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Balancing Nature and Agriculture

This POSTnote explores two approaches to managing land for balancing nature conservation with sustainable food production. *Land sharing* integrates the objectives of agriculture and benefits to wildlife on the same land. *Land sparing* on the other hand separates intensive farming areas from protected natural habitats at larger scales.

Overview

- Currently, the conservation of biodiversity in the UK uses a combination of agri-environment schemes and nature reserves.
- Varying landscapes across Europe may call for different approaches. Current CAP funding primarily rewards land sharing through agri-environment schemes.
- Land sparing involves two key components: sustainable intensification of farmed land, and restoration of 'spared' areas for nature.
- Choosing between land sharing and sparing strategies, and at different scales, has implications for what types of biodiversity and habitats are protected.
- There is ongoing debate as to whether the UK has the appropriate combination of land sparing and land sharing to optimise the balance of nature and agriculture to halt biodiversity loss.

Balancing Food Production and Wildlife

Achieving efficient and productive agriculture to ensure food security while conserving biodiversity is a key challenge considering predicted scenarios of rapid human population growth.[1] Agriculture is highly dependent on benefits derived from nature,[2,3] known as 'ecosystem services' (POSTnote 377). These include pollination, pest control and nutrient cycling.[4] Although agriculture is dependent on biodiversity, agricultural intensification is also a major driver of biodiversity decline.[5,6] Within this context, there is debate about the best way of balancing food production and wildlife protection.

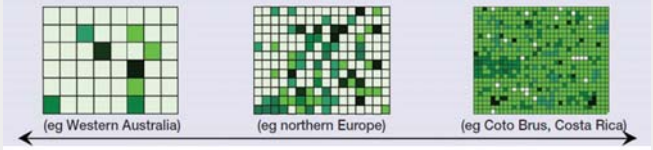
Two approaches for optimising land use have been proposed: *land sharing* and *land sparing.*[6] These two theoretical approaches lie at opposite ends of a continuum (Box 1), but there is a complex range of options in between.[8] The key issue in the land sharing versus land sparing debate is the *spatial scale at which farming and nature should be integrated.* Both approaches include elements of nature and agriculture, but integrate them at different spatial scales. In land sharing, nature and agriculture are normally mixed together in small parcels in a heterogeneous landscape. In land sparing the two elements are separated at larger scales. There is debate as to what land management practices constitute land sharing as opposed to sparing.[7]

Land Sharing

Land sharing attempts to meet both agricultural and conservation needs within the same area. This approach

Box 1. Land Allocation Continuum[8]

Land sharing and sparing represent endpoints on a continuum of approaches to managing biodiversity. The shade of green denotes the value of a grid square for nature conservation; darker shades representing greater value for biodiversity.



Land sparing		*Land sharing*
Integrates agriculture and nature conservation planned at a wider landscape level	vs.	Integrates agriculture and nature conservation at the field or farm level
Beneficial to species that are sensitive to even low intensity agriculture	vs.	Beneficial to species able to exist in farmed habitats

aims to make existing farmland as hospitable to wildlife as possible by reducing pesticide and fertiliser inputs and retaining habitats such as trees, hedges and ponds.[6] Land sharing aims to create a multifunctional landscape that attempts to integrate food production, nature conservation, biofuel production and other ecosystem services. However, it can limit yields, so more land area is required to produce a given amount of food.[8]

Land Sparing

Land sparing works on the basis that increasing yields on existing agricultural land can make it possible for other land to be 'spared' for nature conservation.[5] In theory, this could provide larger areas of land dedicated for wildlife and has the potential to ensure large scale, high quality habitats.[7] It is not clear how well it fits with other environmental management concepts, such as the ecosystem approach (POSTnote 377) which seeks to maintain the integrity of natural resource systems that support human well-being. There are two key components to land sparing:

- sustainable intensification of agriculture
- protection of existing natural habitats, or restoration of natural habitat where it has previously been lost.

