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Agri-environmental schemes: impacts on the agricultural environment

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EDITORIAL

Agri-environmental schemes: how to enhance the agriculture-environment relationship

Environmental protection and human food security co-exist in a critical balance, one that is often difficult to get right. The pressures of population rise, farming intensification, and loss of habitats and species mean that protections afforded under the EU's Common Agricultural Policy are pivotal to the conservation of agri-ecology. In the EU, agri-environment schemes encourage farmers to undertake environmentally friendly practices and are thus vital to the objective of sustainable agriculture. This Thematic Issue looks at some of the impacts that AES have had on European farm ecosystems, biodiversity and farmers.

Intensification was one aspect of the modernisation of agriculture, but it had the unfortunate side-effect of increasing pressure on the environment. That is why the reforms of the CAP since 1992 have aimed to progressively reduce the pressure of agriculture on the environment. Following its introduction in the 1960s, the Common Agriculture Policy (CAP) supported European farmers to achieve the Treaty of Rome's objectives of increasing productivity and ensuring the availability of healthy, quality food. Intensification was actively sought and encouraged often resulting in increased pressure on the environment. Since 1992, reforms of the CAP have aimed to reduce pressures on the environment. Several instruments and tools have been developed and made available to farmers, to mitigate the environmental impact of agriculture. Agri-environment schemes (AES) have been one of these policy tools.

Agri-environment schemes provide financial support for Member States to design and implement agri-environment measures (AEM). Each measure has a specific environmental objective such as the protection or enhancement of biodiversity, soil, water, landscape, or air quality, or climate change mitigation or adaptation. Many measures are multi-functional and are designed to bring simultaneous benefits for several environmental objectives. Each measure also involves paying those farmers who choose to adopt specific environmental management practices on their farms.

Agri-environment measures are developed under the Member State's Rural Development Programme. They are mandatory for national and regional administrations, but voluntary for farmers. Farmers who choose to go beyond the current basic requirements (either mandatory or those allowing them to qualify for a basic subsidy under CAP e.g. specific Good Agriculture-Environmental Conditions[1] (GAEC) standards; or 'greening' practices) can claim payments for AEM.

There is a wide variety of management practices promoted through the AEM mechanism, which reflects the complexity of both farming systems and ecosystems — some examples of measures include organic farming; integrated production; reducing inputs of fertilisers and/or pesticides; crop rotation; enhancing habitats for wildlife; introducing buffer strips; managing livestock to provide the right grazing pressure on grassland species and avoiding the risk of soil erosion; and conserving genetic resources in agriculture and local species and in animal breeds threatened by genetic erosion. Approximately 25% of the EU's utilised agricultural area is under AES contracts with farmers, including organic farming, and expenditure for 2007-2013 was about €23 billion.

This Thematic Issue presents recent peer-reviewed research examining the impact of AES on European farming, with a particular focus on biodiversity and

associated ecosystem services. AES have been shown to benefit a range of animals and plants by increasing the number of individuals and species. However, as with all measurements involving complex ecosystems, the findings and causal links are nuanced, and sometimes difficult to isolate.

Some of the studies examine whether the effectiveness of AES is influenced by farmer training and cultural activities; different ways of measuring the costs; whether collaborative schemes gain more farmer trust; and the significance of aiming at specific objectives and/or areas in AES.

Studies featured in this issue show that results-oriented AES, where applicable, can be beneficial in stimulating long-term positive behavioral change within farming communities, by providing additional encouragement for farmers to improve their conservation skills. Collaborative schemes involving several farmers, and, notably, involving farmers in scheme design, have also met with success.

The studies presented in this issue demonstrate the considerable role of AES as a tool for integrating environmental concerns into agricultural policy and farming. Without these schemes, biodiversity in the agricultural environment would be afforded less protection. However, although there are many demonstrating an increase in the abundance and diversity of species, this Issue also highlights that there are still many improvements and refinements that could be made in order to improve the cost-effectiveness of measures and schemes.

Agri-environment schemes are adaptive and need to be continually revised and improved, allowing for tailoring and targeting to a particular Member State's priorities and ecosystems.

But what is the future of the AES? A debate is now beginning on a post-2020 Common Agricultural Policy, which will certainly include a discussion of the techniques, strategies and funding necessary for achieving our evolving picture of desired environmental outcomes. This Issue provides some pointers towards ways of further improving the design and uptake of agri-environment measures, which should enable such schemes to secure even greater effectiveness and environmental protection in the future.

We would like to thank Dr Daire Ó hUallacháin, of Teagasc Agriculture and Food Development Authority, Johnstown Castle Research Centre, Wexford, Ireland for his help in producing and editing this Thematic Issue and Editorial.

Wild flowers along a field with corn © iStock / photonaj

1. https://ec.europa.eu/agriculture/glossary/good-agricultural-and-environmental-condition_en_en

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How to model trade-offs between agricultural yield and biodiversity

There is an inherent trade-off between increasing agricultural production and protection of biodiversity. This study models the effects of biodiversity conservation agri-environment schemes (AESs) and ecosystem-service-provider schemes, and shows that determining the aim of an agri-environment scheme is key to improving its efficiency. Such an optimisation could allow AES to be rolled out more generally to provide the backbone for both high yields and enhanced farmland biodiversity, say the researchers.

"...determining the aim of an agri-environment scheme is key to improving its efficiency... optimisation could allow AES to be rolled out more generally to provide the backbone for both high yields and enhanced farmland biodiversity..."

AES can use a variety of measures to try to reverse declines in farmland biodiversity, although the general principle is to reduce the intensity of farmland management. For example, the use of pesticides can be limited or habitats with benefits for wildlife, such as hedgerows, can be created or maintained. AES can also be targeted towards promoting more extensive agriculture by reducing the land available for crops or livestock or by restricting certain intensive management practices. However, it has also been argued that the consequent reduction in productivity could lead to increased pressure for agricultural land elsewhere, causing unintended negative impacts on biodiversity.

Researchers in this study suggest that AES can be broadly divided into those focusing on biodiversity conservation, and those focusing on ecosystem services. For example, a *biodiversity conservation scheme* might involve habitat protection for species of conservation concern, such as the protection of semi-natural, species-rich grassland for farmland birds. An e*cosystem services scheme*, on the other hand, might focus on more general, systematic goals related to environmental benefits and the provision of ecosystem services, such as improving water quality, or measures such as beetle banks or providing flowering strips to encourage pollinator species. These schemes tend to target more common species.

Many existing schemes are not easily classified as one or the other; different AES may have synergistic effects or trade-offs between conservation of biodiversity versus the promotion of ecosystem-service providers — although the researchers suggest these effects have not been well explored. For example, biodiversity conservation schemes that focus on particular species may have synergistic effects for ecosystem-service providers through the conservation of suitable habitat. However, as a general rule biodiversity conservation schemes focusing on rare species need to be implemented on large scales. This is to ensure the patchy distribution of the species is covered adequately, to maximise conservation success. Local ecosystem-service providers, such as natural enemies of pests and pollinators, need to be protected at a smaller scale, in comparison.

This study provides a framework to illustrate how biodiversity conservation or ecosystem-service schemes could be allocated depending on the specific needs of the agricultural landscape in question.

For simplicity, the researchers made several assumptions. These included that: increases in ecosystem-service providers will be directly associated with a decrease in management intensity; that production of ecosystem services relies on biodiversity at a local scale; and that an increased population of species of conservation concern results from an increased total conserved area of non-crop land.

Source: Ekroos, J., Olsson, O., Rundlöf, M. Wätzold, F. & Smith, H.G. (2014) Optimizing agri-environment schemes for biodiversity, ecosystem services or both? *Biological Conservation*.172:65–71. DOI:10.1016/j.biocon.2014.02.013

The majority of species of conservation concern (with the exception of some farmland birds) cannot establish viable populations outside their main habitat, e.g. in cultivated farmland, and thus require dedicated biodiversity-conservation schemes. The researchers surmise that ecosystem-service schemes generally do not benefit species of conservation concern. Ecosystem-service-provider species are assumed to be affected by management intensity and are expected to respond to both biodiversity-conservation and ecosystem-service schemes, as the habitat provided for the former will also provide habitats for such species. Ecosystem-service benefits (i.e. pollination and pest control) are also assumed to improve agricultural productivity.

They calculated the assumed relationship between the proportion of area under biodiversity conservation schemes and management intensity, alongside several different third variables: number of species of conservation concern, density of ecosystem-service-providing species, and the yield per hectare.

The analysis describes an '*efficiency frontier*' between biodiversity and agricultural production, showing the maximum number of species of conservation concern that would be attainable for two types of landscape: an agricultural landscape of high productivity, and one of low productivity.

Maximum biodiversity benefits were attained by efficiently targeting biodiversity-conservation and ecosystem-service schemes between landscapes. With higher yields, a progressively higher number of species are lost. If larger yields are needed, the researchers recommend prioritising ecosystem-service schemes over biodiversity conservation schemes in firstly high productivity landscapes, then later in both high and low productivity landscapes. The analysis shows that to maintain biodiversity at the highest levels, while still increasing yield, it is better to create a higher proportion of ecosystem-service provider schemes sooner, to reduce management intensity.

The researchers emphasise that these results would need to be confirmed by future empirical and meta-analytical research — both on the assumed relationships, and to correct the model with further detail. Whether habitats rich in biodiversity and habitats rich in ecosystem-service providers generate equally high services is not actually known, and spatial configuration is also an unaccounted-for factor.

However, they say the model can improve the effectiveness of AES via an increased focus on the underlying function of the scheme in relation to ecosystem services or biodiversity conservation. AES might, in future, be more efficiently targeted at biodiversity or ecosystem services depending on the landscape context and accounting for the trade-offs with agricultural productivity.

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Sowing larger patches of flowers can increase bumblebee reproduction in areas surrounding intensive arable farms

Agri-environment schemes (AES) have been implemented throughout Europe to mitigate against the negative effects of agricultural intensification. Although these schemes have shown positive effects on the abundance and richness of certain species and taxa, the impact of AES on reproduction of target species at the local and landscape scale is poorly understood. This large-scale study looked for the effect of selected AE measures on bumblebee reproduction. Results indicate that bumblebee reproduction is significantly higher on sown flower patches when compared to conventional management. Although the increase is most pronounced at the plot scale, higher reproduction was found in landscapes surrounding larger sown plots (at least one hectare) compared to smaller sown plots.

"Sown flower patches, which provide forage resources all year round, can improve bumblebee reproduction in intensively farmed areas."

Agricultural intensification can result in the loss and fragmentation of habitats, leading in some cases to species decline. To mitigate these declines, the EU has established agri-environment schemes (AES), which compensate farmers for undertaking practices beneficial for biodiversity, such as maintaining existing habitats or creating new habitats.

