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Biodiversity in agricultural landscapes: causes, constraints and opportunities

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Contents

Abstract

In the past century, European agriculture has undergone profound changes. Through technical advances and structural changes, productivity is snowballing while farmland ecosystems are increasingly affected. These changes are taking place not only at the field scale through increased inputs and outputs, but also at the landscape scale through landscape simplification, with ecological effects being attributable to changes at both scales. While the decline of many farmland organisms in response to agricultural intensification is the most apparent effect, many of the biological functions provided by the systems biodiversity (so called ecosystem services such as pollination, nutrient cycling etc.) are also threatened, which could have great economical implications. To counter negative effects of agricultural intensification, EU Member States are using agri-environmental schemes (AESs) to incite farmers to use environmentally friendly practices. However, the effects of these schemes have been questioned both on the uncertain effects on biodiversity and on farmers' reluctance to participate. Many studies have tried to relate AES participation to characteristics of schemes, or demographics of farms and farmers including attitudes. Farmers seem to prefer schemes with flexible contract terms that only infer small changes in farm management. However, linking AES participation to farm characteristics is problematic, and studies often reach opposing results. Regarding ecological effects, lack of clearly stated objectives and the low scientific quality of the CMEF evaluations cloud the assessment of measures. Further, the effects of AESs have been found to vary with landscape composition (cleared/complex) and between taxa. With a deeper understanding of how AES effects interact with the landscape and how farmers relate to conservation initiatives, there are opportunities to improve scheme design. Collection of baseline data, evidence-based measures and result-based payments are examples of ways to advance AESs. To increase farmer engagement in AESs, participatory approaches play an important part in bridging the attitudinal gap between conservationists, legislation and farmers.

1. Introduction

Agricultural land covers almost half of the land area in the European Union. In addition to food production, these human-managed landscapes support a considerable proportion of the wildlife in this region (Pimentel et al. 1992). From a historical perspective, the practices of agrarian societies formed a heterogeneous landscape, where arable fields and meadows, together with interstitial elements such as grass margins, paths, temporary water pools, and stone fences created a habitat mosaic supporting a large diversity of organisms. In return, farmers have relied on the services provided by these organisms, including pest control, crop pollination, and sustainment of the fertility of the soil. Thus, there has been some interdependency between the farmer on the one hand, and the wildlife on the other.

However, the post-war dawn of modern agriculture has taken a high toll on agricultural ecosystems (Pimentel et al. 1992; Krebs et al. 1999), and with this, we do not only see significant negative impacts on the biodiversity itself, but also on the ecosystem services it sustains (Moonen & Bàrberi 2008). To reduce this effect of agricultural intensification (AI), EU Member States are obliged to establish programmes that provide agri-environmental schemes (AESs) to encourage farmers to carry out environmentally beneficial activities on their land. In this essay, I review the role of these programmes in halting the negative biodiversity effects of AI and identify the factors affecting goal attainment. Further, I look for ways in which future farmland conservation work could develop in order to improve the effectiveness of AESs.

1.1 Ecological Effects of Agricultural Intensification

The increased agricultural productivity during the last fifty years has been realized through technical advances and structural changes in farming practices. For example, increased inputs of pesticides and chemical fertilizer, irrigation and drainage systems, reduced proportion of set-asides, a shift from hay to silage systems, and a shift from spring-sowing to autumn-sowing of crops have boosted the output per hectare while larger fields, loss of non-crop habitat and simplified cropping systems have eased the workload and thus made farming more effective (Stoate et al. 2001; 2009). Consequently, intensified farming has changed agro-ecosystems at two scales – at the field scale through increased inputs and outputs, and at the landscape scale through landscape simplification (Tscharntke et al. 2005; Stoate et al. 2009). Hence, farmland biodiversity loss in response to AI can be viewed as the combined effects of fundamental changes in the quality of, and compositional (number of cover types) and configurational (spatial patterning of them) heterogeneity of different cover types (Krebs et al. 1999; Fahrig et al. 2010).

Yet, evidence for the effects of AI on different farmland taxa including plants, invertebrates and birds comes mainly from results of local-scale studies (Kleijn et al. 2008; Geiger et al. 2010a; José-María et al. 2010), or comparative approaches examining biodiversity variation across multiple agricultural landscapes (Holland & Fahrig 2000; Thies et al. 2003; Holzschuh et al. 2010). For instance at the field scale, farmland bird declines across Europe (Chamberlain et al. 2000; Donald et al. 2001) have been attributed to the reduction of food on stubble fields, increased use of pesticides, earlier mowing and a switch from hay to silage (Buckingham et al. 1999; Chamberlain et al. 2000; Vickery et al. 2001; Geiger et al. 2010a). Also, the shift from spring-sown to autumn-sown cereals is viewed as an important driver of decline for ground-foraging birds through a reduction in food availability in denser swards (Atkinson et al. 2005).