Sustainable Intensification (SI)

SI has been defined as '*producing more output from the same area of land while reducing the negative environmental impacts'.*[9] This allows the same yield to be obtained from a smaller area of land (Box 2) leaving other areas to be 'spared' for nature. Proponents of SI include groups such as the National Farmers Union (NFU). Conservation NGOs such as the RSPB are more wary and support an agroecology approach (Box 2). Ecologists advocating the land sparing approach have emphasised that SI should not be misinterpreted as paving the way for business-as-usual intensification of agriculture, but approaches need to be developed to ensure they are sustainable.[10] There is also concern that higher yields from land may increase market pressure to convert 'spared' land to agriculture.[11] Alongside this, 'spared' areas are likely to be on less productive land, with implications for the sorts of habitats that are spared. For land sparing to work there would need to be effective systems and policy structures to link SI both with the improved protection of 'spared' land and restoration of a variety of habitats.[12]

Habitat Restoration and Re-wilding

Remaining natural habitats should be protected by land sparing, but where they are degraded or biodiversity loss has occurred it may be necessary to restore actively or re-wild habitats naturally. Conservation in the UK has traditionally focussed on conserving specific habitats and species through the Biodiversity Action Plan system.[13] Active management to restore specific habitats under these schemes has been a success: a recent review of global restoration projects showed an average increase in biodiversity of 44% over a range of time frames.[14] Habitat restoration and recreation were key recommendations in a recent government-commissioned review of England's wildlife sites (Lawton Review).[15] The EU is also committed to restoring 15% of degraded habitats through its Biodiversity Strategy.[16]

Box 2. How to Close the Yield Gaps

A 'yield gap' is the difference between potential yield of a given area and actual yield produced.[17] In the UK, the average wheat yield has remained at around 8 tonnes per hectare (t/ha) for the last 10 years,[21] but a record of 14.3 t/ha has been achieved[18] and yields of 10 t/ha are regularly recorded. Rothamsted Research is currently undertaking a project to reach a target of 20 t/ha in the next 20 years.[19] Four potential methods for increasing yields whilst minimising negative effects on the environment are:

- Genetic Modification, while a politically sensitive issue, has the potential to reduce chemical input requirements and produce higher yields, for example, by modifying cereal varieties to make them nitrogen fixing (POSTnotes 386).
- Plant breeding has been responsible for almost 90% of yield increases in cereal and oil seed rape crops between 1982 and 2007.[20] Although yield potential has continued to increase, yields produced in the field have remained unchanged since 2000 due to other factors such as soil degradation.[21]
- Precision agriculture uses hi-tech satellite technology to analyse their soils and plants, and focus chemical inputs in the field, thus reducing over-application of pesticides and fertilisers.[22]
- Agroecology uses natural sciences to understand elements of agricultural ecosystems, such as soil properties and plant-insect interactions (POSTnote 412).

Another approach to conservation is to recreate wilderness and to allow natural patterns and processes to take over. An example of this is currently being funded experimentally by Higher-Level Stewardship;[23] very low intensity wild grazing at the Knepp Estate in West Sussex where 1,400 hectares have been taken out of agricultural production and natural vegetation patterns have been allowed to re-establish.[24] Although re-wilding requires less active management and costs less than habitat restoration, the process is often slower to produce biodiversity benefits and results are more unpredictable.[25] Re-wilding and habitat restoration projects are currently undertaken but not linked with increasing yields elsewhere so are not strictly land sparing initiatives.