These practices have been shown to benefit a range of birds, bees and plants by increasing the number of individuals and species, but there is debate as to whether this translates into long-term benefits for biodiversity. In particular, there is limited evidence that AES have positive effects on reproduction of certain taxa (and thus the persistence of populations).

Contributing to the evidence base, this study focused on several species of bumblebees (Bombus), which play an important role as agricultural pollinators, but are now of high conservation concern due to the widespread declines in populations over recent years. The study focused on the importance of flower-rich habitats for bumblebees, more specifically, on the effect of newly sown flower mixtures on bumblebee reproduction (i.e. the abundance of males and queens, i.e. sexuals).

The researchers conducted a large-scale study across seven sites in England, with varying levels of agricultural intensity. At each site, a flower mixture (20% legume and 80% fine-leaved grasses — as recommended under the AES 'nectar flower mixture' option under the Entry Level Stewardship (ELS) scheme in England), was sown in patches of various sizes (0.25–1ha).

The patches were established on land taken out of arable production. Control 'patches' were selected at each of the seven sites to represent non-crop vegetation that was typical of the area, ie. the non-crop vegetation that would normally be available to bees in the absence of a sown flower patch or margin. Control patches were always within around 3km distance of sown patches — so that all four patches at a site were separated by an average of 3km.

Source: Carvell, C., Bourke, A., Osborne, J. & Heard, M. (2015). Effects of an agri-environment scheme on bumblebee reproduction at local and landscape scales. *Basic and Applied Ecology*, 16(6): 519–530. DOI: 10.1016/j.baae.2015.05.006.

Fixed transects were also established in established patches, controls and also in conventionally managed field margins), surrounding both sown and control patches. This was to assess any 'spillover effect': when flower patches encourage increases in reproduction that can be detected in surrounding landscapes. The numbers of males and queens were recorded in monthly surveys from June to September over a three-year period (2005–2007). Researchers combined the numbers of bumblebee males and queens to create an index of the total biomass of bumblebee sexuals (referred to as MQ), which was used as a measure of reproduction. The MQ index and the density of flowers recorded on each survey were calculated for each patch, and statistical models were used to assess the relationship between the two.

The reproductive measure (MQ) was significantly higher on the flower-sown, flower-dense patches than on the unsown, conventionally managed patches throughout the three-year period. When the researchers measured the areas surrounding the patches (at 'landscape-scale'), they found far less significant effects, with minimal improvement in biomass relative to the control patches.

However, patch size also mattered. At a local scale, the size of sown flower patches did not have a notable effect on MQ for any species. But more significant effects of patch size were seen at the landscape scale MQ for certain species (and for all bumblebees measured together) was highest in areas surrounding larger sown flower patches (covering 1 hectare) — suggesting that the size of sown flower patches influences reproductive capacity in intensively farmed landscapes.

The researchers also found that the positive effects on reproduction were greater where there was a greater proportion of arable land for certain bumblebee species. There was a higher MQ index on sown patches, than on the control patches in the most intensively farmed landscapes, but MQ indexes were similar on both sown and control patches in the less intensively farmed areas.

Taken together, these results suggest that sown flower patches, which provide forage resources all year round, can improve bumblebee reproduction in intensively farmed areas. Furthermore, if sown flower patches are big enough (at least one hectare), the beneficial effects can extend to surrounding areas. Overall, these positive effects suggest that larger sown patches in intensively farmed areas could provide the greatest benefits for this AES measure.

Although their results support enhancing forage resources in arable farmland by sowing flower patches, the study's authors say this is not a universal solution, and that their findings should not detract from using flower mixtures in other more mixed or grassland-dominated landscapes, or enhancing floral resources using other measures, such as organic farming, which can benefit other important species.

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Wildflower planting supports a range of beneficial insects, not only bees

A study of wildflower planting within agri-environment schemes has demonstrated that the practice can support a diverse array of economically beneficial insect species, not just prominent pollinators such as wild bees and hoverflies. The study demonstrates the high conservation potential of wildflower planting within agricultural landscapes and the value of insects outside the traditional focus of conservation efforts.

"...increasing the availability of flowers in agricultural landscapes through species-rich wildflower plantings should support important insect species."

Agri-environment schemes (AES) have been implemented across Europe as a way to restore and maintain biodiversity in agricultural landscapes. AES often target pollinators, such as wild bees and hoverflies, as they can improve yields of nearby pollinator-dependent crops.

Knowledge regarding the benefits to insect pollinators (and wild bees and hoverflies in particular) provided by AES is growing. However, there is limited information regarding how AES benefit other flower-visiting insects, which represent a large proportion of insect biodiversity and provide pollination services along with additional ecosystem services, such as the control of crop pests.

This study assessed flower visitor communities on 14 wildflower plantings in the district of Marburg-Biedenkopf, Hesse, central Germany. The district has seen the planting of over 400 wildflower patches between 2010 and 2013 as part of an AES aimed at promoting sustainable land use and restoring biodiversity[1]. The researchers aimed to learn more about the diversity of insect species associated with planting wildflowers during the course of the flowering season, as well as wider landscape factors such as connectivity with other wildflower habitats and the surrounding arable land use.

The 14 wildflower plantings, which were selected to have varying levels of surrounding arable land and connected wildflower planting areas, were surveyed between the early to late flowering season from May to July 2014. Insect species were surveyed using transects, and insects visiting flowers were caught in nets for laboratory identification, to species or family level. The abundance and species richness of the flowering plant community was also recorded. The researchers separated the insect visitors into four groups: wild bees; hoverflies; honeybees from managed beehives; and all other insect flower visitors.

In total, 76 flowering plant species and 322 insect species were recorded across the 14 plantings. Across the four groups this comprised: 427 wild bees (representing 41 species); 470 hoverflies (39 species); 588 individual honeybees (1 species); and 1680 other visitors (241 species from nine different insect groups). This latter group made up over half of the total insects visits recorded and 74% of all species recorded.

The results show that wildflower planting supports highly diverse communities of insect visitors, including many species that are outside the traditional focus of conservation efforts. Interestingly, the study also demonstrated that wildflower planting is attractive to different insect species, regardless of whether the abundance or richness of the planted area is low. However, the surrounding landscape was an important factor in the make-up of the flower-visiting communities and the composition of flower visitors also varied over the course of the flowering season: in the

Source: Grass, I., Albrecht, J., Jauker, F., Diekötter, T., Warzecha, D., Wolters, V., & Farwig, N. (2016). Much more than bees — Wildflower plantings support highly diverse flower-visitor communities from complex to structurally simple agricultural landscapes. *Agriculture, Ecosystems & Environment*. 225: 45–53. DOI:10.1016/j.agee.2016.04.001.

early flowering season, wildflower plantings that were accompanied by additional local plantings and within more variable landscapes supported the highest abundances of habitat specialists (e.g. bumblebee species), whereas isolated plantings were mainly visited by agricultural generalists (e.g. predatory hoverflies and pollen beetles). These differences diminished towards the end of the flowering season.

Bees and hoverflies have an important role in agricultural landscapes as pollinators. However, other species may provide similar or complementary ecosystems services. For example, certain species of flies other than hoverflies (Diptera), which made up 43% of the 'other flower visitors' in this study, can be important pollinators of wild and crop plants. Many of the other flower visitor species are also predators of crop pests and contribute to decomposition and nutrient cycling. However, it is important to note that wildflower planting also has the potential to support certain agricultural pest species, although this has been little studied.

Overall, the study indicates that increasing the availability of flowers in agricultural landscapes through species-rich wildflower plantings should support important insect species. The findings also suggest that future assessments on the value of wildflower plantings should consider the entire flower-visitor community, not just prominent species such as bees.

Meadows along Dutch river Meuse © iStock / Roel_Meijer

1. At the time of the study, the AES was called HIAP (Hessian integrated agri-environment programme) and has now been renamed HALM (Hessian program for agri-environmental and landscape management measures): https://umweltministerium.hessen.de/agrarumweltprogramm

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Agri-environment schemes should be diversified and customised to meet habitat preferences of different species

The Natura 2000 network is the backbone of nature conservation in the EU, and agri-environment schemes (AES) are an important tool to protect biodiversity on European farmland. A recent study, which investigated the effectiveness of AES in relation to grassland birds in Poland, found that AES were not associated with species richness of target species, and proposed a number of reasons for this. The researchers recommend that AES management regimes should be diversified and customised to provide optimal habitat for a wider range of bird species.

"...AES management regimes should be diversified and customised to provide optimal habitat for a wider range of bird species."

Farmland biodiversity in central and eastern European countries has, until recently, been relatively well preserved, and has avoided the large-scale decline in species richness and abundance observed in northern and western Europe. Recently, however, biodiversity in central and eastern European farmlands has also started to decrease sharply, due to rapid economic transformations that are changing the region's agricultural landscape .

Agri-environment schemes (AES) and Natura 2000 together are two of the most important initiatives in halting biodiversity decline in Europe. AES aim to protect the environment in agricultural landscapes, while Natura 2000 is a broader network of protected habitats. Special Protection Areas (SPAs) under Natura 2000 are designed to protect the most suitable areas for birds, in order to reach a favourable conservation status for all species listed in Annex 1 of the Birds Directive. There are over 5 400 SPAs in Europe, covering more than 12% of the land area of EU Member States. The two initiatives sometimes overlap, and it is important to understand their interactive effects in order to maximise their benefits for biodiversity.

This study investigated the relationships between the two initiatives and Polish grassland bird fauna. Over €280 million was spent on agri-environment measures for grassland birds in Poland between 2007 and 2014.

During this period there were two types of AES that focus on the protection of birds in Poland: within and outside Natura 2000 areas. Under the current Polish Rural Development Programme (2014–2020), AES to protect birds are restricted to areas inside Natura 2000 SPAs, on the basis that this generates the best results in terms of grassland bird diversity. Under the rules of the previous programme, to qualify for payments a farmer had to prove that at least one of 10 target bird species was breeding in a field under their ownership, and also had to employ less intensive grassland management over the payment period of 5 years.

The researchers compared the birds found at 585 grassland sites[1] across Poland over a two-year survey (2013–14). They recorded eight AES target species and 11 SPA target species. The number of AES-target species was not higher at AES sites than control sites, but was generally higher within than outside SPAs (with one exception — the common snipe (*Gallinago gallinago*) was a species more often found at AES than control sites). The number of SPA-target species was not significantly associated with SPAs or AES sites. There was also no significant interaction found between AES sites and SPAs, as the effect of AES did not differ according to whether they were

Source: Żmihorski, M., Kotowska, D., Berg, Å. & Pärt, T. (2016). Evaluating conservation tools in Polish grasslands: The occurrence of birds in relation to agri-environment schemes and Natura 2000 areas. *Biological Conservation*, 194, 150–157. DOI: 10.1016/j.biocon.2015.12.007.