At the same time, landscape simplification has reduced the proportion of field boundaries, hedges, fallows, and other marginal habitat that many farmland organisms depend on. Local diversity is heavily influenced by the surrounding landscape (Benton et al. 2003; Tscharntke et al. 2005), and in complex (mosaic) landscapes, diversity is higher compared to structurally simpler landscapes. It is worth noting that the homogenization process is two-faced, with intensification in some regions, and concurrent abandonment in others (Stoate et al. 2009), both resulting in declines due to loss of heterogeneity (Wretenberg et al. 2006). However, most studies do not address the importance of landscape heterogeneity for biodiversity directly (Fahrig et al. 2010; but see Thies et al. 2003).

While biodiversity decline is alarming in itself, biodiversity also provides a range of biological functions within an ecosystem – such as nutrient cycling, pest control and pollination (Altieri 1999). For instance, (Biesmeijer 2006) found that outcrossing plant species relying on declining pollinators themselves declined more than species not reliant on these pollinators. Further, decreases in the abundance of predatory insects resulting from insecticide use can remove biological control potential and facilitate pest outbreaks such as aphids (Krauss et al. 2011). A higher diversity in the number of species within functional guilds can also increase the effect of some functions that these guilds perform. An example of this mechanism was shown by (Hoehn et al. 2008), where a higher number of species pollinating a certain crop was shown to increase yields in pumpkin.

Since many variables of AI are correlated, confounding factors impedes the validity of inferences made about cause and effect, which makes it difficult to distinguish the cause of an observed decline from other components of AI. Therefore, while there is a scientific consensus that AI is detrimental to biodiversity, the relative contributions of different AI components are not well understood (however see Geiger et al. 2010a).

2. Rural Development Policies & Agri-Environmental Schemes

2.1 Background

To remedy the negative effects of AI on ecosystem services and function, and on biodiversity, AESs provide farmers with economic incentives to stimulate environmentally friendly farming practices. These subsidies are payed according to the “provider gets”-principle, where farmers are compensated for voluntarily participating in environment-related activities going beyond legal requirements (e.g. cross compliance). These payments shall “cover the costs incurred and income forgone as resulting from voluntary environmental commitments”.

Member States design agri-environmental programmes, usually comprising a set of AESs. The implementation of the schemes is pyramidal, with schemes that can be implemented in different ways (Figure 1). A distinction has been made between horizontal schemes, which make only modest demands on farmers’ practices and include a large number of farmers over a wide area and thus pay little, and area-specific schemes, which make more substantial, site-specific demands, and instead include fewer farmers who get paid correspondingly more (European Commission 2005). Since each Member State defines their own measures in relation to the specific environmental needs, there is a big potential to create country- and even site-specific measures.

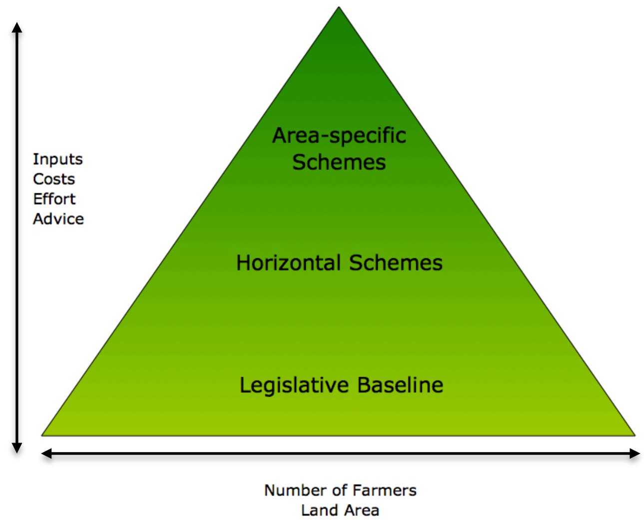

Figure 1. The pyramidal design of AESs. Adapted from Birdlife (2008).

However, AESs are only a part of a bigger policy for rural development, which aim to support the environment *and people* in rural areas through a concept called 'agricultural multi-functionality'. Thus, apart from environmental protection, the rural development policies also aim to secure employment and preserve and diversify the rural landscape and culture (Regulation 1698/2005 & 473/2009). Consequently, there is a balance of funding towards AES and towards socio-economic measures, which is decided by each Member State. The rural development programmes are, in turn, one of two 'Pillars' that make up the Common Agricultural Policy (often called CAP) – the other Pillar containing market support measures and direct subsidies. In contrast to these market and direct aids, the rural development programmes requires co-funding from national budgets.