Current Approaches to Managing Nature

Land Sparing: Protected Area Networks

The EU Habitats and Birds Directives form the cornerstone of Europe's nature conservation policy and set out strategies and targets including the creation of a connected network of protected sites.[26] Across Europe and the UK there are different types of protected areas with varying levels of protection. In Europe (including the UK), the Natura 2000 network is made up of Special Protected Areas and Special Areas of Conservation.[27] In the UK, National Nature Reserves and Sites of Special Scientific Interest are also designated.[28]

Land Sharing: Agri-Environment Schemes

The main agri-environment scheme (AES) in England, Environmental Stewardship,[29] sits towards the land sharing end of the land allocation continuum (Box 1). AESs, where farmers are paid to manage their land to benefit wildlife, were first introduced in the EU in 1992 and have been part of the Common Agricultural Policy (CAP; Box 3) since 2003.[30] In England, AESs have been a major component of government policy for twenty years and the effectiveness of these schemes has been studied for over a decade. Although some local benefits have been demonstrated, overall farmland biodiversity continues to decline (Box 3).[31, 32, 33, 34]

Timescales

Agri-environment schemes are short term contracts funded by the EU through the CAP. There is a mismatch between the short (7 year) timescales of CAP budgetary cycles and the longer lengths of time required to demonstrate biodiversity gains and ensure wildlife recovery. One suggestion is that future approaches may link natural habitats to markets over longer timescales (see *Potential Policy Tools: Market based measures*).

Natural Environment White Paper

In June 2011, following the publication of the Lawton Review,[15] the Government published its first Natural Environment White Paper for 20 years.[35] It recognises that the level of demand for food production and land are increasing and outlines the Government's vision for the natural environment, shifting the emphasis from piecemeal conservation action towards a more integrated landscape scale approach. The Government's Biodiversity 2020 strategy also emphasises this, and the Land Use Futures Foresight report[45] points towards the need to develop a more strategic approach at the landscape level (POSTnote 380). Although land sharing and land sparing are not explicitly discussed in the Natural Environment White Paper, the Government has committed to identifying ways to increase food production that also improve the environment. Defra is doing this through the Green Food Project which brings together representatives from farming, food industries and NGOs.[46]

Box 3. The EU CAP and Agri-environmental Management

The Common Agricultural Policy (CAP)

The latest review of the CAP will play a major role in shaping land use and biodiversity policy across Europe from 2014-2020. The CAP exerts strong influence on land management in the EU through:

- Pillar I payments made to farmers for adhering to mandatory Cross Compliance requirements which encompass Birds and Habitats Directives and measures to deliver 'Good Agricultural and Environmental Condition' (70% of the budget).
- Optional Pillar II payments which reward delivery of environmental public goods which are not valued through conventional markets (e.g. participation in agri-environment schemes).

Greening of CAP Pillar I

CAP Pillar I is not currently associated with environmental outputs. The European Commission has proposed three 'greening' measures for Pillar I in the reform for the 2014- 20 period:

- maintaining permanent pasture
- crop diversification
- setting aside 7% of land area as 'Ecological Focus Areas'.

There is disagreement whether proposed changes are likely to have significant environmental benefits. Organisations like the RSPB and Wildlife Trusts have argued that Ecological Focus Areas do have potential to deliver benefits to wildlife. However, a recent Environment, Food and Rural Affairs Select Committee report[36] suggested that they are unlikely to achieve the EU's environmental goals and that the reforms could have a detrimental effect if farmers choose to opt out of Pillar II AES's as further environmental measures become compulsory under Pillar I.[36] Agricultural organisations such as the NFU think that the CAP reforms do not move enough towards a production focus and won't incentivise sustainable intensification.[37] In contrast, environmental organisations have argued that long-term food security will be secured, in part, through protection and improvement of biodiversity, and soil and water management.

Agri-Environment Schemes: Environmental Stewardship

A forthcoming review of the Rural Development Programme (in line with the new CAP for 2014-20) will look at AES systems and consider a more spatially targeted approach to resource allocation for environmental interventions.[38] In England, around 70% of eligible farmland is under an Environmental Stewardship agreement,[39] but the quality of agreements is variable, which limits the environmental benefits that are delivered. Species specific and targeted schemes,[40] such as Higher-Level Stewardship[41,42], have been successful, but there is little evidence to demonstrate any real benefits of broad and shallow AES, such as Entry-Level Stewardship (ELS).[31] A limited number of studies suggest that some management options adopted under ELS can deliver population level benefits to some taxa.[43] However, nationally, biodiversity loss continues[44] and local monitoring is insufficient to show where benefits have been achieved. In response to the recognised problems with ELS scheme design, Defra has been leading a project called *Making Environmental Stewardship More Effective* in an attempt to improve delivery of benefits.