Felixmittermeir. CC0 Public Domain

within or outside SPAs. The researchers give several possible explanations for the absence of a link between Polish AES and the targeted species; Natura 2000 is a conservation project covering a much larger area in Poland than AES areas — the average SPA area is 39 000 hectares, while the average size of an AES area in this study was just 8 hectares.

Moreover, there is a history of abundance and species richness of birds in Polish farmland, which may have caused the control areas to also have high bird diversity as a baseline. The effects of AES in a biodiversity-rich landscape will potentially be low — in contrast to its effects in a more intensive agricultural landscape. Also, the researchers suggest that AES grassland management tends to be restricted by certain procedures and can result in grasslands which are less species-richFor example, delayed mowing is the main conservation measure in Polish AES — as early mowing can reduce chick survival. However, while this measure may benefit some species, such as the corncrake (*Crex crex*), it may also reduce numbers of other birds such as the lapwing (*Vanellus vanellus*), which prefers short and sparse ground vegetation.

To improve the effectiveness of Polish grassland AES, therefore, the researchers suggest that in future, AESs designed and targeted at the protection of birds should be more diverse and consider the habitat needs of all target species. Thus, one method of variable management of AES land would be to link management to the species originally present at the AES. In this way, mowing in some areas might be postponed until August, when late breeding birds, such as corncrakes or aquatic warblers, are present. They emphasise the need for more targeted, customised AES that include local management variations to benefit all target grassland bird species.

1. A 100 m radius was considered suitable in open, grassland habitats because all species are easily heard or seen within this area and it is large enough to yield a good sample size for most species.

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Grassy field margins provide additional biodiversity benefits by connecting habitats

Habitat fragmentation is a threat to biodiversity, especially in agricultural land where there are also many endangered species. Corridors between habitats are one way to counteract its effects. A study suggests that grassy field margins — established throughout Europe to improve water quality — could act as corridors. The study, which measured the effects field margins' on butterflies, concludes that agricultural schemes should include this corridor function.

"Researchers suggest that the effectiveness of grassy field margins could be improved, perhaps by adding flowers (which could decrease emigration from corridors) or even reducing habitat quality (which could increase the speed at which butterflies move...)."

Intensive agriculture can have negative effects on landscape for example, causing habitat fragmentation, whereby large sections of land are divided into smaller, isolated areas. Habitat fragmentation affects the survival and persistence of species, and thus biodiversity, by preventing animals from breeding with each other (and, therefore, also reducing genetic variability) and limiting the 'rescue effect', which describes emigration by individuals to a smaller population, which saves it from extinction.

Increasing the ability of species to move between patches of land has been proposed as a tool to mitigate fragmentation. One way to achieve this is via 'corridors': strips of land that connect habitats and species.

This study focused on grassy field margins: linear, grassy strips around 5-10 metres wide that are traditionally set up along watercourses to mitigate run-off from crop fields. Subsidies for grassy field margins have been made available across Europe via the mandatory practices/good agricultural and environmental conditions (GAEC)[1] of the first pillar of the Common Agricultural Policy. France chose grassy field margins as a GAEC, but other countries may have chosen different options, such as maintaining natural grasslands. Then, GFMs became a part of the tools of the Water Framework Directive[2] and are now mandatory along watercourses.

The study investigated whether grassy field margins can also act as corridors for species in fragmented landscapes. To do this, the researchers monitored the movement of butterflies, a known method of demonstrating corridor function, in grassy field margins in France.

They focused on the Meadow Brown (*Maniola jurtina*), a butterfly found in a wide range of grassy habitats and particularly in the agricultural landscapes of Western Europe. The study was conducted in Brittany in the north-west of France, in a 13 000-hectare Long Term Ecological Research (LTER) site containing a mixture of crops, hedgerows and small grassland patches. Grassy field margins in the area are on average 10 m wide, 150 m long and planted with *Trifolium* (clover) and *Poaceae* (grasses). The researchers monitored butterfly movement in the grassy field margins and adjacent meadows in the summer of 2009.

Source: Delattre, T., Vernon, P. & Burel, F. (2013). An agri-environmental scheme enhances butterfly dispersal in European agricultural landscapes. *Agriculture, Ecosystems & Environment*, 166: 102–109. DOI: 10.1016/j.agee.2011.06.018.

The results showed that the movements of the butterflies were clearly influenced by the grassy field margins. The movements were similar to those associated with foraging or mate-searching, and unlike dispersal strategies used to move out of habitats. The observed movements suggest the butterflies were not hesitant to enter and move within the margins, and the boundaries imposed meant the butterflies moved towards potential habitat patches.

Of the 74 grassy field margins observed, around half provided a corridor function (e.g. were connected to meadows at both ends). Those that were connected to at least one meadow were of an average length and width (10 m x 150 m), which are well suited to movement between habitat patches and have been shown to increase dispersal rates by 400%. Although the remaining margins could not act as corridors (e.g. because they were isolated), the vast majority (93%) of margins were less than 15 metres from a meadow and thus could act as 'stepping stones' between habitats.

Although grassy field margins have already been shown to mitigate run-off and increase local biodiversity by providing habitat, this study shows that they can also enhance wider biodiversity by acting as corridors.

According to the researchers, these findings have significant implications for management of agricultural landscapes across Europe. Grassy field margins are used as a conservation measure across Europe. Although local implementation varies, these buffer strips can feature as one of the types of Ecological Focus Area, which arable farmers need to implement on their farms, under the 'greening' of the first pillar of the CAP[3].

However, policy could be amended to incorporate these findings, say the researchers. Grassy field margins were originally established to improve water quality but prescriptions for other ecological benefits may not be as effective. For example, current CAP regulation does not require margins to be near meadows, even though this study suggests they could benefit biodiversity in fragmented landscapes.

Due to the global importance of field margins for biodiversity, their wide distribution in Europe, and the amount that is invested in agri-environment schemes, the researchers argue that their corridor function should also be investigated for other species. They also suggest that their effectiveness could be improved, perhaps by adding flowers (which could decrease emigration from corridors) or even reducing habitat quality (which could increase the speed at which butterflies move within the field margins).

1. https://marswiki.jrc.ec.europa.eu/wikicap/index.php/Good_Agricultural_and_Environmental_Conditions_(GAEC)
2. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060
3. http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.2.5.html

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Set-aside fields increase the diversity of decomposers in soil in Hungarian agricultural landscapes

A new study has investigated the effects of set-aside management — when fields are taken out of agricultural production — on common invertebrate decomposers in soil. The diversity of woodlice species was higher in set-aside fields compared to neighbouring wheat fields and this effect increased in older set-asides. This study highlights the importance of set-aside areas as habitats for soil invertebrates, which are important for soil health.

"...set-aside fields that are removed from crop rotation for more than two years could be a valuable option for establishing 'ecological focus areas...'"

Agricultural landscapes both provide and depend on soil-related ecosystem services such as nutrient cycling and water regulation. Maintaining healthy soils is therefore an important part of sustainable agriculture. Soil invertebrates such as woodlice (*Oniscidea*) and millipedes (*Diplopoda*) help to decompose plant material, which contributes to nutrient cycling and therefore soil fertility. Intensive agricultural management practices can affect the diversity of these soil invertebrates, and therefore also soil conditions and vegetation.

Obligatory set-aside management — fields or field edges taken out of agricultural production to provide environmental benefits — was abolished in most EU countries in 2008, due to demands for higher production of cereal crops. However, in Hungary, set-aside remains a common management practice, where the establishment of sown set-aside fields is a requirement of certain agri-environment schemes in High Nature Value Areas (HNVA).

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Source: Tóth, Z., Hornung, E., Báldi, A. & Kovács-Hostyánski, A. (2016). Effects of set-aside management on soil macrodecomposers in Hungary. *Applied Soil Ecology*.99:89–97. DOI:10.1016/j.apsoil.2015.11.003.

This study assessed the diversity and abundance of woodlice and millipedes in set-aside areas compared to arable wheat fields and semi-natural grassland controls in Heves, a HNVA in north-eastern Hungary. The Heves HNVA was designed to protect rare farmland birds, especially the great bustard (*Otis tarda*), which is extinct in some areas of Europe and classified as vulnerable by the IUCN. Establishment of set-aside fields is part of the Hungarian National Agri-environment Programme[1] launched in 2009.

Three pairs of similarly managed wheat (*Triticum aestivum*) fields and adjacent set-aside fields of different ages (one, two or three years) were sampled using pitfall traps, to assess the overall number of woodlice and millipedes (abundance) and the number of different species (richness). Six semi-natural grasslands were also surveyed as a control. Plant species richness, vegetation cover and the amount of bare ground was also measured at all fields.

The species richness and abundance of woodlice was significantly higher in set-aside compared to wheat fields. No significant effects on the abundance (or species richness) of millipedes were observed. The researchers suggest this may be because millipedes are less sensitive to drought, while woodlice are more affected by soil moisture content and temperature, and prefer habitats with higher humidity and greater shelter. The latter conditions are more prevalent in set-aside fields because of higher plant diversity and more complex vegetation structure.

However, the study found that almost all species occurred in higher numbers in set-aside fields compared to neighbouring wheat fields. The researchers also highlight the reduced impact in fields adjacent to set-aside, probably due to the poor migration ability/mobility of the species assessed. Land set-aside for more than two years also had higher richness and abundance of woodlice and millipedes compared to younger set-aside fields. The researchers suggest that reduced agricultural activity, such as less use of chemicals or soil disturbance, allows habitats to develop a wider range of plants, which provides food and shelter for invertebrate decomposers.

The study demonstrates the importance of set-aside management for invertebrate species, particularly two years after establishment. The researchers say that set-aside fields that are removed from crop rotation for more than two years could be a valuable option for establishing 'Ecological Focus Areas' as part of greening under the Common Agricultural Policy, as these fields are likely to help conserve biodiversity both above and below ground.

1. As part of the Scheme, 21 action plans were announced for 2009-2014. One of these was the arable farming action plan that affected the most agricultural fields in Hungary.

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Farmers with experience of agri-environment schemes develop more wildlife friendly habitats

Researchers have found that farmer experience, concerns and motivation influences environmental outcomes for agri-environment schemes (AES), in a study in southern England. Farmers with more environmental management experience and/or concern for wildlife benefits created habitats that provided more pollen and nectar for bees and butterflies and winter seed for birds. The results suggest that supporting farmer environmental learning may increase the success of AES.

"...working with farmers, actively engaging them or facilitating them to develop skills in environmental management through advice and training, might improve the success of AES."