2.2 AESs in the European Union and Sweden

Today, all Member States run their own AESs, with schemes varying in several aspects, including the priority given to schemes within the rural development programmes, the environmental objectives and type of management, geographic coverage, and the definition of the regulatory baseline (Hart 2010).

In general, richer Member States (e.g. Finland, Ireland, UK, Austria, Sweden, and Denmark) give higher priority to agri-environmental measures than poorer member states (e.g. Bulgaria, Romania, and Malta), which allocate more to socio-economic and social cohesion measures (valid at least before the late-2000s financial crisis) (RSPB 2008). Thus, the design of, and priority given to agri-environmental programmes in a country or region is not only a reflection of the environmental status of the agricultural landscape, but is also influenced by the prevailing socio-economic situation. Furthermore, another result of differing priorities between conservation and socio-economic/cultural measures, the reference level of mandatory environmental requirements (regulations and cross compliance requirements) differ between member states. Thus, actions that are part of an AES in one Member State can be part of obligatory regulation in another (Hart 2010).

The Swedish rural development programme has five different measures directed at preserving and enhancing the environment and the countryside, where agri-environment payments and support for non-productive investments account for the largest part (78%) of the budget. The principal environmental concerns related to agriculture are biodiversity loss due to changes in land-use, nutrient leaching and use of pesticides (Höjgård & Rabinowicz 2011). Hence, there are several measures to counter these problems, which include payments for e.g. organic forms of production, semi-natural grasslands, and valuable natural and cultural environments in the agricultural landscape.

2.3 Effectiveness of AESs

Evidence for the effectiveness of AESs at halting farmland biodiversity loss is equivocal. A review by (Kleijn et al. 2011), found mixed effects of biodiversity conservation on farmland where some initiatives were found to enhance biodiversity while others did not. Furthermore, the uptake rates (whether farmers engage or not) of schemes has a big impact on whether scheme objectives can be met (Kleijn & Sutherland 2003), which makes the question of what factors determine farmer participation very important. Consequently, there is an extensive literature on factors affecting farmers' participation in AESs.

3. Factors Affecting AES Implementation

A key characteristic of AESs is the voluntary nature, meaning that farmers can choose whether or not to participate and the hitherto failure to meet overall objectives has, to a great extent, been ascribed to farmers’ reluctance to participate (Kleijn & Sutherland 2003). Consequently, the determinants of farmer participation in environmental support schemes have gained a considerable amount of attention in recent research. The focus of these studies has, to a large extent, been on the effects of different scheme characteristics (including payment), farm and farmer demographics (e.g. farmer age or education, and farm size or structure), and different aspects of psychological and socio-cultural influences on decision-making (see e.g. Siebert et al. 2006; Vanslembrouck & Van Huylenbroeck 2011).

3.1 Scheme Characteristics

Several studies have found economic incentives to be key drivers of farmers’ participation in AESs (reviewed in Siebert et al. 2006). In a study of participation patterns of over 750 farmers across ten countries, 79% gave financial reasons as their main motive for joining a scheme

(Wilson & Hart 2000). However, as Siebert et al. (2006) point out, it is not unexpected since operating on a market inevitably introduces economic considerations. Further, farmers have been found to value flexible contract terms and shorter contract durations (Christensen et al. 2011), and also show a strong preference for maintaining their current management strategies (Espinosa-Goded et al. 2010). For example, farmers may show less interest in, or require adequate compensation for new measures that infer changes in farm management (e.g. reducing applications of fertilizers and pesticides), as compared to more traditional measures (e.g. winter feeding and erecting nest boxes), which are carried out without compensation (Herzon & Mikk 2007).

Also, the logistics of schemes, including information flow (e.g. from advisors to farmers), follow-up and monitoring are important for uptake (Wilson 1997). Another factor, which has not been thoroughly studied is the effect of the complicated application processes, which in some cases has been shown to discourage participation (McGregor & Willock 1995; AgraCeas 2003).

3.2 Farm & Farmer Demographics

Many studies have found probability of participation to increase with farm size (Morris & Potter 1995; Wilson 1997; Larsén 2006). However, area-specific schemes do sometimes also engage smaller farms (Siebert et al. 2006). AES uptake may also differ between agricultural regions, with higher rates of uptake in regions of relatively extensive land use (Buller 2000), which probably reflects the relatively low costs of adaptation to AESs in these regions compared to more intensively farmed regions (Osterburg 1999). Another main determinant seems to be prior participation in similar schemes (Morris & Potter 1995; Wilson 1997; Wilson & Hart 2001). This is possibly due to shifts in farming practices implemented at a prior participation occasion, which facilitates future participation. There is also the possibility that this results from a shift in attitude originating from positive experiences of participation. However, there are to my knowledge no studies that identify conditions under which the willingness to continue participation increase or decline.

