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Farm and landscape management for ecosystem services in the Hoeksche Waard

Willemien Geertsema¹, Joana Frazão², Mirjam Pulleman² and Paul van Rijn³

¹Centre for Crop Systems Analysis, Wageningen University
P.O. Box 430, 6700 AK Wageningen

²Department of Soil Quality, Wageningen University
P.O. Box 47, 6700 AA Wageningen

³Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam
Science Park 904, 1098 XH Amsterdam

Introduction

Three research projects in the programme Biodiversity Works are being conducted in the agricultural landscape of the Hoeksche Waard. The projects focus on the relation between farm and landscape management and the performance of ecosystem services that support crop production, including natural pest control, pollination, improving soil quality and water regulation. The collaboration with stakeholders of these projects is in many cases a joint action. In this contribution we describe these joint actions, focussing on the way researchers collaborate with stakeholders and the expected output of the projects. First we will start with a short description of how the different approaches of the three projects complement each other and how they are related to farm and landscape management. Next we will describe how the projects collaborate with the stakeholders in the Hoeksche Waard and how knowledge is developed together.

Ecosystem services in the agricultural landscape of the Hoeksche Waard

The Hoeksche Waard is an intensively used agricultural landscape that is characterised by open polders surrounded and crossed by dikes and intertwined with a network of creeks and ditches. Land use is dominated by annual crops, mainly potatoes, sugar beet, cereals and some vegetables. Stakeholders (including individual farmers, farmers' organisation LTO, agri-environmental collective Rietgors, water board Hollandse Delta, nature and landscape conservation organisation Hoekschewaards Landschap, municipalities, and Province of Zuid Holland) share the ambition to improve natural pest control, pollination, soil quality, water purification, biodiversity and landscape aesthetics. This is a response to concerns regarding the observed negative externalities of agricultural practices such as loss of biodiversity, run-off of pesticides, and loss of soil and water quality. Different measures have been taken to achieve the aims (creating flower strips in field margins, reduced tillage, adjusted management of landscape elements). At the same time, the group of stakeholders is keen to learn about improving the effectiveness of management actions, to scale up from field to landscape level, and to increase understanding of trade-offs and synergies between different ecosystem services. The three projects focus on different aspect of this relation between farms, landscapes and ecosystem services.

The first project is aimed at understanding the interaction between soil properties, arable management and surrounding landscape in their effect on earthworm communities in arable fields and in field margins. This relation is studied with field surveys and experiments (Figure 1). Preliminary results indicate that field margins sustain different earthworm communities than the adjacent arable fields, and that residue management can increase the abundance of the epigeic species *Lumbricus rubellus* (epigeic species live in upper soil layers, are important decomposers). However, increasing the abundance of anecic species (build burrows into mineral soil layers, improve soil structure) with adjusted soil and residue management remains hard. The project aims to advise farmers about which management options improve the diversity of the earthworm community and how this effectively improves soil quality.



Figure 1 | Field experiment in the Hoeksche Waard with focus on residue management in a mouldboard ploughed (*left*) and in a non-inversion tillage (*right*) arable field and its impact on earthworms. In the ploughed arable field the position in the soil profile and quantity of residue provided were investigated, whereas in the non-inversion tilled field, the focus was on the quantity of residue. *Photos: J. Frazā*

The second project studies the relation between landscape composition and natural pest control. The question is how the composition of a landscape (with different annual crops, flower strips, road verges, woodlots, etc.) influences the abundance and persistence of predatory insects (such as hoverflies) and their impact on aphid pests in crops (Figure 2). This question is studied with population dynamics models that are fed with field data (collected in the Hoeksche Waard) on resource availability within different habitats. The results show that for effective pest control hoverflies need different ('complementary') habitats to complete their life cycle: e.g. woodlots for shelter and for prey, nectar and pollen in winter and spring, different crops for aphids in early and late summer, and flower strips for nectar and pollen close to these crops. These results are used in the discussion with stakeholders about management and spatial design of crop rotation and non-crop habitats in the Hoeksche Waard.



Figure 2 | Landscape in the Hoeksche Waard different habitats: arable field, sown flower strip, ditch banks, woody habitats. Each habitat provides different resources to natural pest enemies: prey or hosts, floral resources, shelter. *Photo: P. van Rijn*

The third project aims to integrate knowledge about different ecosystem services in the design and management of agricultural landscapes, including the Hoeksche Waard. The project develops knowledge about the seasonal distribution of resources (mainly pollen and nectar) for beneficial insects in the landscape and how that influences the potential for pollination and pest control. The project integrates this kind of knowledge with insights from other projects about the relations between farm and landscape management and the delivery of ecosystem services. These relations will be integrated in the landscape optimisation model 'Landscape Images'. Understanding trade-offs and synergies between ecosystem services and other landscape functions is an important issue in this project. It takes the different objectives and ambitions of different stakeholders into account.

Collaboration with stakeholders

The three projects collaborate with stakeholders for various purposes. In some activities the projects act together, and in others they operate separately, depending on the phase of the project and the aim of the activity. The separate activities mainly relate to field surveys and experiments. Here we focus on the joint activities.

In the early stage of the projects (2012), two joint workshops were organised. The first one was a kick-off meeting, where a landscape design game was played with project members and stakeholders to exchange ideas about multifunctional landscape design and communicating and discussing the aims of the projects. The second one was organised to discuss with stakeholders their ambitions concerning the future development of the landscape. Not only local stakeholders, but also provincial and national governments were represented. An inventory was made how the objectives of the stakeholders relate to different ecosystem services. The stakeholders were also asked to identify management actions that were needed to realise the different objectives. The results of this workshop already gave an indication of the possible synergies between stakeholders: management actions that support multiple objectives.

In a third joint meeting (spring 2013), the three projects provided more detailed information about the research and expected results. It also informed them about the relation between the different research projects. From this workshop the idea emerged to start an initiative to design and realise a real, 'ideal landscape' in two parts of the Hoeksche Waard that could function as pilots for other areas (also outside the Hoeksche Waard).

To elaborate on this idea of the 'ideal landscape', stakeholders from the Hoeksche Waard organised different meetings, field visits and a workshop in 2014 with many stakeholders from the area itself, but also representatives from agri-food organisations ('Sustainable agriculture in a sustainable landscape') (Figure 3). We participated in these activities by sharing knowledge about the role of semi-natural habitats in the landscape to support ecosystem services and we identified knowledge gaps related to this subject. The original idea for an ideal landscape was modified in the end, and resulted in a plan to identify a number of demonstration farms that each will focus on specific aspects of sustainability and implement measures to realise these specific sustainability goals.

The paragraph above illustrates that participation with stakeholders is not always a predictable process. It requires flexibility within the research plans to respond to requests from the stakeholders. External factors such as the adjustment of European agricultural policies (especially regarding greening measures within the Common Agricultural Policy reform) were modifiers of the process.

Meetings and contact with the stakeholders do not always have to be formally related to the projects. One non-project-based activity is a field practical in May each year as part of the Agrobiodiversity course for students at Wageningen University. These students stay for one week in the Hoeksche Waard, performing a number of experiments at the farms of farmers who also participated in the aforementioned workshops. The students are supervised by the researchers from the three projects and during this week there is ample contact with the farmers, but also with representatives of local government, the Hoeksche Waard Landschap and the agri-environmental collective Rietgors.

In the near future the results from the different projects will be discussed again with the stakeholders, with a focus on the options for management on the farm and landscape scale and the implications for different stakeholder groups.



Figure 3 | Field visit with a number of stakeholders (local organisations and representatives of provincial and national government). *Photo: W. Geertsema*