Agri-environment schemes (AES) provide farmers with financial incentives to adopt wildlife-friendly management practices. Despite considerable expenditure — the EU allocated a budget of €22.2 billion for AES from 2007–2013 — a number of studies have highlighted variable success rates of AES in terms of providing environmental benefits. Limited farmer engagement with the aims of AES is one possible reason for the limited success of some schemes. In this study, researchers examined the associations between farmer experience and environmental understanding, as well as landscape and local environmental factors, and the biodiversity and habitat benefits of AES in England.

The Entry Level Environmental Stewardship (ELS) scheme, a type of AES in England, gives farmers the option of sowing selected plant species at field edges to provide habitat for species of conservation concern. Options include planting nectar- and pollen-rich plant species for bees and butterflies, and seed-bearing species for farmland birds. This study assessed variations in the habitats created on farms participating in this scheme in relation to social, ecological and environmental factors.

The study looked at 48 arable and mixed farms in southern England, including an even mix of the nectar- and seed-rich habitat enhancements. The researchers assessed the quality of created habitats in terms of the availability of nectar, pollen and winter seed resources. The number of flowering heads (clusters of flowers) as well as bumblebee and butterflies numbers were recorded within the nectar-rich habitats, while seed resources and bird activity was measured in the seed-rich habitats. As a control, nearby field edges not planted with nectar-rich or seed-rich species were also measured for habitat quality and species of conservation interest.

Interviews explored farmer attitudes towards, and history of, environmental management and their perceptions and understanding of the management requirements for providing nectar- or seed-rich habitats. The researchers used the interviews to establish three categories of farmer attitude to and commitment to agri environment schemes:

Contact: McCracken, M.E., Woodcock, B.A., Lobley M., Pywell, R.F., Saratsi, E., Swetman, R.D., Mortimer, S.R., Harris, S.J., Winter, M., Hinsley, S. & Bullock, J.M. (2015). Social and ecological drivers of success in agri-environment schemes: the roles of farmers and environmental context. *Journal of Applied Ecology*. 52(3): 696–705. DOI:10.1111/1365-2664.12412.

- **Experience:** describing the farmer's history of environmental management, both in and out of formal schemes.

- '**Concerns:** these were farmers' perceptions on how easy it would be to meet the requirements for creating and managing the habitat (e.g. establishing the plants).

- **Motivation:** this categorised the farmers in terms of their stated motivation for where they placed the strips on the farm, from more wildlife focused to more pragmatic.

In addition, the surrounding landscape and habitat present on each farm was mapped using land cover data from the Centre for Ecology and Hydrology. The influence of weather was assessed using data from the British Atmospheric Data Centre, and national species lists were referenced to determine the species potentially present within the farmland.

The surveys indicated that the abundance and richness of birds, bumblebees and butterflies was higher in ELS field edges compared to the control fields.

These outcomes were influenced by a range of factors including surrounding local habitat, weather conditions and species present in the area. Some of these factors cannot be controlled by farm management and can partly explain the high variability in success of AES. However, the researchers also found that the quality of the created habitats was affected by the farmer's experience, concerns and motivation: higher floral and seed resources were found in farms where farmers had more experience of agri-environmental management. In addition, there were a greater number and diversity of bumblebees on farms with more experienced farmers, and more butterfly species when farmers had sufficient knowledge to place their enhanced field edges in locations best for wildlife. The fact that farmers with greater experience were more successful in creating wildlife friendly habitats suggests that farmers learn while implementing AES.

Farmers with more concerns about wildlife, rather than practical motives, were shown to produce higher flower numbers, but the opposite was found for weight of seeds in a wild bird seed strip. Interestingly, farmers who had predicted greater problems with establishing and maintaining these wildlife habitats produced habitats with a greater seed yield.

The researchers suggest that working with farmers, actively engaging them or facilitating them to develop skills in environmental management through advice and training, might improve the success of AES.

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How bridging organisations aid design and uptake of EU agri-environment schemes

Managing landscapes effectively requires the involvement of a wide variety of stakeholders. The views and interests of these different groups can be effectively integrated by agri-environment 'collaboratives' — a type of bridging organisation which can be found in varying forms in Europe. Using data from Germany and the Netherlands, a study concludes that these groups make important contributions to landscape management, ranging from implementing policy to generating income.

"Agri-environemtal collaboratives (AEC) are voluntary collaboratives formed by local stakeholders and can include farmers, conservationists, municipalities and residents."

Caring for the landscape requires collaboration between a range of rural groups. These include farmers, who most clearly shape the landscape through their activities and whose central role is acknowledged by the EU Rural Development Regulation[1]. Other groups include users of the land who influence the landscape through economic and recreational activities, and local government, who shape the landscape through building and planning regulations.

Managing all these different expectations and interests related to landscape management is a difficult task, but can be facilitated by these bridging organisations, which connect and mediate between stakeholders. This study considers the role these organisations — and in particular agri-environmental collaboratives (AEC) — play in achieving sustainable landscape management.

AEC are voluntary collaboratives formed by local stakeholders and can include farmers, conservationists, municipalities and residents. They may also include governmental stakeholders, although AEC are non-governmental organisations and have no statutory power to enforce rules. They exist in different countries under different names, but all work towards the same goal of sustainable landscape management. This EU-funded[2] study focused on AEC in Germany (where they are known as 'landscape management associations') and the Netherlands (where they are called 'agricultural nature groups' and 'landscape organisations').

The research was based on the views of AEC members and individuals they work with. Data were gathered from a cross-section of groups in Germany and the Netherlands, selected to cover a range of landscapes and activities. Overall, 22 key informants and 19 others (e.g. representatives of umbrella organisations) were interviewed about the groups to which they belonged, their goals and their contributions and achievements. Informants were also asked about which gaps would arise should their group be disbanded.

Both countries have roughly the same number of collaboratives (around 150), but Dutch groups are larger (on average 100-200 members) than those in Germany (around 50 members). The most strongly represented sector in both countries is farming.

The interviews revealed that none of the groups had undertaken a formal evaluation of their contributions or had a structured method of assessing the impact of their activities, and most were lacking the resources needed to carry out monitoring. Despite this, the interviews revealed six major areas of contribution:

Source: Prager, K. (2015). Agri-environmental collaboratives as bridging organisations in landscape management. *Journal of Environmental Management,* 161: 375–384. DOI: 10.1016/j.jenvman.2015.07.027.

- **Policy implementation and service provision**

German groups, for example, help to implement monitoring for the Natura 2000 network, and Dutch groups are involved in shaping and implementing national government policies. Several groups were found to contribute to design and implementation of policy, including agri-environment schemes. The collaboratives helped to tailor schemes to the local context, increase uptake, improve the quality of applications and reduce transaction costs. The analysis also showed that AEC help to implement measures under the Landscape Convention.

- **Coordination and mediation**

Groups helped to resolve conflicts (e.g. between farmers and conservationists or farmers and developers), initiate projects and facilitate networking.

- **Awareness-raising and behaviour change**

The groups raised awareness of environmental issues among farmers and the public.

- **Care for 'everyday' landscapes**

Members reported working not only in protected landscapes, but also 'everyday' landscapes without protected status, and maintaining areas on marginal land of little economic interest and vulnerable to abandonment.

- **Maintenance and protection of landscapes**

A major area of AEC contributions related to maintaining and preserving the landscape, including species and their habitats. For example, groups in the Netherlands protected meadow birds and rare species while German groups coordinated management of grazing on marginal grassland.

- **Income generation and economic benefits**

Collaboratives provide economic benefits by creating jobs, keeping the landscape attractive for tourists and developing options that allow farmers to generate income from landscape management.

Given this wide range of contributions, the study concludes that governments should support AEC. However, creating groups to achieve specific government objectives would be 'counterproductive', as the collaboratives work best under open, flexible conditions. Groups should be able to pursue their own aims under the broad goal of sustainable landscape management, and governments should support existing networks (which is also more cost- and time-effective than creating new ones).

The researcher says building on the efforts of existing organisations could deliver outcomes rapidly and at low cost, as AEC are already established in many places. However, she suggests financial support is needed and should be focused on two areas: funding for **facilitators**, who play a critical role in motivating existing members and establishing new connections, and **monitoring**, so that groups can collect the data they need to protect nature and assess impact.

1.The Rural Development Regulation (EU Regulation No 1305/2013) encourages farmers to apply agricultural practices that are compatible with protection of the environment and the landscape, for example by making payments available for agri-environment measures.
2.This study was funded by the European Commission through its Seventh Framework Programme, via a Marie Curie Intra-European Fellowship: http://cordis.europa.eu/mariecurie-actions/eif/home.html

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An investigation into the receptivity of English farmers to collaborative agri-environment schemess

A team of UK researchers has analysed interviews with a selection of farmers from across England in an effort to determine the sociocultural factors influencing their decisions to cooperate with each other on collaborative agri-environment schemes (cAES). Results from this study have significance for the success of agri-environment schemes (AES) in the region, as it may be that only by collaborating on such schemes can farmers adequately conserve crucial landscape-scale ecological processes. The study finds that cAES which provide greater flexibility, with opportunities for farmer involvement in scheme design and locally targeted and clearly defined aims are more likely to gain more support from farmers. Farmers might also be more receptive to environmental interventions if they could be partially involved in cAES.

"By taking into account farmers' preferences to create collaborative agri environmental schemes (cAES), policymakers have the opportunity to increase AES uptake while delivering greater environmental benefits at the same time."

Landscape-scale conservation has been established as an important factor in maintaining biodiversity, and at a national level, such large-scale efforts will invariably require the cooperation of farmers. Although there are examples in Europe of successful environmental collaborations involving farmers, such as the German *Landschaftspflegeverbände* groups and Dutch Environmental Cooperatives, but British farmers thus far have been relatively reluctant to cooperate much beyond the borders of their own farms. Greater co-operation between farmers, resulting in a landscape-scale approach could play an important role in preserving the UK's ecosystems.

Farmland conservation in the EU is currently administered by way of AES. However, AES in their current incarnation do not often address ecological processes at a sufficient scale. In order to do this, the researchers suggest that it is important that farmers are willing to cooperate with each other. For this study, the researchers conducted semi-structured interviews with 33 farmers from three distinct locations in England. The interviews included quantifiable elements, ensuring some consistent information was always collected, together with open-ended topics that were analysed qualitatively. Specifically, farmers were asked for their views on existing AES, as well as their opinions on broadly and hypothetical cAES. They also provided scores from 1 to 7 for their responses to a range of proposed behaviours, as well as the perceived attitudes of other farmers.

Several themes emerged from these interviews, which may prove beneficial in guiding the design of future cAES. A lack of communication between farmers was one such theme, and the researchers suggest that one way to tackle this is to introduce an external organisation to oversee any joint operations and break down barriers (something that 80% of farmers involved approved of). Another key theme was a desire for flexibility and timeliness in any collaborations, both of which are notably absent in current AES. A response to this would be to create cAES that actually address farmers' issues about existing AES, and therefore increase overall participation in AES as well.