Regarding individual characteristics, the age and level of education of the farmer seem to be the most important determinants of participation, with younger and more educated farmers being more prone to participate (Wilson 1996; 1997; Vanslembrouck, Van Huylenbroeck & Verbeke 2002; Mathijs 2003; Jongeneel et al. 2008). However, the importance of age varies between studies (Siebert et al. 2006), and there also exists AESs where participants have been older than non-participants (CEAS 1997), suggesting that the relationship between age and participation is not as straightforward as one might first think. Of course, age in itself is not an explanatory variable, but rather represents certain attitudes to agriculture and nature, which each individual has acquired during childhood, adolescence and adulthood. There are several other factors that have been examined in different studies in relation to participation (such as amount of semi-natural habitat on the farm, length of residency or sex); however they often show ambiguous patterns between studies (see e.g. Siebert et al. 2006; Ahnström et al. 2009).

In summation, as the review by Ahnström et al. (2009) establish, there are often contradictory results between studies on how different demographic variables relate to the willingness to participate in conservation measures, which might lead to seemingly contradictory outcomes. One interesting example mentioned in the review is that younger and more educated farmers seems to be more willing to try new methods in general, which could lead to higher pesticide use *and*, at the same time, more conservation work in terms of habitat elements.

3.3 Farmers' Personal Characteristics – attitudes, social norms & cultural capital

When Morris & Potter (1995) surveyed participation of the Environmentally Sensitive Areas (ESA) scheme in the UK, which act to safeguard areas of particularly high landscape, wildlife or historic value, adopters were both younger and had larger farms than non-adopters. However, the greatest difference was linked to attitudes rather than demographics (see also Battershill & Gilg 1997).

Over the last decades, the study of farmer attitudes in relation to AES participation has gained a considerable amount of attention and several studies have found participants to have a larger interest in nature and nature conservation than non-participants (Morris & Potter 1995; Macdonald & Johnson 2000; Fish & Seymour 2003; Herzon & Mikk 2007). Interestingly, two studies emphasize that there seems to be no link between *knowledge* of nature and willingness to participate in conservation measures (Jacobson et al. 2003; Herzon & Mikk 2007).

(Wilson 1996) suggested that these effects of attitude in turn are likely to be most relevant on farms where scheme participation might be a balance between economic benefits and nature conservation (such as smaller farms). In contrast, there are potentially larger financial benefits (or lower costs) from participation for larger farms, which might overshadow attitudinal factors. Thus, since smaller farms have lower uptake than larger farms, and the effects of attitude on participation is more important, it is important to further study the decision-making process of small-to-medium-scale farmers to determine methods to increase uptake in this category of farms.

The conceptualization of attitudes is however problematic and (Burton 2004) noted that many attitudinal studies on AES participation have a tendency to draw on overly simplistic models of the attitude-behaviour relationship. According to theoretical psychology, attitudes are 'formed by what an individual believes to be true about the attitude object, where the perception may be based on knowledge and/or emotion' (Edwards-Jones 2007), and they relate to different subjectively perceived factors including interests, knowledge, values, norms, and self-perception.

A commonly used theoretical framework in the study of decision-making is '*the Theory of Planned Behavior'* (TPB; Ajzen 1991), which suggests that attitudes, together with subjective norms, and perceived behavioural control influence behaviour (Figure 2). In this context, the subjective norms of a farmer relate to his or her belief of how individuals or groups (that are important in the eye of the farmer) approve or disapprove of performing a given behaviour. In contrast, conflicting social norms can also come from other directions, such as nature conservation agencies, NGOs or the public. Perceived behavioural control in turn, refers to a persons' perception of the ease or difficulty of achieving expected results.

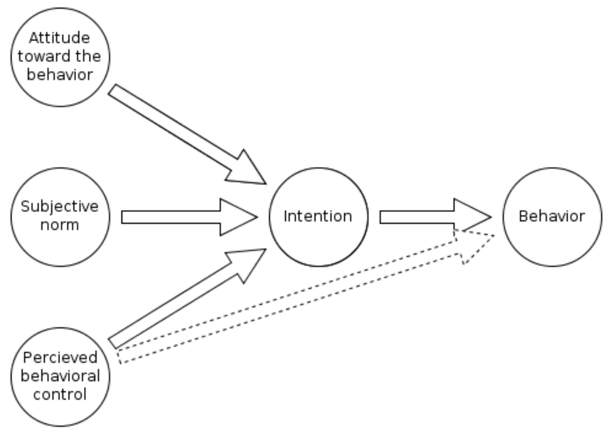

Figure 2. The 'Theory of Planned Behaviour' (Ajzen 1991).

