Enhancing biodiversity on arable farms in the context of environmental certification schemes

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INTRODUCTION

1.1 Background: the decline in biodiversity and landscape quality in agricultural districts

On agricultural farms and in farming districts throughout Europe, biodiversity has been in decline since the middle of the last century, the result of ever-increasing intensification and industrialisation of agriculture (Baldock, 1990; Swift and Anderson 1993; Fuller *et al.*, 1995; Andreasen *et al.*, 1996; Delbaere *et al.*, 1998). Among the main factors responsible for this decline in species diversity are increased use of inorganic fertilisers and artificial pesticides, simplification of crop rotations, loss of spring cropping, increased drainage and mechanization (Sotherton *et al.*, 1985; Fuller *et al.*, 1995; Robinson and Sutherland, 2002; Benton *et al.*, 2003 and others). The decline has been observed in plants, insects, mammals and birds and other species groups on both cropland and meadows as well as in adjacent semi-natural habitats (Tapper and Barnes, 1986; Tew *et al.*, 1994; Fuller *et al.*, 1995; Andreasen *et al.*, 1996; Panek, 1997; Wilson *et al.*, 1997 and 1999; Edwards *et al.*, 2000; Smart *et al.*, 2000; Bence *et al.*, 2003; Benton *et al.*, 2003; Asteraki *et al.*, 2004).

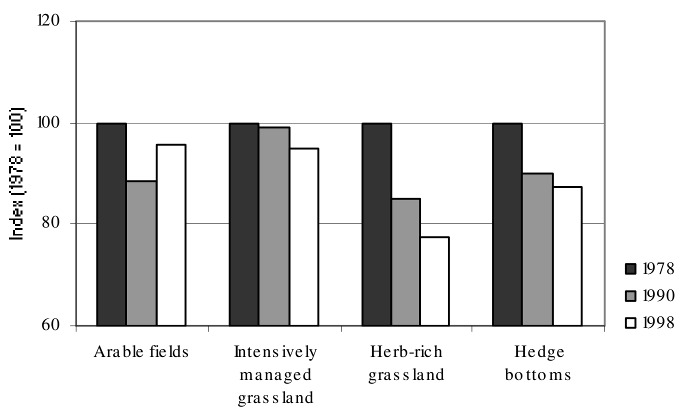

Figure 1: Changes in plant species diversity in fields and hedges in the United Kingdom (Smart *et al.*, 2003).

As an illustration, the general decline in plant and bird species diversity in the United Kingdom (Figure 1 and 2) is shown (DEFRA, 2003) and the decline in threatened plant species (the Dutch Red List of threatened species) of arable fields (Figure 3; van der Meijden *et al.*, 2000).

Figure 2: Trends in woodland, farmland and all native bird species in the United Kingdom in time (source: www.defra.gov.uk/wildlife-countryside).

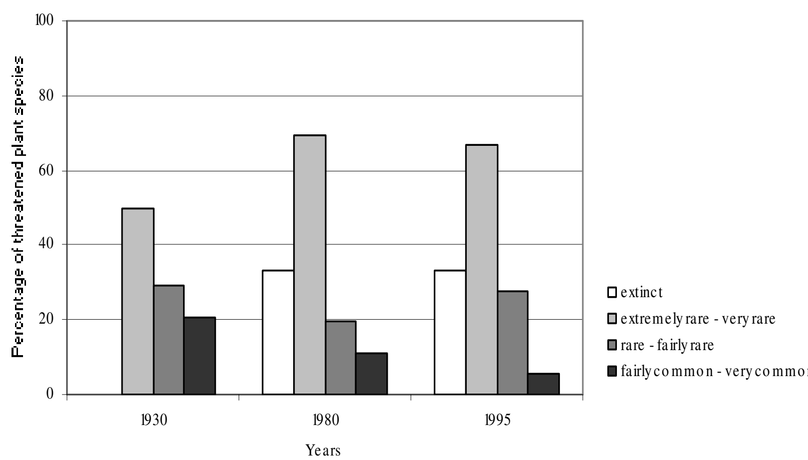

Figure 3: Changes in the presence of threatened plant species of arable fields (cf. the Red List of threatened species) per year and per rarity class based on the species presence in the Netherlands on a 1 × 1 km grid for the years 1930, 1980 and 1995 (based on van der Meijden *et al.*, 2000 and Tamis and 't Zelfde, 2003).