The study stresses the need for a more targeted approach to cAES that would not necessarily need the involvement of farmers on a 'whole-farm' approach. An example of this in action is the potential for farmers to only enter part of their farm into a cAES scheme. This might mean that the ecological goal

Source: Emery, S.B. & Franks, J.F. (2012). The potential for collaborative agri-environment schemes in England: Can a well-designed collaborative approach address farmers' concerns with current schemes? *Journal of Rural Studies.* 28: 218–231. DOI: 10.1016/j.jrurstud.2012.02.004

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is achieved (if the part in question is ecologically significant), but the farmer has been allowed some flexibility. Other broader examples include involving farmers in scheme design and ensuring schemes are specific to location. This partial approach might be beneficial because it makes environmental interventions more acceptable to farmers. Thus the study suggests that non participating farmers would be happy to contribute to a landscape-scale design through less extensive changes such as the creation of corridors or stepping stones. However the administrative feasibility and costs of such an approach should be taken into account.

Even during the interviews, the researchers observed several farmers, who have not taken part in AES, responding favourably to the concept of cAES. By taking into account farmers' preferences to create cAES, policymakers have the opportunity to increase AES uptake while delivering greater environmental benefits at the same time. However, the study says that more research is needed into the socio-cultural mechanisms which influence farmers' attitudes in relation to AES.

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Farmers with knowledge of environmental policy are more willing to create wetland habitats

The willingness of farmers to create wetlands within agri-environment schemes (AES) has been assessed as part of a new study in Sweden. Land-owning farmers and those with prior knowledge of the Water Framework Directive (WFD) were more likely to create wetlands than leasehold farmers or those with no prior knowledge of WFD. Common reasons for not wanting to take part in the scheme included the farmers' senior age, that wetlands would not be suitable on the farm and high costs — leading the researchers to suggest that changes in subsidy payments may increase wetland creation.

"One of the main reasons given by farmers for not participating in wetland creation schemes were the high costs involved — hence, an increase in financial support could help to attract more farmers."

Drainage for agriculture — whereby excess water is removed from soil to aid crop production — has led to major losses of wetlands throughout Europe. In Europe 35% of wetland loss between 2000 and 2006 was due to conversion to agriculture[1], and in south-western Sweden almost 70% of wetlands have been lost due to drainage over the last 50 years. As wetlands provide important ecosystem services in relation to enhancing biodiversity and improving water quality, their restoration has been a focus of environmental efforts.

This study focused on Sweden, where AES, such as those under the Swedish Rural Development Programme, are used to encourage landowners to create wetlands as a means of reducing eutrophication — the release of nutrients (such as nitrogen and phosphorous in fertilisers) into waterways, which causes excessive growth of algae and reduces the amount of oxygen in the water. Wetlands created on farmland can mitigate against excessive nutrients entering rivers, lakes and the sea.

Attracting farmers to participate in wetland creation has, however, been challenging with only two thirds of the national targets of 12 000 hectares (ha) of new wetland between 2000 and 2010, being met.[2] Lack of participation could be for several reasons, including inadequate financial incentives as well as aspects of scheme design such as long contracts, lack of flexibility and a high administrative burden.

The study focused on Himmerfjärden, a eutrophic bay in southern Stockholm, which has been identified as a priority area for reduction of both nitrogen and phosphorus in the EU's Water Framework Directive, as well as by Stockholm County, which has designated the area a 'hot spot' for wetland creation.

The researchers devised a questionnaire examining the importance of a farm (e.g. farm type and size) and farmer characteristics (e.g. age, education and gender) in relation to willingness to create new wetlands. In total, 135 farmers in the region responded to the questionnaire. The researchers also devised a choice experiment, which analysed the likelihood of farmers participating in a scheme to create a new wetland by changing various elements of the scheme, including time frame, level of practical support and economic compensation.

Source: Franzén, F., Dinnétz, P. & Hammer, M. (2016) Factors affecting farmers' willingness to participate in eutrophication mitigation — A case study of preferences for wetland creation in Sweden. *Ecological Economics*. 130: 8–15 DOI:10.1016/j.landusepol.2015.02.007.

Approximately 70% of respondents were unwilling to create wetlands on their land. However, farmers with previous knowledge of the WFD were almost three times more likely to participate than farmers without prior knowledge of the Directive. The researchers suggest this may be because information on wetland construction presented to farmers in the AES was consistent with information provided from the WFD.

However, the most important farmer characteristic for willingness to create a wetland was being a landowner. Farmers who owned their land were 3.5 times more likely to create a wetland, compared to farmers who only own the lease to their land. This is likely due to the long term (up to 20 years) and costly commitment of creating a wetland, which could be greater risk for a leaseholder on a short tenancy. Considering the trend towards fewer and larger farms in Sweden, where the amount of leased land has increased substantially since the 1970s, this is a problem that may need to be addressed in future AES.

One of the main reasons given by farmers for not participating in wetland-creation schemes were the high costs involved — hence, an increase in financial support could help to attract more farmers. The researchers also suggest that results-based AES could be useful in increasing participation, where payment is given for provision of an ecosystem service, such as nutrient retention, rather than a specific management action. Result-based schemes could encourage farmers to innovate in order to manage their farms more sustainably because they will be paid for what they produce, rather than paid for an action with an uncertain outcome.

1. Swedish Environmental Protection Agency, 2011. Environmental objectives on a new basis. The Swedish Environmental Protection Agency's Revised Yearly Report of the Environmental Objectives 2011. Report 6433.
2. http://www.eea.europa.eu/data-and-maps/figures/cause-of-loss-of-wetlands

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Social promotion of flowering meadows enables farmers' results-based agri-environment measures in France

This study assessed the implementation of the 'Flowering Meadows' agri-environment scheme in France, a results-based scheme which encourages farmers to conserve meadows in the Bauges, Haut Jura and Vercors natural parks. While there was limited change in agricultural practices, the scheme did help to maintain meadow habitats. Farmers also welcomed the results-based payments approach, which gave them greater responsibility for and flexibility in managing their farms.

"...supporting farmer environmental learning may increase the success of AES."

The expansion and intensification of agriculture are major causes of biodiversity loss. Less intensively managed grassland habitats (e.g. meadows) are a particular focus of agri-environment schemes (AES) as they contain a wide range of flowering plant species and are vulnerable to changes in agricultural practice.

This study looked at the management of flowering meadows. Maintaining a diversity of meadow flower species can maintain a meadow's value in terms of feed nutrition and appeal longer than a meadow with lower species diversity and higher productivity. Enhanced biodiversity can benefit agricultural landscapes as it helps to support important ecosystem services such as pollination, and some farmers mention the positive effect of flowering meadows on milk quality, cheese flavour and animal welfare.

In means-orientated agri-environmental payment schemes, farmers are contracted to carry out certain agricultural practices, while payment in result-orientated schemes is based on the provision of a biodiversity-related outcome, allowing farmers to choose how they achieve the desired result. The French 'Flowering Meadows' agri-environmental measure (AEM) was established in 2007 to preserve high floral diversity on meadows. Farmers commit to ensuring that at least four plants, from a reference list of 20 species of 'high ecological value', are present in meadows on their land. The reference list was collectively drafted by a range of stakeholders, including farmers.

In this study, 39 farmers from three regional natural parks (Bauges, Haut-Jura and Vercors — representing 26% of the 149 farmers contracted to the scheme) were interviewed to clarify their motivations for taking part in the Flowering Meadows AEM and any associated changes in farming practices. Forty-four other stakeholders were interviewed, including representatives of agricultural organisations, the agri-food sector, park and local government officials, members of environmental protection associations and researchers. Of these, over half (27) had been involved in the development or implementation of the AEM.

Farmers seemed to approve of the flexibility of the results-orientated scheme, as it gave them greater responsibility to decide which practices to use in order to maintain the required ecological indicators, compared to means-orientated schemes, for example, by allowing them to adapt practices from year to year.

The scheme supported continued low-intensity meadow use by providing farmers with another

Source: Fleury, P., Seres, C., Dobremez, L., Nettier, B. & Pauthenet, Y. (2015). "Flowering Meadows", a result-oriented agri-environmental measure: Technical and value changes in favour of biodiversity. *Land Use Policy,* 46: 103–114. DOI:10.1016/j.landusepol.2015.02.007.

incentive (in addition to good-quality forage) to maintain the ecological diversity of meadows. It also seemed to foster farmers' interest in this form of biodiversity. However, this could not be attributed solely to the AEM, as other, local measures are likely to have contributed, including training and educational activities for farmers, and annual flowering meadows competitions.

The result-based approach created few constraints and thus there was a positive response from farmers regarding the maintenance and interest in flowering meadows. In general, farmers selected fields to be part of the scheme that already had more than the required diversity of plant species of high ecological value, and had little need to change their practices. The researchers identified technical changes in farming practices in only four of the 39 farmers interviewed. These were: mowing later in the season; not mowing certain areas to let flowers go to seed; manually gathering and sowing seeds in molehills; buying organic activators to fertilise meadows; and diluting liquid manure before spreading.

A few farmers foresaw making future changes, such as over-seeding fodder plants and limiting fertilisation, and two farmers said the AEM discourages intensification in flowering meadows.

The researchers conclude that for results-orientated AES to be effective, they can be combined with means-oriented measures, to ensure baseline actions are taken and to lower the (real or perceived) risk for farmers. The payment calculations might also be reconsidered; instead of being calculated relative to (as lower than) compensation payments for losses in production and supplementary costs, they could in future be more directly linked with the ecosystem services farmers provide.

Also, they recommend that ecological indicators (such as the 20 flowering meadow plant species used in this AEM) should be compatible with agricultural production. These indicators should also be easily recognisable to farmers and adequate guidance should be provided to allow farmers to implement the measures required to meet them. The researchers also suggest that a two-level payment structure could provide higher rewards to farmers who have improved biodiversity: for example, if they increase the number of ecologically valuable species within their meadows rather than simply maintaining the diversity of ecologically valuable species already present.[1]

They also suggest that preparatory local and collective actions, and participative governance are required to complement and support the AEM — including long-term discussions and mutual understanding between environmental and agricultural stakeholders, and peer discussion between farmers about the implementation of the measure. In this case, the integration of a positive biodiversity norm into agriculture was mediated by a visual symbol, 'meadow flowers', and a wording, "flowers in meadows are the proof of a good agro-ecological balance"—which were understandable and mobilised by the farming and wider community, resulting in sustainable social connections and practices.

