Diversity). Occupying 70% of the land area of the Netherlands, the agricultural landscape is the largest habitat for plants and animals. A large number of these species depend on the agricultural landscape as their prime habitat. However, in recent years species which are important for the Netherlands, like the black-tailed godwit (*Limosa limosa*), lapwing (*Vanellus vanellus*), partridge (*Perdix perdix*) and the skylark (*Alauda arvensis*), have declined. Strikingly, the most significant cause of the decline of meadow birds lies in their breeding grounds in the Netherlands, rather than elsewhere along their migratory route (Wereld Natuur Fonds, 2015; PBL, 2014). The dairy sector uses 40% of the terrestrial area of the Netherlands. As such, the sector has a large impact on the biodiversity in the agricultural landscape. Moreover, the dairy sector is one of the largest contributors to nitrogen deposition in nature areas, which is considered one of the main causes of ongoing biodiversity loss in open nature areas (Dise *et al.*, 2011).

Biodiversity is not only relevant for nature but also for agriculture, which often has specific biodiversity which contributes to ecosystem services, such as soil biota, pollinators, butterflies, etc. Therefore, decline of these species in nature also affects agriculture. Agriculture in turn can contribute to the increase and conservation of biodiversity. Agriculture has different functions of which production of food, feed and fibres and sustaining socio-economic structures and management of ecosystem services are the most important. In doing so, agriculture often makes use of and contributes to the services provided by ecosystems, such as healthy soils. In a resilient agricultural system, farming practices provide a good balance between the exploitation and use of biodiversity, ecosystem services and the natural surroundings.

In these systems, the challenge is to optimise food production while at the same time minimising impacts on the environment and the ecosystem. The notion that agriculture depends on biodiversity and that many specific species of animals and plants depend on sustainable agricultural landscapes is key in the approach of resilient agricultural systems. Both agriculture and nature can benefit from an holistic approach towards resilient systems. This approach focuses on an optimal use of agro-biodiversity and a reduction of long-term (economic and natural) risks by using ecosystem services rather than external inputs.

To promote resilience (as described in the resilience model) on dairy farms, an integrated approach is required (Buckwell *et al*., 2012). The starting point of the proposed conceptual framework is the desire to reverse the decline of biodiversity and on the other hand to better use and enhance biodiversity on the farm. Considering the importance and function (promoting resilience and reducing risks) of biodiversity on dairy farms, it is important to enhance the functional (agro) biodiversity. Functional (agro) biodiversity enhancement, however, is not enough and should be supported by landscape elements and diversity and the connections of biodiversity source areas in an area including several other farms and land uses.

We distinguish four interconnected pillars for biodiversity (Figure 1).

1. Functional (agro) biodiversity on the farm. This encompasses management of soil biodiversity, including rooting systems, grass- and cropland biodiversity, and the diversity of farm animals, the cycles of nutrients, water and energy on the farm (soil, crop, cow, business); optimised by using the functional agro-biodiversity and to serve as a basis for underground and aboveground biodiversity, water management, carbon sequestration, nutrient use, etc. The intensity of a farm largely determines whether cycles are closed at the farm level.
2. Landscape diversity at the farm: influence of the landscape elements (hedges, ditches, flower zones, trees and forests, etc.) to support the functional agro-biodiversity.
3. Specific species management (mowing, fertilisation timing, water management, etc.) at the farm for maintaining and increasing specific species (e.g. farmland/meadow birds).
4. Source areas and connection zones (landscape): management within an area (ecological corridors, exchange and connection of dry and wet zones, regional biodiversity, etc.) (Erisman *et al*., 2016).

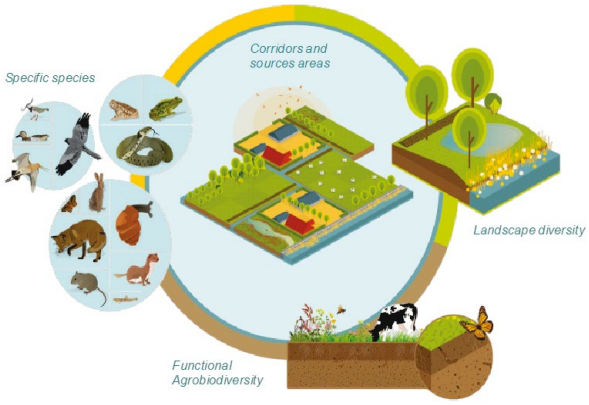

Figure 1. Four interconnected pillars for biodiversity in and around. agriculture. It starts with optimising the functional Agrobiodiversity (pillar 1), supported by landscape diversity (pillar 2), measures for maintaining specific species can be taken (pillar 3) and corridors and source areas for biodiversity (pillar 4) (Erisman *et al*., 2016).

These four interconnected pillars form the basis of the conceptual model and help the farmer to manage the farm sustainably. It builds on the force of nature which is determined by the potential of the land, region and climatic circumstances by focusing on soil, roots, grass and mineral cycles (pillar 1), supported by the region specific landscape elements (pillar 2) in connection with biodiversity sources areas, hydrological and landscape features (pillar 4). Except for the third pillar, the farmer benefits from focusing on the improvement of the other three. The third pillar is mainly for promoting the biodiversity value of agriculture and to preserve vulnerable species which depend on the agricultural land for breeding and food.

Conclusion

A paradigm shift is needed in agriculture to stop the large-scale loss of biodiversity. At present, the risks in intensive agriculture are managed by a so-called (risk) control model based on externalities, with important side effects such as risks of social costs and decreased function of natural processes. In a resilient system, risks are lower, thereby reducing costs and increasing biodiversity. Adaptive risk management is most successful when a portfolio of measures is taken. This can be achieved by focusing on four interconnected levels of biodiversity for sustainable management of ecosystem services (functional (agro) biodiversity; landscape diversity; specific species management; source areas and connection zones). The proposed conceptual framework provides a basis to derive strong indicators at the four levels and therewith forms a basis for measures of biodiversity enhancement and building farm resilience. These levels also provide the basis for a system of reward or other incentives. By managing (bio)diversity in agriculture, sustainable agriculture can contribute to reaching several Sustainable Development Goals such as clean water and climate mitigation and adaptation.

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