Besides the direct impact of agricultural intensification on biodiversity, there have also been major changes in the agricultural landscape. Fields have been enlarged and ditch banks and other semi-natural habitats like ponds and shrubs have been removed. Throughout Europe, this has led to less varied landscapes and a marked decrease in the length and area of hedgerows, ditch banks and other semi-natural habitats on farms (Boatman, 1984; Mackey *et al.*, 2001; Geertsema, 2002; van Duuren *et al.*, 2003; Hietala-Koivu *et al.*, 2004). As an illustration, Figure 4 shows the steady decline in linear semi-natural habitats in Dutch farming districts during the 20[th] century (Source: van Duuren *et al.*, 2003).

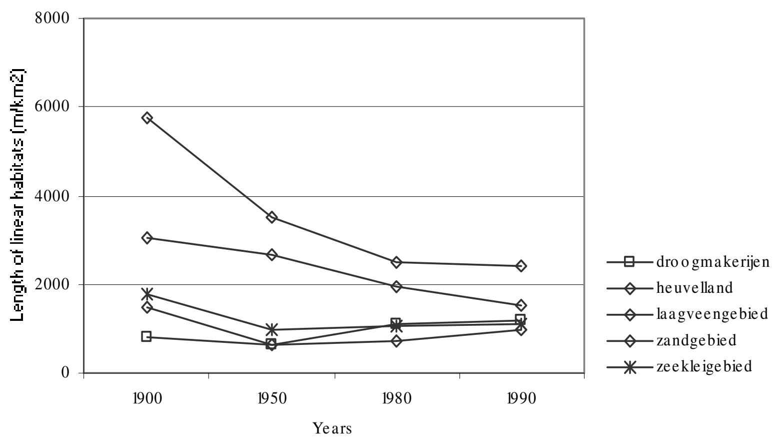

Figure 4: Trends in the length of linear semi-natural habitats (m/km^2) in the Netherlands (Source: van Duuren *et al.*, 2003). Legend: 'droogmakerijen' = reclaimed district, 'heuvelland' = hill district, 'laagveengebied' = lowland peat district, 'zandgebied' = sand district, 'zeekleigebied' = marine clay district.

For both the trends in species diversity and landscape variation, an equilibrium has been seen since the nineties of the last century (Figure 2 - 4). In the case of plant diversity in arable fields even a small increase has been noticed in the UK (Figure 1) as well as some stabilisation in the decline of extinct and extremely rare plant species of arable fields in the Netherlands (Figure 3). A possible explanation might be the start of several nature restoration projects in the 1980s (Tamis *et al.*, 2005). However, despite these improvements, further actions are required to reverse these declines.

1.2 Initiatives to improve biodiversity and landscape quality in agriculture

To reverse this decline in biodiversity and the quality of agricultural landscapes, the European Union has introduced a number of regulations and resolutions. Initiatives have also been taken by several actors in the agro-production chain, including retailers, food processors, auctioneers and farmers. The goal of most of these EU-regulations / resolutions and initiatives in the agro-production chain is to reduce farm management intensity and improve environmental quality on and around farms, as will be shown in the following brief description.

In the agricultural context the European Union has taken several initiatives to improve environmental quality and agro-biodiversity, as set out, for example, in the Common Agricultural Practice (CAP) and Agenda 2000 (European Commission, 1992; 1997). In the first place, EU-funded agri-environmental schemes have been introduced in several European countries since the 1990s with the aim of directly improving on-farm biodiversity (EEC Regulation 2078/92). The majority of these agri-environmental schemes seek to increase species richness and diversity in less-intensive farmed areas and farmers implementing them are financially compensated for income losses (Kleijn and Sutherland, 2003). They are limited in scope, being restricted to specific regions and receiving only limited funding. They also differ across regions and countries as they are implemented at the national level, with most of them geared to particular species such as Red List species or indicator species (LASER, 2004; Kleijn and Sutherland, 2003).

Secondly, 'cross-compliance' provisions were put in place, with the dual aim of supporting farmers' income and improving environmental quality (EEC Regulation 1259/1999). Dutch arable farmers, for example, receive support for maintaining cultivation-free buffer zones adjacent to watercourses as a means of reducing pesticide and nutrient drift (V&W *et al.*, 2000; LNV, 2004).

Thirdly, the European Parliament has adopted a resolution concerning the quality of agricultural produce and food products (European Parliament, 1998). This resolution, which aims to encourage development and improvement of sustainable agriculture within Europe, has motivated retailers, food processors, auctioneers and farmers to introduce guidelines for sustainable agriculture, as well as environmental certification schemes for agricultural produce and food products. Examples of introduced guidelines for agricultural produce and food products are the Good Agricultural Practice (EurepGAP) and the Sustainable Agriculture Initiative which aim to promote sustainable agriculture in Europe (EUREPGAP, 2004; SAI, 2002).