1. However this should take into account that the calculation of payments follows World Trade Organisation (WTO) rules: i.e. if a farmer receives payment from a government, that payment does not influence the type or quantity of agricultural production: https://www.wto.org/english/tratop_e/agric_e/ag_intro03_domestic_e.htm

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Results-based agri-environment measures are an effective conservation strategy for species-rich grassland

Results-based agri-environment measures are an alternative to management-based measures that, in certain circumstances, could be both more effective and more cost-efficient, since their payment depends on the provision of the desired conservation outcome. This study reviews the success of a scheme, introduced in Germany in 2000, to preserve biodiversity in species-rich grassland.

"Results based agri-environment measures are a good option for preserving species-rich grassland, and could encourage wider uptake in agri-environment schemes across the EU."

Under the EU's Common Agricultural Policy (CAP), the majority of agri-environment measures (AEM) are action-based, meaning that farmers and land managers are paid when they undertake the prescribed management activities. An alternative system is the introduction of results-based agri-environment measures (RB-AEM), whereby payment is provided when the desired environmental outcomes have been achieved. Wider implementation of this system could not only improve cost efficiency, but could also provide more direct control of environmental impact, greater flexibility for farmers (as they can choose how to achieve the outcome) and increased environmental awareness.

From Ireland to Sweden, many RB-AEM have been established across the EU[1], focusing on goals such as the conservation of important farmland habitats and species. Most ongoing initiatives aim to preserve biodiversity in species-rich grassland, and this study focused on one such project, MEKA-B4.

Based in the Baden-Württemberg region of Germany, MEKA-B4 is the first RB-AEM co-financed by the CAP, and was in place between 2000 and 2014. Participating farmers qualified for annual payments if they could demonstrate that at least four species from a list of 28 key indicator species/taxa of wildflowers were growing in their meadows. In 2014, MEKA-B4 was replaced by FAKT-B3, which introduced two levels of payment (one for four and one for six species) and raised the payment rates.

For their analysis of MEKA-B4, the researchers conducted a literature review, including peer-reviewed articles, 'grey' literature and statistical data, as well as series of face-to-face interviews. They interviewed 14 relevant stakeholders, including representatives from the Ministry for Rural Area and Consumer Protection, as well as 24 local farmers — 17 participating in MEKA-B4 and seven outside the scheme (but participating in other agri-environment measures).

Based on their findings, the researchers say that MEKA-B4 should be considered a reward or an incentive, rather than a policy instrument that uses markets or price to provide the motivation, because it did not cover all opportunity costs (the loss of other alternatives when only one is chosen) related to intensive grassland management strategies, i.e. the income that could be obtained from

Source: Russi, D., Margue, H., Oppermann, R. & Keenleyside, C. (2016). Result-based agri-environment measures: Market-based instruments, incentives or rewards? The case of Baden-Württemberg. *Land Use Policy*, 54: 69–77. DOI: 10.1016/j.landusepol.2016.01.012.

the land in the absence of the RB-AEM. In fact, the payment seemed to cover the opportunity costs of only some types of grassland farming (hay producers, less productive fields, part-time farmers) but not those related to intensive cattle raising and biogas production, which are incompatible with the conservation of species-rich grassland.

The researchers suggest that farmers who maximise the income from their grassland with intensive cattle or biogas production and who are not interested in environmental conservation will not change their practices if the related incentive does not cover all their opportunity costs. For this reason, for most farmers involved it is their intrinsic motivations (i.e. ethical or personal convictions) that are key to participation.

The researchers also noted decreasing participation in MEKA-B4 in recent years, possibly as a result of the low payment compared to the higher economic benefits of more intensive management strategies. Increasing the payment to cover a greater share of the opportunity costs, as has been partly done in the new version of the scheme (FAKT-B3), may help to ensure a wider enrolment in the result-based measure in the long term. Higher payments in the short term will ultimately result in long-term savings, because of the high projected costs associated with the restoration of species-rich grassland ecosystems.

In addition, in recent years the subsidies on biogas introduced by the German Renewable Energy Sources Act, 2014, made biogas production more profitable than extensive grassland management, thereby increasing the opportunity costs of extensive grassland management. This shows the importance of the integration and coherence of environmental policies that have different objectives.

Finally, the researchers note that the analysed RB-AEM have an educational role which contributes to farmers' intrinsic motivations (and therefore encourages further participation), and presents low overall risk for farmers. All this suggests that RB–AEM are a good option for preserving species-rich grassland, and could encourage wider uptake in agri-environment schemes across the EU. This is already being field-tested in three-year pilot RB-AEM schemes with farmers in England[2], Ireland, Romania and Spain funded by the European Commission[3] and due to be completed in 2018.

1. Detailed information on these schemes can be found here: http://ec.europa.eu/environment/nature/rbaps/index_en.htm and a 2014 report on the current and future use of result-based agri-environment payments here http://ec.europa.eu/environment/nature/rbaps/handbook/docs/rbaps-report.pdf
2. For more information contact Annabelle.lepage@naturalengland.org.uk
3. EC specification for the funding call: http://ec.europa.eu/environment/funding/pdf/rbaps/EP%20Pilot%20grant%20RBAPS%20call.pdf

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Tailoring agri-environment schemes to species and habitats could improve cost-effectiveness

The cost effectiveness of agri-environment schemes to conserve species and habitats under the Scottish Rural Development Programme has been assessed by a recent study. Cost effectiveness was found to vary widely between schemes. Improvements in cost-effectiveness relative to specific conservation objectives might be achieved with increased geographical targeting, advice and monitoring of impacts.

"...farmer characteristics, such as age, knowledge and training — all .... correllated to AES uptake in this study"

Improving the efficiency of conservation programmes is desirable in order to make the most of limited conservation funding. However, effectiveness depends on a large number of complex factors, such as the suitability of the intervention to the species or habitat targeted, and assessing the cost effectiveness of such programmes is difficult due to limited data about the economic returns from biodiversity programmes. Expert knowledge can be useful, though, in understanding the outcomes of conservation policies, as demonstrated by this study.

In this study, researchers analysed the cost effectiveness of a variety of species and habitat protection programmes under the Scottish Rural Development Programme (SRDP) 2007 — 2013, which delivers Pillar 2 of the Common Agricultural Policy and was approved by the European Commission in 2006. Agri-environment schemes under the SRDP are designed to encourage farmers to manage their land for the benefit of wildlife and the environment.

Species examined in the study were selected from Scottish Natural Heritage's Species Action Framework (SAF), which includes 32 species targeted for management actions by the SRDP between 2007 and 2012[1,2]. Species assessed included five native birds, two mammals, one fungus and a plant species of conservation interest. The three habitats assessed (hedgerows, arable fields and wetlands) were selected as they were deemed important for biodiversity and for the UK's future land-management requirements. Information on spending was extracted from Rural Payments and Inspections Directorate (RPID) data, maintained by the Scottish Government.

The conservation success and cost-effectiveness of the schemes was assessed through interviews with 28 species and habitat advisers from public agencies (Scottish Natural Heritage, Forestry Commission), conservation NGOs (RSPB, Game and Wildlife Conservation Trust, Butterfly Conservation Scotland), land owners and other stakeholder groups (Scottish Land and Estates, SAC Consulting). Assessments of conservation success were related to the specific conservation objectives for each species from the SAF, and habitat objectives, taken from the UK Biodiversity Action Reporting System. Cost-effectiveness analysis was then used to analyse outcomes in relation to total spending for the schemes.

Source: Austin, Z., McVittie, A., McCracken, D., Moxey, A., Moran, D. & White, P.C.L. (2015) Integrating quantitative and qualitative data in assessing the cost-effectiveness of biodiversity conservation programmes. *Biodiversity and Conservation*, 24: 1359–1375. DOI: 10.1007/s10531-015-0861-4.

Sea eagle. Kdsphotos. CC0 Public Domain

The study's cost-effectiveness ratio is simply a measure of the 'cost per unit of effectiveness'; the higher the estimated value, therefore, the higher the cost of each unit of effectiveness gained[3]. Cost-effectiveness estimates ranged from £3 500 (€4 154) for the sea eagle (*Haliaeetus albicilla*) agri-environment schemes, to a maximum of £4 564 800 (€5 432 112) for the black grouse (*Tetrao tetrix*) schemes. For habitats, estimates ranged from £131 700 (€156 332) for schemes on arable fields to a maximum of £1 800 100 (€2 135 662) for those focused on hedgerows.

Improving geographical targeting was the main measure recommended by experts as a way of improving cost effectiveness. They also recommended providing more effective management advice to landowners and establishing monitoring programmes to evaluate success in meeting conservation objectives.

The researchers conclude that there is scope to improve the cost-effectiveness of biodiversity conservation programmes through better design, but also to improve the robustness of cost-effectiveness assessments, particularly in terms of clarity in setting and monitoring objectives.

Overall, the researchers say that creating bespoke schemes to provide the greatest conservation benefit in a specific location may reduce management cost in relation to conservation effectiveness for certain species and habitats, and thus increase cost-effectiveness.

1. The management cost in relation to conservation effectiveness for the species or habitat under the conservation scheme.
2. The research was conducted at the end of 2012 to assess the effectiveness so far of committed spend.
3. The estimates are subject to a number of caveats, discussed in the paper. For example, estimates are difficult to compare across schemes due to differences in how objectives are defined and measured, and more generally are subject to uncertainties arising from various data issues.

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How best to implement agri-environment schemes?

Agri-environment schemes (AES) are widely researched, but some important issues, however, remain unstudied. Researchers have investigated some of these issues using a sample of olive growers in southern Spain. Their study reveals the level of monetary incentive needed for farmers to accept an 'ecological focus area', and a general unwillingness to participate collectively. These results could help policymakers design more cost-effective AESs.

"The research also looked at farmers' views on ecological focus areas (EFAs) — areas containing, for example, buffer strips, fallow land, trees or catch crops."

A great deal of research has been conducted on how to design an effective AES, yet some aspects of AES are less well understood than others. This study investigated some of the more neglected issues, beginning with farmers' willingness to accept cover crops — plants that are grown to manage soil erosion, improve soil health and water availability and help control pests and diseases. Cover crops also have benefits for soil carbon storage, biodiversity, water quality and landscape aesthetics, yet few studies have assessed farmers' willingness to accept them within an AES.

The research also looked at views on ecological focus areas (EFAs) — areas containing, for example, buffer strips, fallow land, trees or catch crops. They are beneficial for biodiversity and soil conservation and constitute an important element of the Common Agricultural Policy (CAP)[1].

Finally, the study investigated collective participation. When farmers collectively sign AES contracts it can reduce costs, as the number of applications to be processed and the costs of monitoring are fewer. It can also increase environmental benefits, especially if farms within the collective show high connectivity or closeness and/or present an adequate spatial configuration (for example, 100m of hedgerows on sloping areas would be more useful to reduce soil erosionavoid landslides, etc., if they were aligned perpendicular to the slope than if they were aligned parallel to the slope).