Potential Policy Tools

A number of policy tools would be required to implement land sparing or land sharing approaches. These could include market based measures and changing subsidies:

Market Based Measures

As food prices rise, the demand for land for food production increases and the costs of conservation will increase.[1,47] Market approaches such as Biodiversity Offsetting (Box 4) may be a way to avoid rising costs to the taxpayer while protecting biodiversity. The UK National Ecosystem Assessment (NEA)[4] provides an account of how the natural world, including its biodiversity, provides services that are critical to human wellbeing and economic prosperity (POSTnote 378). One way of recognising these services is to develop markets to support environmental benefits provided through land management ('Payment for Ecosystem Services', POST Report 370). However, in terms of land sparing, there are currently no market mechanisms to ensure that a doubling of wheat yield in one area will spare land elsewhere. Another concern is that once biodiversity on intensively farmed land is lost, there could be pressure to change the rules and allow the remaining protected areas to be converted to agriculture.

Re-shaping Government Subsidy Schemes

Given the billions of Euros invested in agri-environment schemes, it should be possible to re-shape CAP Pillar II funding schemes to reward high-yielding farmers who invest in large scale habitat restoration in support of a land sparing approach. A *reverse auctioning* approach where farmers bid for contracts for environmental management projects (for

Box 4. Biodiversity Offsetting

Biodiversity offsetting is usually a market-based conservation tool that measures negative impacts on biodiversity and compensates for the loss through improvements elsewhere (POSTnote 369). In the context of land sparing, biodiversity offsetting principles could be used to link agricultural intensification to protection and/or restoration of 'spared' land. Defra considers biodiversity offsetting to have the potential to deliver compensation for biodiversity loss from development in an effective way and is currently undertaking six biodiversity offsetting pilot schemes across the country.[48] Systems for biodiversity off-setting could include the establishment of habitat banks (e.g. the UK-based Environment Bank),[49] which trade in corporate responsibility credits and habitat restoration credits. Farmers could collaborate to 'spare' marginal land and trade in for conservation credit payments.

example, to create a wetland) has the potential to allow better spatial targeting of resources,[50] and farmers also get to choose activities that they have specific interests in, instead of choosing from a prescriptive list of one-size fits all options. Reverse auctioning has been shown to be successful in reducing pesticide and fertiliser run-off in the Conestoga Watershed in Pennsylvania, US.[51,52] It has the potential to improve value for money although there are concerns over potentially high transaction costs.[50]

Which Approach is Better?

One high profile case-study in two tropical landscapes showed that the land sparing approach was the most efficient form of protecting wildlife in frontier forest landscapes.[53] However, this does not mean that land sparing is always the best approach. The findings cannot be extrapolated to other landscape types such as open steppe habitats, wetlands or the highly modified habitats found across much of lowland England. Land sparing is not, for example, appropriate where wildlife is dependent on an agricultural practice,[8, 55] such as hay meadows. In the UK, 28 bird species are classified as 'farmland birds', which are entirely or partially reliant on farmland habitat.[54] In addition, different groups of species operate at different scales: what constitutes enough land spare for a beetle may not be enough to provide food and nesting habitats for a bird.[7] Scale thus needs to be operationally and ecologically meaningful to work for both land managers and biodiversity. Some commentators, such as Professor Tim Benton at the University of Leeds, think that a 2 km^2 scale, at least, is likely to be most appropriate in the UK, especially for avian species. In reality, land sharing and land sparing approaches are likely to be used to deliver different outcomes:

- Land sharing is most likely to benefit widespread generalist species and ecosystem services (such as pollination (POSTnote 348)) which need management to be distributed throughout the landscape. It is also more likely to benefit species that have survived a history of land use change.[6]
- Land sparing is more likely to benefit habitat specialists (including rare species) which are only found in a few protected locations. In addition, it may also provide ecosystem services such as carbon storage and water purification provided by upland peatlands. It is also more likely to be successful in protecting species that are sensitive even to low intensity agriculture.[6]

Europe and the UK

Different groups of biodiversity will be protected under land sharing and land sparing scenarios. In a 'frontier landscape' where forest is being cut down to make way for agriculture, forest specialist species may be conserved by protecting the original forested habitat. Across much of Western Europe, however, it is harder to make this distinction clearly, because many species rely heavily on semi-natural farmed habitats, such as lightly grazed salt marsh.[55] The EU can currently be considered to have a nested scenario of sharing and sparing: the UK has intensive agriculture, while parts of Eastern Europe have been 'spared' intensification.[56] However, within the agricultural landscape of the UK there are also pockets of spared semi-natural habitats (e.g. woodland copses/wetlands).

Eastern Europe

A recent research paper[57] identified parts of Eastern Europe as a potential area for increasing agricultural outputs (Box 2). Land sparing would allow for intensification. However, some scientists have argued this could be devastating to biodiversity in areas where traditional semi-subsistence farming has developed and been practiced over hundreds of years.[58] These low input extensive agricultural systems support rich biodiversity that is no longer present in much of Western Europe, with species such as corncrake and yellow-bellied toads abundant.[59] Some NGOs and academics have suggested intensification should be regulated to ensure that traditional low input agriculture is maintained in the most species rich areas. However, this could lead to indirect land-use change as displaced demand may drive food production elsewhere.[60]

In parts of Eastern Europe, it appears that a kind of 'land sparing' is occurring without legislation because of economic factors. As agriculture intensifies in areas in receipt of CAP incentives, other marginal land is abandoned, although this is not protected. In response, the 'Rewilding Europe' Initiative[61] aims to re-wild at least one million hectares of abandoned land, returning it to wilderness, by 2020. Five pilot projects have been identified, including one in the Romanian Carpathian Mountains.

UK Context

The UK has predominantly open habitats and landscapes that have been subjected to disturbances from glaciations, floods and a long history of agriculture and forest clearance. The resultant species mix is made up of groups that have endured habitat fragmentation and survive in highly modified habitats.[4] Although there is little quantitative data analysis of land sharing versus land sparing, given the land-use history of the UK, bodies such as the RSPB have argued that a land sharing approach, coupled with protection of remaining semi-natural habitats is likely to bring the greatest biodiversity benefit. One study has suggested that a land sparing approach may be more efficient, as long as spared land is equivalent to SSSI quality.[62] However, there is a lack of conclusive evidence on how best to conserve biodiversity in areas with a long history of agriculture, high population density and little remaining semi-natural habitats.[63] There is no obvious baseline habitat for comparison, but useful frames of reference come from existing protected and restored habitats, along with remaining habitats in other parts of Europe. There are also many social, cultural and technical issues that would need to be addressed to implement large scale land sparing in the UK, such as:

- deciding where agriculture should be intensified, and where land should be spared
- how to implement the 'sparing' element of the policy
- how to manage the 'spared' land and who would be responsible
- how to implement the 'intensification' element of the policy
- whether society would accept a large scale land sparing.

Endnotes

For references, please see http://www.parliament.uk/documents/post/postpn418_balancing-nature-and-agriculture-references.pdf

POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of policy issues that have a basis in science and technology. POST is grateful to Helen Hicks for researching this briefing, to NERC for funding her parliamentary fellowship, and to all contributors and reviewers. For further information on this subject, please contact the co-author Dr Jonathan Wentworth.