Several European countries, including the UK, Sweden and the Netherlands, have already established environmental certification schemes for agricultural produce and food products (de Snoo and van de Ven, 1999). Their express aim is to reduce the adverse impacts of intensive farming on food safety, environmental quality and biodiversity (e.g. van Ravenswaay and Blend, 1997; EHI, 1998; ICA Handlarna, 1999). Most of them focus on production of particular crops, however, with no specific intention paid to habitat management as a means of improving on-farm biodiversity (de Snoo and van de Ven, 1999). Given the need for crop rotations to maintain the cropping system, these product certification schemes cannot provide continuity of habitat management as they are keyed to crops rather than fields.

Alongside these environmental certification schemes for conventional farming, there is a similar scheme for organic farming that dates back to 1925 (www.platformbiologica.nl). Organic farming, inspired by 'holistic' thinking, seeks to achieve a balanced form of agriculture in a healthy environment with no use of artificial pesticides or fertilisers (European Council, 1997; www.platformbiologica.nl). The organic certification scheme was formalised at the European level in 1991, i.e. prior to the certification schemes for conventional farming, and in contrast to the latter is geared to overall farm management rather than to individual products. Today, 2% of farmland in Europe is organically certified (Willer and Yussefi, 2004). With its rejection of artificial pesticides and inorganic fertilisers, organic farming is generally accepted as being more environmental friendly than conventional agriculture (e.g. Gardner and Brown, 1998; Hole *et al.*, 2005). Nonetheless, on-farm biodiversity is not yet specifically incorporated in the organic certification scheme and neither in the certification schemes for conventional farming (de Snoo and van de Ven, 1999).

1.3 Objectives and research questions

A number of initiatives have thus far already been taken to improve environmental quality and to enhance biodiversity and landscape quality on farms and in agricultural landscapes. In the previous paragraph these initiatives were shown to be mostly aimed at reducing farming intensity and improving environmental quality. None of these initiatives address criteria for on-farm biodiversity in conventional agriculture in Europe. Introduction of a certification scheme for the farm as a whole, rather than for individual products, would create scope for improving on-farm biodiversity, as well as the quality of the wider landscape (Udo de Haes and de Snoo, 1997; de Snoo and van de Ven, 1999). There is therefore a need to explore a more general approach to including criteria for improving on-farm biodiversity in environmental certification schemes for arable farming and with this in mind, the present dissertation has two basic objectives:

1. to develop a methodology for assessing the effects of current arable farming practices and management regimes of semi-natural habitats on on-farm biodiversity;
2. to develop criteria for enhancing on-farm biodiversity and landscape quality for inclusion in an environmental certification scheme for arable farming.

If farmers are to be motivated to participate in such a scheme, they must have scope to directly influence progress towards the selected biodiversity targets. It must be clear that proposed adaptations or changes in farming systems, management regimes or farm layouts will have a direct, positive impact in this respect. The scheme should be applicable throughout Europe, moreover, regardless of farm types, farming practices or environmental conditions. By establishing appropriate criteria for habitat management and farm layout in combination with suitable indicators for quantifying targets and results, it should be possible to develop such a pan-European certification scheme.

In pursuit of this goal, a series of studies was carried out with the following fourfold objective: 1) to analyse the attention of current environmental certification schemes to environmental quality and on-farm biodiversity, 2) to develop indicators and threshold values for on-farm biodiversity, 3) to evaluate farmers' views regarding inclusion of habitat management in an environmental certificate and on-farm implementation of such a scheme, and 4) to apply the developed indicators in a case study comparing the plant species richness of ditch banks on organic and conventional farming. Based on the differences emerging from these studies, criteria for on-farm biodiversity are proposed for use in environmental certification of arable farms rather than their crops or products.

In the following sections, these four objectives will be discussed in more detail and research questions will be formulated.

1. Analysis of environmental certification schemes

The criteria and associated threshold values of the current Dutch environmental certification schemes for ware potatoes, fruits and vegetables were analysed and assessed with respect to methodology and completeness. This was done for five aspects of farming: pesticide use, nutrient use, water management, energy and materials consumption, and habitat management to answer the following specific research questions (Chapter 2):

- Do current environmental certification criteria address all relevant aspects of farming?
- Are the respective criteria and threshold values in these environmental schemes effective for improving environmental quality and on-farm biodiversity?

In this thesis, the term 'labelling' will refer to the certification of products and the term 'environmental certification scheme' will be used, in specific, for the certification of farm holdings. However, the labelling of products is a form of certification.