The researchers, who received EU funding[2], analysed the preferences of olive growers in Andalusia, southern Spain, regarding all of these issues. Olive-grove systems are socially and economically vital for the region, but to a certain extent have also resulted in environmental challenges, including soil erosion, biodiversity loss and water pollution. There is great potential for reducing the environmental impact of olive growing through AESs, but it is important to design a scheme that farmers are willing to comply with.

To assess farmers' preferences, the researchers used choice experiments — a technique which involves asking individuals about their preferences among hypothetical alternatives. The choices included two options for cover crops: area (which could be either 25% or 50% of the olive grove) and management (which could be free or restrictive[3]). For EFAs, levels were set at either 0% (equivalent to the requirement included in green payment for permanent crops) or 2% of the olive grove plots (below the 5% for arable lands established in the CAP). Participation was either collective (a group of at least five farmers located in the same municipality) or individual.

Payment levels were used to assess farmers' willingness to accept each element of the hypothetical scheme, ranging from €100/hectare (ha) to €400/ha. A total of 295 farmers were asked to choose between two alternatives or 'no-choice', which means they continue with their current practice.

The results revealed a wide range of views among farmers, which the researchers grouped into four different classes, categorising the farmers' attitudes toward AES. There was one clear group of 'potential participants', comprising almost 30% of the farmers surveyed. This group had

Source: Villanueva, A., Gómez-Limón, J., Arriaza, M. & Rodríguez-Entrena, M. (2015). The design of agri-environmental schemes: Farmers' preferences in southern Spain. *Land Use Policy*, 46: 142–154. DOI: 10.1016/j.landusepol.2015.02.009.

characteristics typical of those likely to take up AES schemes: farmers were younger, with a higher level of education and were more likely to be professionally trained. A second group (15%) would be willing to participate, but only if restricted management was not required, while two further groups (totalling 56%) were identified as 'potential non-participants', who were unwilling to participate in the AES presented. These final three groups shared characteristics with those less likely to take up AES schemes, with the fourth group being the least likely to participate. Farmers making up the last (fourth) group were older, with the lowest levels of education and were the least keen to use cover crops.

The researchers first discuss their results in terms of cover crops — the most important practice for improving the environmental impact of olive groves. The survey showed that the majority (three quarters) of farmers use cover crops, on average covering 25% of their land. Almost half would be willing to use them at a higher level of 50% for low to medium incentives (between €1 and €4.1/ha per 1% additional cover crop area), but most (70%) would be unwilling to manage the crops with restrictions (e.g. restriction on the use of herbicide or in growing tillage). Therefore, if policymakers want to increase AES participation, the researchers suggest they should evaluate current management restrictions (e.g. target restrictions on herbicide usage to environmentally-sensitive areas).

In terms of EFAs, almost half of the farmers would be willing to accept a 2% level for low monetary incentives (€8-9/ha per additional 1% of farmland taken up by an EFA), while the remainder would only accept this for moderate to high payments of €41-151/ha per additional 1% of farmland).

The researchers detected a general reluctance towards collective participation, likely due to farmer perceptions of the related transaction costs and potential loss of freedom. CAP regulations include a 30% bonus for farmers who participate collectively3, but this would not be enough to encourage any of the classes of farmers identified in the study to do so. The researchers suggest further research is needed to determine the right level of incentive for collective participation in AESs.

They also discuss some general factors which are linked to uptake of AES, such as a large farm area (where economies of scale are higher and per hectare transaction costs lower) and irrigated olive groves (where farmers are more likely to adopt new technology and are less reluctant to adopt cover crops). They also discuss the importance of farmer characteristics, such as age, knowledge and training — all of which correlated to AES uptake in this study.

1.Farms that fulfil basic environmental requirements, including dedicating 5% of their farmland to EFA, receive green payment under the CAP. See Regulation 1307/203, Article 43-47: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0608:0670:EN:PDF
2.This research was part-funded by the European Regional Development Fund and the European Social Fund.
3.The common agricultural policy (CAP) and agriculture in Europe — Frequently asked questions

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Getting value for money in agri-environment schemes: recommendations from the UK

Many would agree that the efficiency of agri-environment schemes (AES) could be improved, but how? A new study considers how AES could deliver ecosystem services better, using peatlands in the UK as a case study. The researchers suggest a number of approaches to improving the link between the payments given to farmers and the environmental benefits they deliver; these include methods of targeting payments to particular areas.

"As an example of good practice, the researchers describe Glastir — an AES in Wales, UK. The scheme pays for the delivery of environmental goods and services relevant to climate change, water management and biodiversity at the farm and landscape level."

Agricultural subsidies are an important tool for land management worldwide and can also be a useful instrument for environmental protection. In the EU, agri-environment schemes (AES) provide payments to farmers who adopt measures that protect the environment. These schemes represent a significant portion of expenditure under the Common Agricultural Policy and are an important tool for the delivery of ecosystem services.

There are growing demands for the money invested to be more closely linked to the benefits delivered to society, i.e. payments should be related to ecosystem service delivery and should only pay for the costs of supplying these services. However, most AES (including those in the EU) are 'input-based', which means payments are based on actions or inputs rather than outcomes.

This study considered how AES could be improved in order to increase the ecosystem services provided for the payments administered, using UK peatlands as a case study. Peatlands provide a wide range of ecosystem services and their management in the UK experiences many challenges shared by AES across the EU.

The researchers say output-based payment schemes (which pay for results) would be more economically efficient than the current input-based schemes, but describe several challenges to implementing them, including:

- **Scientific uncertainty:** Understanding of the connections between interventions and the delivery of ecosystem services remains limited. This makes it difficult to assign payments to providers.
- **Pricing ecosystem services:** Ecosystem services are complex and difficult to price individually.
- **Timing payments:** Payment only when results are seen is unlikely to appeal to landowners, as they require a regular income to cover their costs.
- **Compliance with regulations:** Payments under output-based AES do not comply with current World Trade Organization or CAP regulations.

To overcome some of these challenges, the researchers recommend:

Source: Reed, M., Moxey, A., Prager, K., Hanley, N., Skates, J., Bonn, A., Evans, C., Glenk, K. & Thomson, K. (2014). Improving the link between payments and the provision of ecosystem services in agri-environment schemes. *Ecosystem Services*, 9. 44–53. DOI: 10.1016/j.ecoser.2014.06.008. This study is freely available at: http://nora.nerc.ac.uk/508943/

- Using **competitive bidding**, where farmers bid to deliver ecosystem services, or **non-market valuation techniques** (such as preference techniques, which assess the value people attribute to different services) to set prices for ecosystem services.

- Using **modelling** and **expert knowledge** to establish links between management and ecosystem service delivery, and to identify areas where the greatest benefits could be expected from different management options.

- Combining AES with funding from **private payment-for-ecosystem-services** schemes, in order to reward landowners for delivering ecosystem services while also providing a reliable income.

As an example of good practice, the researchers describe Glastir – an AES in Wales, UK. The scheme pays for the delivery of environmental goods and services relevant to climate change, water management and biodiversity at the farm and landscape level. Glastir targets interventions to specific areas using a modelling approach, driven by environmental data. The process-based model (based on a theoretical understanding of relevant ecological processes) scores land holdings in terms of their ability to achieve environmental objectives and identifies the interventions best suited to achieving these benefits.

The researchers say evidence-based AES like this, which target management actions to the locations where the greatest gains in ecosystem services can be delivered, could increase the economic efficiency of current purely input-based programmes.

To achieve this more widely, they recommend using pressure-response functions (which can rapidly and cost-effectively assess the links between management actions and ecosystem services outputs) and computational models (which can show how different forms of management will affect the delivery of ecosystem services in specific locations). They describe this as part of an in-between stage to fully output-based schemes. While payments would still technically be based on activity, this approach would be a significant improvement on current methods and provide better value for taxpayers' money, say the researchers.

They also recommend focusing on the ecosystem services most valued by society and incentivising cross-boundary collaboration, as some ecosystem services, such as carbon sequestration, span wide spatial scales.

Although this study is focused on AES in a specific land type in the UK, its authors say their findings could be extended to other habitats and locations, and to privately-funded payment-for-ecosystem-services schemes.

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What encourages farmers to participate in EU agri-environment schemes?

Isolating specific reasons for involvement in agri-environment schemes (AES) is a key step in the formulation of schemes that are more appealing to Europe's farming community. Through a comprehensive exploration of the literature on AES across the EU, this study contributes to a better understanding of what drives farmers' participation in such initiatives, revealing important factors such as previous experience with schemes and flexibility in management.

"...they recommend greater involvement of farmers in the design of schemes to improve participation and engagement."

AES have been a component of EU policy since the 1980s, with their significance increasing following changes to the Common Agricultural Policy[1] (CAP) in 2013. Between 2007 and 2013, over €22 billion was allocated to EU Member States to cover AES payments, which are distributed to participating farmers following their commitment to greener farming practices. The fact that such large amounts of public money are invested, means that there is a need to assess performance. This study[2], which was co-financed by the EU[3], reviews the existing literature on the factors that influence farmers to join AES, resulting in a series of recommendations for policymakers.

One of the central principles of AES is that they are voluntary, but this means that environmental policy objectives will only be achieved if the schemes are appealing to farmers. To assist with this, farmers are incentivised for their participation, but payment needs to be set at a level that encourages uptake whilst remaining cost-effective.

This study pinpoints the main influences on farmers' participation in AES by undertaking meta

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Source: Xavier B. Lastra-Bravo, X.B., Hubbard, C., Garrod, G. & Tolón-Becerra, A. (2015). What drives farmers' participation in EU agri-environmental schemes?: Results from a qualitative meta-analysis. *Environmental Science & Policy*. 54: 1–9. DOI: 10.1016/j.envsci.2015.06.002.

analysis of papers published in peer-reviewed journals between 2000 and 2013. The papers selected covered surveys performed in most EU Member States. Over 160 variables affecting uptake were identified, and grouped into five major categories: economic factors, farm structure, farmer characteristics, farmers' attitudes towards AES, and social capital (i.e. the connections, shared values and understandings between individuals and groups).

Results indicate that farms less likely to join AES are those where there is a high dependence on agricultural activities for farm income; those where there is the presence of a successor on a farm (farmers are unwilling to agree to long-term contracts that may affect their successors); and farms with a high proportions of family labour.

On the other hand, previous involvement with AES or lower agricultural capacity (smaller farms, for example) were positively associated with AES uptake — perhaps because farmers, by being paid for additional work under an AES, can more significantly increase their incomes with AES payments and also use some areas that are not available for agricultural activities.