Studies of the decision-making process of individual farmers often build on the ‘behavioural approach’, which is a (mainly) questionnaire-based methodology integrating concepts from theoretical psychology, social science and agricultural economics, which according to (Burton 2004) does not account for the effects of subjective norms and perceived behavioural control on behaviour. Thus, there is a possibility that expressed attitudes and action shows little correlation (Wicker 1969). Burton (2004) also concluded that future research needs a much more systematic approach to investigate behaviour. The reason for this negligence has in part been assigned to the relatively straightforward quantitative techniques involved in attitudinal studies (and the similarly complex approaches used to study social influences), making it an appealing survey tool for economic and science based researchers (Edwards-Jones 2007).

While some international studies have found several direct social influences (such as the local farm community and family), and indirect social influences (such as cultural, political, and juridical influences) to affect participation (Mathijs 2003; Jongeneel et al. 2008), this area of research continues to be understudied.

Recent work has also recognized the importance of symbolic capital for farmers’ rejection of AES involvement (Burton et al. 2008). Skills of the farmer generate symbolic capital, which contribute to the social status of the farmer. However, the lack of possibilities within AESs to display behavioural skills, compared to conventional farming where ‘tidy and efficient’ farming practices (such as straight lines and evenly coloured fields) generate this symbolic capital, is alleged to support a cultural resistance against conservational practices (Burton et al. 2008; Burton 2011). Thus, as Siebert et al. (2006) note, reluctance to participate in AESs does not necessarily stem from a lack of environmental interest, but rather derive from “contradictory perceptions of the role of agriculture” of farmers and conservationists/politicians.

Even if attitudes can give insights into the decision processes that determine farmers’ willingness to participate in farmland conservation, they are not static (Ahnström et al. 2009). On the contrary, attitudes depend on the situation and are influenced by both social and cultural factors, which is something that needs to be considered in further research and implementation plans of AESs.

3.4 Summary

Table 1. Factors influencing farmers' AES uptake.

Scheme Characteristics

- Payments (Wilson & Hart 2000; Siebert et al. 2006)
- Contract terms (Christensen et al. 2011)
- Severity of change in farm management (Herzon & Mikk 2007; Espinosa-Goded et al. 2010)
- Scheme logistics: Information, follow-up and monitoring (Wilson 1997)

Farm & Farmer Demographics

- Farm Demographics
  Farm size (Morris & Potter 1995; Wilson 1997; Larsén 2006)
  Surrounding landscape (Buller 2000)
  Prior participation (Morris & Potter 1995; Wilson 1997; Wilson & Hart 2001)
- Farmer Demographics
  Age (Mathijs 2003; Jongeneel et al. 2008)
  Education (Wilson 1996; 1997; Vanslembrouck et al. 2002)

Attitudes, Social Norms & Cultural Capital

- Interest in Nature (Morris & Potter 1995; Macdonald & Johnson 2000; Fish & Seymour 2003; Herzon & Mikk 2007)
- Direct Social Influences: Local farm community and family (Mathijs 2003; Jongeneel et al. 2008)
- Indirect Social Influences: Cultural, political and juridical influences (Mathijs 2003; Jongeneel et al. 2008)
- Cultural *'symbolic'* capital (Burton et al. 2008)

Source: Adapted and expanded from (Brotherton 1989; Vanslembrouck & Van Huylenbroeck 2011).

Some of the factors determine farmers' decisions to adopt agri-environment measures, which are summarized in Table 1. However, this should not be viewed as a complete list of everything that could possibly influence a farmers' decision whether to participate in an AES. In many studies, these factors have been identified through questionnaires as hypothetical participation to an imaginary scheme. However, it is difficult to interpret this hypothetical participation into actual participation because of differences in characteristics between actual schemes, which will affect both participation rates *per se* and also reasons for engagement (Wilson & Hart 2001; Wossink & van Wenum 2003).

An important finding is that the relationships between above listed factors and probability of participation in AESs differ depending on region and farming types (i.e. organic vs. conventional; (Wilson & Hart 2000; Siebert et al. 2006; Gorton et al. 2008). However, this spatial dimension to conservation behaviour is poorly studied and demands further research, particularly regarding socio-demographic and economic factors (Raymond & Brown 2011). Further, to gain a better understanding of how these factors operate and constrain AES uptake, we need to study how factors linked to willingness (e.g. attitudes and motivation) and ability to engage in AESs (e.g. farm size) interplay with farming intensity and landscape structure in determining participation.

To ensure the continuity of environmental improvements, not only participation, but also a change in farmers' environmental awareness is needed (Wilson 1996; Burton et al. 2008).