2. Indicators for on-farm biodiversity

If enhancement of on-farm biodiversity is to be included as a target in environmental certification schemes, criteria must be defined for the presence of specific species or, at a higher level, for management of semi-natural habitats, adjacent crops, farm layouts and on-farm nature conservation plans. However, independent of whichever options is used for defining the criteria: indicators and associated threshold values are needed to quantify targets and results. In addition, based on the developed indicators and other relevant results, criteria can be defined for farm certification.

These to-be-developed indicators must have relevance for on-farm biodiversity and at the same time be easy to use. They must also provide due scientific accuracy, i.e. have a clear and well-established quantifiable relationship with the target variable, and be more efficient to measure than the targets to which they relate (Vos *et al.*, 2000; Waldhardt *et al.*, 2003). They should also be generally applicable on farms throughout the EU, which means they must be able to capture a wide range of conditions regarding farm layout, farm management, farming practices, habitat management, environmental conditions and so on. Adopting quantitative threshold values for the indicator as a certification criterion will also increase the general applicability of the indicator, as results can then readily be assessed and compared.

Given these consideration, in this thesis three indicators for on-farm biodiversity have been selected for further study: on-farm acreage of semi-natural habitats (Chapter 3), plant species richness of semi-natural habitats and crops (Chapter 4) and availability of shelter sites for small mammals and birds (Chapter 5). Additional arguments for selecting these particular indicators for a certification scheme are provided in the respective chapters.

Application of the indicators developed will show results related to semi-natural habitats management regimes, farm layouts, environmental conditions and other relevant factors. These results will be used to define suitable threshold values which can be incorporated as management criteria in the environmental certification schemes.

To elaborate these indicators, a research programme was carried out on arable farms in the Netherlands. To assess practicability within an environmental certification scheme for arable farming, for each of the indicators the following research questions were addressed:

- Is it a robust indicator for on-farm biodiversity that can distinguish relevant differences in semi-natural habitats management regimes, farm layouts, environmental conditions and other relevant factors?
- What methodology can be used to apply and measure the indicator on farms?
- What threshold values are suitable for use in the certification scheme?

3. Farmers' perceptions of environmental certification schemes

Before an environmental certification scheme can be practically implemented, farmers' attitudes towards participation or non-participation need to be evaluated, as do their attitudes towards inclusion of different aspects of farming and in specific habitat management in such a scheme. To this end, the following research questions are addressed in Chapter 7:

- What are the motives for farmer participation, or non-participation, in environmental certification schemes?
- What agencies would farmers like to see involved in developing such a scheme and monitoring on-farm implementation?
- What is the farmers' opinion about their own on-farm biodiversity, the importance of well-developed semi-natural habitats and the creation of new semi-natural habitats?
- Would farmers like to see criteria for on-farm biodiversity and other aspects of farming included in the scheme?
- Do farmers have the knowledge to enhance on-farm biodiversity?

4. Case study: comparing organic and conventional farming

To compare the effects of conventional and organic arable farming on on-farm biodiversity and landscape quality, the indicators developed for acreage of semi-natural habitat, plant species richness of ditch banks and shelter site availability (Chapter 3 to 5) were applied in extended case studies (Chapter 5 and 6) that also addressed differences in farming practices, habitat management regimes and farm layouts. The following research question will be answered:

- Is organic farming more beneficial for on-farm biodiversity than conventional farming?

1.4 Thesis structure

In Chapter 2, four Dutch environmental certification schemes for agricultural food crops are compared by analysing their methodology and the completeness of their criteria for different aspects of farming.

Chapter 3 focuses on the first indicator for on-farm biodiversity: acreage of semi-natural habitats, with specific reference to conventional arable farms in the Netherlands. A small case study based on the literature is also included to compare organic and conventional farms.

In Chapter 4, the second indicator, plant species richness of semi-natural habitats and crops on conventional arable farms, is developed along with sampling areas and threshold values.

In Chapter 5, a model is developed to estimate on-farm shelter site availability for birds and small mammals, based on the vegetation structure of crops/cropland and semi-natural habitats as these vary in space and time. In a pilot study, shelter site availability for four species was assessed on organic and conventional arable farms.

In Chapter 6, the indicator for plant species richness developed in Chapter 4 is used to assess the effects of farming systems and management regimes on the plant species richness of ditch banks on organic and conventional arable farms.

Chapter 7 evaluates farmers' attitudes and motives regarding participation or non-participation in an environmental certification scheme for sustainable arable farming and the inclusion of criteria for on-farm biodiversity in such a scheme.

Based on the research described in the previous chapters, in Chapter 8 conclusions are given and recommendations are made for possible directions for future research as well as for habitat management criteria for inclusion in an agri-environmental certification scheme and the implementation of such a scheme in practice.

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