Unsurprisingly, payment emerged as one of the most important drivers. Many of the farmers indicated that they would consider smaller payments and lower levels of disruption to their activities as an alternative to higher payments with greater disruption. This has important implications for policymakers, as it suggests that a more flexible system, including an incremental adoption of measures of increasing intensity with linked increases in payment, could cut costs while encouraging uptake among farmers. This might also encourage farmers to adopt more innovative practices, such as landscape scale management measures with neighbouring famers, which could achieve greater environmental benefits.

Other recommendations made by the researchers include holding community workshops to promote AES among farmers. Farmers previously involved in schemes might act as advocates or champions of the benefits of AES participation. Additionally, they recommend greater involvement of farmers in the design of schemes to improve participation and engagement.

Finally, it is important for policymakers to consider the interplay between AES and other policies that impact the rural community (such as rural development, food safety, climate change, sustainable development and regional policies), as they may serve to either increase or decrease participation.

1.www.ec.europa.eu/agriculture/cap-post-2013/
2.For a revised open access version of this study, see: http://eprint.ncl.ac.uk/file_store/production/214035/670B95C8-8F5A-4CBA-81A0-5231CD54483C.pdf
3.This study was partly funded by the European Regional Development Fund, which aims to strengthen economic and social cohesion in the EU. See: www.ec.europa.eu/regional_policy/en/funding/erdf

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Training farmers in management for bird conservation could improve overall biodiversity on farms

Agri-environment schemes (AES) are a means by which farmers can ensure greener agriculture, but their success is based on many factors, including the effectiveness of the scheme and participation by farmers. In an effort to understand how different factors affect uptake of AES, this study assessed the attitudes and values of decision-making for a sample of UK farmers involved with bird conservation. The results indicate that effectiveness and participation rates could be improved by informing farmers about the state of bird populations in their region and highlighting the impacts of different management practices on bird conservation.

"Providing farmers with information on the current state of bird populations in their region, as well as highlighting the impacts of different management practices on birdlife is likely to improve participation rates."

Farmers must balance numerous factors when making decisions about farm management, of which environmental impact is just one. Voluntary AES can play a major role in benefiting biodiversity on farms, but there is a need to increase the effectiveness and the level of participation, suggests the study. Furthermore, it has been suggested that specific biodiversity targets can only be met with equally specific measures — so-called ecologically related AES (ER-AES) — and some general land management AES may be too broad to produce useful outcomes.

This study explored the attitudes and values that affect farmer decision making, focusing specifically on ER-AES measures to benefit farmland birds. The researchers conducted telephone questionnaires with a sample of 46 farmers from Scotland's Lunan catchment, who were deemed to represent the region's range of farm types and sizes. As an intensively managed area, Lunan receives financial support from the EU to protect the local environment.

In the questionnaires, farmers were asked to indicate to what extent they agreed or disagreed with an array of questions concerning AES, birds, and farm management generally. The results indicated that farmers were concerned about the birds that were on their land, but also revealed conflicting priorities — such as the desire to maintain a 'tidy' landscape, which has been shown to reduce biodiversity. Crucially, there was a lack of understanding about current bird population trends and habitat requirements, as well as mixed perceptions regarding the benefits that ER-AES can have for birdlife. Overall, only a minority of the farmers sampled intended to participate in ER-AES in the future.

The researchers suggest that their findings are likely to be applicable to other intensively farmed parts of Europe, highlighting ER-AES in Germany and Ireland. For policymakers looking to develop more popular and effective ER-AES in the future, the key lesson that emerges from this study is the importance of knowledge provision. The researchers conclude that participation in AES is strongly linked with an ethical desire to improve the ecological value of the land. Providing farmers with

Source: Guillem, E.E. & Barnes, A. (2013). Farmer perceptions of bird conservation and farming management at a catchment level. *Land Use Policy*, 31: 565–575. DOI: 10.1016/j.landusepol.2012.09.002
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information on the current state of bird populations in their region, as well as highlighting the impacts of different management practices on birdlife is likely to improve participation rates. This requires extensive assessments of the effectiveness of different practices, which can then be reported to the farmers. This principle could also be extended to other forms of AES.

ER-AES are effective for improving biodiversity precisely because they are so specific, and this needs to be taken into account in future reform of the Common Agricultural Policy and notably Rural Development support. However, if farmers are to expand their range of voluntary AES activities, there will be a need to increase their level of subsidy— particularly for those who prioritise production and profit over environmental action.

1.www.ec.europa.eu/agriculture/cap-post-2013/

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Organic farming enhances pollination but may reduce yield compared to non-organic agri-environment schemes

There are several types of wildlife-friendly farming scheme, some of which are more prescriptive than others. A recent study compared the effects of different wildlife-friendly farming approaches, including organic farming, on pollination. The findings suggest that organic farming practices enhance pollination services but may compromise crop yield. 'Conservation Grade' farming schemes — biodiversity-focused practices funded by sales of labelled food products — can support both pollination and yield.

"CG farms had the highest number of total insect wildflower visits, proving that this method of management attracts foraging bees."

Insect pollinators, such as bees and butterflies, are in decline across the globe. This decline is driven by a combination of bee hive pests, such as *varroa*, habitat loss, climate change and use of agricultural chemicals.

Policy responses have generally focused on improving habitat and, in particular, on increasing flower availability, as a lack of flowers has a significant impact on bee populations. Areas with more flowers generally have more pollinators, a more diverse range of pollinators and higher levels of pollination.

In Europe, the main tools for increasing floral resources in agricultural landscapes are wildlife-friendly farming schemes (including EU-funded agri-environment schemes — AES). This study compared three types of wildlife-friendly farming in England: **Entry Level Stewardship** (ELS, a flexible AES, non-organic), **Conservation Grade** (CG, a more prescriptive AES, non-organic) and **organic farming** (organic versions of AES).

The English governmental scheme Environmental Stewardship included several options for enhancing floral resources in non-crop habitats. This study used entry-level stewardship (ELS) as a baseline scheme, which covered 65% of England's agricultural land area in 2013, and included an option for sowing patches of flower mixes and legumes. Conservation Grade is a non-governmental scheme, under which farmers must provide wildlife habitat on at least 10% of the farmed area (4% of the farmed area must be pollen- and nectar-rich), funded by the purchase of food products accredited with the 'Fair to Nature' brand. Finally, organic farming is a more traditional method of biodiversity-friendly agriculture — involving ecological processes to aid production, such as using legumes to enhance soil fertility rather than depending on chemical fertilisers.

According to the researchers, this is the first study to compare how these methods differ in terms of floral resources, number of different types of pollinators and pollination services they provide.

Source: Hardman, C., Norris, K., Nevard, T., Hughes, B. & Potts, S. (2016). Delivery of floral resources and pollination services on farmland under three different wildlife-friendly schemes. *Agriculture, Ecosystems & Environment*, 220: 142–151. DOI: 10.1016/j.agee.2016.01.015.

The study, which was carried out in summer 2013, included four sets of three farms (one in each management type) in southern England. The researchers investigated crop and non-crop habitats in terms of their flower density and diversity, pollinator density and diversity, and pollination services, measured using phytometers — potted plants that cannot be fertilised by their own pollen and are pollinated by insects — a method known to be effective for measuring pollination. They chose to use the potted plant Californian poppy (Eschscholzia californica) — an ornamental species not found in the natural environment.

The total floral resources available to pollinators in crop habitats were significantly higher on organic farms (46%), compared to CG (11%) or ELS (0.28%) farms. As well as more flowers, organically managed crops also had higher levels of pollination services and wildflower visits by insects than non-organic crops

Although pollination services were higher on the organic farms, the number and diversity of pollinators did not differ between the different types of farm management. To explain this result, the researchers suggest that the benefits of organic farming for pollination services are more due to the *increase in the number of flowers than the increase in the number and/or diversity of pollinators.*

CG farms had the highest number of total wildflower visits by insects, proving that this method of management attracts foraging bees. The most flexible approach (ELS) supported high numbers of flowers in non-crop areas and a similar level of pollination to CG. These results highlight the importance of managed non-crop habitat (such as flowery margins, which received the highest number of insect visits in this study), for providing resources for pollinators and thus helping to tackle species decline.

Although organic farming practices, such as sowing clover together with the prohibition of herbicide use, increase the number of flowers in crop habitats and enhance pollination, researchers warn they may lead to trade-offs with other ecosystem services that damage crop production; for example, the high weed abundance in the crop may compete with the crop for resources. Indeed, data collected from farmers revealed that organic winter wheat yields were significantly lower than those in CG and ELS farms. The researchers suggest CG may be a way of supporting pollinators in farms where high yields are needed.

When deciding which scheme to use on individual farms, biodiversity and production targets should be considered, as well as the conditions and productivity of the land, the researchers conclude. Spatial or geographical targeting, which is being used for a new stewardship scheme in England, is thus highly important, however additional research is needed to understand where and what management practices will optimise pollination services for specific crops.

Further reading

You may also be interested in reading the following publications from Science for Environment Policy.

News Alert articles

Climate-smart agri-technology innovations: how to increase uptake (April 2016)

'Climate-smart agriculture' aims to sustainably increase agricultural production and increase resilience to climate change. One aspect focuses on climate-smart technologies. This study interviewed users and producers of these technologies, highlighting barriers to adoption and possible means of overcoming them, including increasing awareness, user-focused design and changes to policy.

http://ec.europa.eu/environment/integration/research/newsalert/pdf/climate_smart_agri_technology_innovations_how_to_increase_uptake_453na3_en.pdf

New method of developing agri-environment schemes proposes €3 million saving in Germany (November 2016)

A method for developing more cost-effective agri-environment schemes is outlined in a recent study. The procedure can be used over large areas, accounts for hundreds of management regimes and several different endangered species. The model is one of the first to account for the timing of measures and, when applied to Saxony in Germany, proposed savings of over €3 million, while also improving some conservation outcomes.

http://ec.europa.eu/environment/integration/research/newsalert/pdf/new_agrienvironment_schemes_3million_euro_saving_germany_476na2_en.pdf

Herbicide run-off reduced by grassy ditches in Italy — recommended for agri-environment schemes (November 2016)

A method for developing more cost-effective agri-environment schemes is outlined in a recent study. The procedure can be used over large areas, accounts for hundreds of management regimes and several different endangered species. The model is one of the first to account for the timing of measures and, when applied to Saxony in Germany, proposed savings of over €3 million, while also improving some conservation outcomes.

http://ec.europa.eu/environment/integration/research/newsalert/pdf/new_agrienvironment_schemes_3million_euro_saving_germany_476na2_en.pdf

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Future Briefs

The value of Natura 2000 (April 2016)

The Natura 2000 network encompasses nearly a fifth of EU territory and provides protection for more than a thousand rare and threatened species. The benefits provided by the network are estimated to be worth €223–314 billion per year. In this new Future Brief we examine the 'value' of Natura 2000 from different angles: in terms of biodiversity conservation, the benefits for people, and economic value.

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