However, this attitudinal shift is to a large extent lacking, and instead schemes only facilitate the expression of existing attitudes rather than to invoke any attitudinal changes (Burton et al. 2008).

4. Factors Affecting Effects of Agri-Environmental Schemes

The mere implementation of schemes does not ensure that the environmental effects meet objectives. While some studies have shown positive effects of conservation measures on farmland biodiversity and other relevant ecosystem properties (e.g. eco-system functioning and services), there are also studies showing ambiguous, or even negative effects (Kleijn & Sutherland 2003). To ensure that future schemes are effective at reaching desired environmental goals, we must identify factors affecting the outcome of performed measures.

4.1 Scheme Design & Evaluation

Currently, many evaluations of ecological effects of AESs are questioned on the basis of their scientific quality. Also, the Common Monitoring and Evaluation Framework (CMEF) itself, together with scheme layout have been subject to a widespread debate (Kleijn & Sutherland 2003; Primdahl et al. 2010; Höjgård & Rabinowicz 2011). A meta-analysis of studies evaluating farmland conservation initiatives by (Primdahl et al. 2010) found that over half of the reviewed evaluations relied on common sense and lacked any qualitative or quantitative measure of change.

Another shortcoming of AESs, that hinders continuous and comprehensive evaluation, is the lack of clearly stated objectives (Kleijn & Sutherland 2003), which possibly relates to the absence of a well defined quantitative biodiversity measure as suggested by Spangenberg (2007). This inability to formulate biodiversity targets not only impedes the evaluation, but might also have a direct negative influence on the possibilities for successful conservation measures. This view is further supported by the success of initiatives targeting single species where the causal link between objectives and measures are likely to be distinct (Peach et al. 2001; Perkins et al. 2011). However, there is a certain risk of publication bias where unsuccessful projects are less likely to be published.

The non-scientific basis (conservation measures are not evidence-based) of schemes has also been debated, where much conservation is considered to be “based upon anecdote or myth”, and the failure to properly evaluate and document the effects of measures taken is argued to result in inadequate practices being accepted (Sutherland et al. 2004; for further details, see http://www.environmentalevidence.org/index.htm)

4.2 Effects of Landscape, Time & Taxon

Biodiversity benefits of AESs are dependent on the character of the surrounding landscape (Concepción et al. 2007; Geiger et al. 2010b; Batáry et al. 2011). In a recent meta-analysis covering 109 studies of biodiversity effects of AESs by Batáry et al. (2011), species richness of croplands increased more in simple compared to complex landscapes. The weaker effects of AESs in complex landscapes has been hypothesized to result from a continuous re-colonization of fields from neighbouring fields (Concepción et al. 2007), compensating for the negative effects of intensified cultivation independent of the use of AESs. Further, the outcome of farmland conservation measures is suggested to be affected by the landscape through a “rare habitat effect” (Wretenberg et al. 2010). According to this hypothesis, an increase in a farmland habitat only affects biodiversity positively if it was previously uncommon.

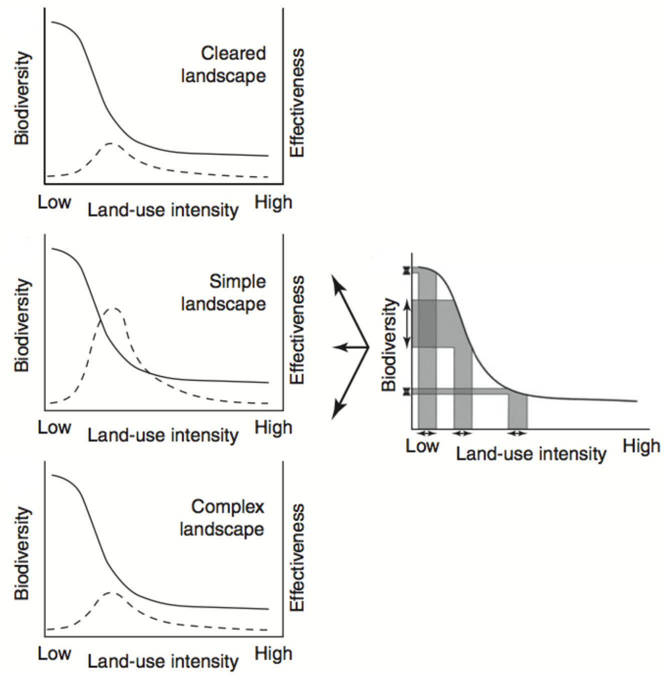

Figure 3. A conceptual model of the potential effectiveness of AESs, depending on AI and landscape complexity (cleared, simple and complex. According to this model, the biggest biodiversity gain is seen in simple landscapes with intermediate land-use intensity. Solid lines indicate biodiversity; dashed lines indicate potential biodiversity gain from AESs. (from Kleijn et al. 2011).

Thus, biodiversity changes due to conservation initiatives are moderated by both land-use intensity, landscape structure and their interaction (Kleijn et al. 2011; Figure 3), which is something that needs to be considered when designing new schemes. The relative importance of local and landscape effects might also differ depending on life-history traits such as home range size and landscape perception of the focal species (Concepción & Díaz 2011). For example, landscape and within-field factors are most important for small birds, whereas regional and landscape factors are most important for large birds (Concepción & Díaz 2011). Further, the amount of land under AES in the surrounding landscape also seem to influence local diversity (Gabriel et al. 2010).

Accounting for contingent time lags between implementation and organism responses has also been ascribed importance when evaluating biodiversity effects. (Jonason et al. 2011) found an increase in butterfly abundance with increasing time since transition to organic farming over a 25 year period. However, this time effect was not evident for increased butterfly and plant richness on organic farms indicating an immediate response to establishment. If the environmental benefits of schemes are not immediately visible, they risk not being sustained in the long term even when the environmental effects are positive. Thus, further research on the importance of a time component for environmental effects is needed.

There are also differences in response depending on the organism considered, where plants tend to show larger positive responses than invertebrates, birds or mammals (Kleijn et al. 2006), which might again be due to life-history traits such as range requirements and mobility (Concepción & Díaz 2011). There is also a tendency that AESs are more successful when aimed to maintain existing habitats with high biodiversity, than to rehabilitate degraded sites (Kleijn et al. 2011). Further, even if schemes are achieving results at field or farm scale it is important to consider effects at regional or national scales, since local increases might not provide enough resources to be important for population level changes (Whittingham 2011; see also Fahrig et al. 2010).

While the effects of many measures are ambiguous, at least organic farming seems to frequently show considerable biodiversity benefits (Rundlöf et al. 2008; Gabriel et al. 2010; Winqvist et al. 2011). Despite that organic farming is part of agri-environment payments, the purpose is not necessarily restricted to biodiversity conservation, but rather to achieve multiple environmental goals such as a non-toxic environment and zero eutrophication through decreased farming inputs (Kleijn & Sutherland 2003).

4.3 Summary

Even with the insights mentioned above, the current outlook on AESs (excluding organic farming) is that their potential to achieve biodiversity gains is bad (Whittingham 2011; Kleijn et al. 2011). However, in the study by (Batáry et al. 2011), species richness and abundance was found to increase not only in studies of organic farming but also in studies of other AESs (25 % of the studies). However, knowledge of the factors affecting the effectiveness of conservation initiatives on farmland, and those governing the certainty of evaluations has improved over the last years, and the need to include a landscape approach when designing future schemes has become apparent. Further, depending on the conservation objectives – which could be aimed at increasing biodiversity as such, or to enhance ecosystem services – different strategies of implementation and evaluation are needed (Kleijn et al. 2011).

5. Opportunities for Agri-Environmental Schemes

Up to this day, AESs have had only limited environmental effects and their role as a conservatory tool has been criticized regarding both the failure to attract participant farmers and the unclear effects on biodiversity (but see Batáry et al. 2011). However, when schemes are applied with management advice, and are spatially targeted, they can yield considerable biodiversity gains (Whittingham 2011 and references therein). Furthermore, current research is finding new techniques and new implementations of already existing biodiversity measures in agricultural landscapes, which provides opportunities to improve the efficiency of AESs in specific and conservation initiatives in general.

5.1 Scheme Design & Evaluation opportunities

There is growing evidence that we need to advance the evaluation process of AESs. This includes improved formulation of established objectives (Perkins et al. 2011), use of quantitative 'impact models' to identify causal relationships between policy objectives and policy outcomes, collection of baseline data, and maybe most important, introduction of common methodological standards across the EU which provide science-based evidence (Kleijn & Sutherland 2003; Primdahl et al. 2010; Höjgård & Rabinowicz 2011).

Sutherland et al. (2004) recognized the need to accumulate the experience of individual practitioners in a central evidence database, which would give practitioners access to similar cases when working with a specific conservation matter. Further, adaptive management is a way to modify running schemes by incorporating new management options identified through continuous monitoring, which has been shown to have positive effects on biodiversity benefits (e.g. Nichols et al. 2007; Perkins et al. 2011).

Few studies have related conservation initiatives to national population trends of species. However, studies could be scaled up to higher spatial scales to assess the contribution of local conservation initiatives to national biodiversity objectives (Kleijn et al. 2011). For example, Wretenberg et al. (2007) compared three periods of agricultural policy and their effects on regional population trends of farmland birds over three types of farmland and found regional trends to vary not only over policy periods but also between farmland regions showing that large scale changes do have effects on larger spatial scales.

There are also ideas of how to incorporate a landscape approach when implementing AESs. For example, we might see greater biodiversity effects if farms (compared to individual fields or field margins within a farm) or groups of neighbouring farms were managed extensively (Whittingham 2006). Further, a British study (Butler et al. 2007) found that in order to reverse the decline of farmland birds, British AESs need to place greater emphasis on improving cropped areas, where food and nesting habitats have been lost, instead of managing marginal habitats which have only a small effect on populations. However, this might induce a conflict if farmers' concept of biodiversity is restricted to wildlife outside the fields and thus differs from academic definitions (Herzon & Mikk 2007). Such conflicting views could potentially have an effect on the adoption of measures related to biodiversity, and thus be an obstacle in farmland conservation work (Ahnström et al. 2009). In particular, farmers might be less reluctant to participate in AESs that try to implement measures on the cropped area of fields, such as skylark plots and manipulation of sowing row width, than they do in schemes aimed at non-cropped habitats.

While most European AESs offer payments for compliance with a set of management requirements, it could be more (cost) effective to offer payment by results (Gibbons et al. 2011). Another positive aspect (and maybe the most important) of having result-based schemes might be that it could spur entrepreneurship and innovation and establish a means for production of symbolic capital by increasing the social importance of conservation behaviour in farmers' social networks (Burton et al. 2008).

As mentioned earlier, financial motives and ease of adoption often seem to outweigh environmental considerations as incentives for farmers' participation in AESs. For farmland conservation to be successful in the long run, it is important not only to recruit universally, but to recruit conservation-oriented farmers and to contribute to long-term changes in attitudes towards the environment and its conservation (Wilson & Hart 2001).

5.2 Participatory opportunities

In recent years, several projects have been introduced to save farmland bird populations, where the development and implementation of conservation projects in the farmland have been done in close cooperation among stakeholders, who together implement farmland bird conservation with a high level of consultation. Further, these and other regional networks such as Leader networks or the Regional Innovation Networks in the Netherlands, formed through encounters between top-down governmental initiatives and bottom-up initiatives of societal stakeholders, show the potential of co-operation (Aarts et al. 2007).

However, there are very few studies analysing the role that these encounters have in increasing biodiversity benefits of conservation work, or maybe even more important, in changing the attitudes of farmers towards a more conservation oriented outlook. There are several conceivable mechanisms for attitude change. An increased awareness of the problems ones' practices exert on wildlife is likely to make farmers more prone to participate in conservation work, while a lack of problem awareness is likely to prevent actions to stop further declines (Smallshire et al. 2004). Similarly, socially active farmers are likely to be more broad-minded to new demands from society and are thus more likely to engage in AESs (Jongeneel et al. 2008).

Thus, advisory encounters and participatory conservation projects could possibly play a role in softening the clash of social norms of farmers and conservationists, which, as mentioned above, is likely to hinder fruitful conservation practices. The Volunteer & Farmer Alliances run by the Royal Society for the Protection of Birds (RSPB) in the U.K. and by the Swedish Ornithological Society in Sweden are examples of such projects that take such an approach.

6. Conclusion

AESs seek to salvage farmland biodiversity, which is decreasing due to transformation and intensification of agricultural practices. AESs may also have the potential to facilitate economically valuable ecosystem services, and improve the resilience (the systems ability to withstand and/or recover from disturbance) of the agri-ecosystem through increased biodiversity (Tscharntke et al. 2011; Whittingham 2011).

These agri-environmental schemes encourage farmers to participate in environmentally friendly farming practices by offering subsidies to pay for income forgone. As we have seen however, these payments are not equally beneficial for all farmers, which depend on different farm-specific factors such as size and economy. Further, there are also differences between farmers regarding e.g. age and level of education. These demographic factors, together with the social and informational environment that the individual farmer operates in, determine the attitudes towards, and thus the willingness and ability to practise environmentally friendly farming.

The biodiversity benefits of AESs, in turn, are affected by the agricultural intensity and the landscape structure. At present though, scheme are not designed to increase participation in landscapes where their effects would be highest. Consequently, a lot of money is being spent on schemes in areas where their effect is dubious. Further, scheme designs show little reflection over how the *process* of participation could change farmers' attitudes towards farmland biodiversity conservation, which is crucial to gain farmers interest in AES.

Much of today's research on participation in agri-environmental conservation measures emanates from the fields of agricultural economics and social sciences, while the effects of implemented measures are the focus of ecologists. While there is an obvious need for integration of disciplines and interest groups, barriers related to integrative research (e.g. time needed for integration, different academic traditions and the lack of common terminology) often thwarts realization of such projects (Tress et al. 2007).

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