green alliance...

# Protecting our assets

## Using Natural Infrastructure Schemes to support sustainable agriculture

National Trust

**Protecting our assets**
Using Natural Infrastructure Schemes to support sustainable agriculture

By William Andrews Tipper

**Green Alliance**
Green Alliance is a charity and independent think tank focused on ambitious leadership for the environment. We have a track record of over 35 years, working with the most influential leaders from the NGO, business and political communities. Our work generates new thinking and dialogue, and has increased political action and support for environmental solutions in the UK.

**Acknowledgements**
Thanks to the following individuals for their insight and advice: Peter Fane, Simon Ward, John Kay, Alan Bullivant, Mat Roberts, Marcus Gilleard, Patrick Begg, Stewart Clarke, Laura Mann, James Peacock, Jonathan Dobson, Kate Rice, Adrian Moore, Rob Macklin, Liz Lowe, Chris Clark, Kate Trumper, Chris Featherstone and Felicity Roos.

The following organisations kindly supported this project:

Green Alliance
11 Belgrave Road,
London, SW1V 1RB
020 7233 7433

ga@green-alliance.org.uk
www.green-alliance.org.uk
blog: greenallianceblog.org.uk
twitter: @GreenAllianceUK

The Green Alliance Trust
Registered charity no. 1045395
Company limited by guarantee
(England and Wales) no. 3037633
Registered at the above address

Published by Green Alliance,
December 2017

ISBN 978-1-909980-97-6

Designed by Howdy

Green Alliance is the author and publisher of this work.
National Trust owns the rights.

# Executive summary

England has some of the most productive farmland in the world, much of it concentrated in the Anglian river basin in the east. However, over centuries, as low lying land has been drained and farmed, the soil has become degraded. Only 16 per cent of the East Anglian peat stock which existed in 1850 still remains, and up to 21 millimetres of top soil is lost every year. Much of this soil, and the nutrients added to it by farmers, ends up in watercourses, creating significant pollution challenges.

Deteriorating soils already cost farmers £246 million per year, due to erosion, compaction and the loss of organic matter. Climate change will intensify soil loss, and could lead to seasonal reductions in river flows of as much as 80 per cent in 2050. It is estimated that, in some areas of the Fens, agricultural output could drop from £480 per hectare to £30 per hectare over the next 60 years. Halting, and ultimately reversing, declines in soil and water quality will be essential to preserve the long term prosperity of UK farming.

**"Halting, and ultimately reversing, declines in soil and water quality will be essential to preserve the long term prosperity of UK farming."**

Payments for ecosystem services (PES) has emerged as a powerful idea to improve the environmental performance of farming. It is mostly proposed as an alternative to producing food. In this report, we look at whether PES could protect the productivity of UK agriculture, based on a private contract for improvements to soil and water quality.

Our Natural Infrastructure Schemes (NIS) concept, which we first proposed with the National Trust in 2016, is a private marketplace in which transactions are agreed based on avoided costs. Buyers pay farmers for the creation and maintenance of natural infrastructure on farmland to reduce their costs, for instance to manage flood risk or clean up water.

This report sets out a thought experiment assessing whether this approach could complement regulation to further reduce concentrations of nitrates in groundwater whilst improving soils in eastern England. We examine the financial and environmental benefits of combining cover crops alongside lower input commodity production across 1,000 hectares in a catchment. This would improve soil structure and reduce water contamination, by avoiding the use of fertilisers and other farming inputs. We set out a hypothetical scenario aimed at increasing understanding of the benefits of the scheme, if conducted at a scale sufficient to eliminate the need for an expensive new water treatment facility over the next 15 years.

Our inquiry suggests the following benefits are possible:

- A water company could significantly reduce its costs for meeting regulatory standards for clean drinking water. Under our most optimistic assumption, this could reach £2 million over 15 years.
- Farmers' use of ammonium nitrate fertiliser could reduce sharply, potentially by over three million kilogrammes over 15 years. This is in a scenario where winter wheat is replaced by cover crops, followed by spring wheat, across 500 hectares, and by winter barley across another 500 hectares, with an agreement to reduce fertiliser application on the barley crop by 50 per cent against usual levels.
- Payment to the farmers means they can recover their costs from planting and maintaining cover crops, and replace lost earnings from lower farm output, in full. Our scenario suggests that, for a consortium of ten farmers, they could could each increase their annual profits by over £5,000 per year, depending on the terms of the agreement.
- Food companies could benefit from greater resilience in their supply chains, and improvements to their environmental footprint, at a cost of a few thousand pounds per year.

A number of barriers will make this market-based approach challenging. But, given the scale of the financial and environmental benefits potentially available, we suggest three ways in which the government could facilitate transactions of this kind:

- Create a new regional model for the governance of land use and water, with the legal authority to sanction land management that results in excessive soil loss or nutrient leaching and stress to water resources.
- Introduce financial incentives to drive investment in improving farmland ecosystems. This might include the Natural Capital Allowance model, which we have previously proposed, making investments in environmentally beneficial land management eligible for tax relief.
- Consult on the ways to ensure commercial land management enhances, rather than depletes, environmental assets. For instance, new requirements to prepare natural capital accounts, either on an annual basis or when land is sold.

# 1
# Why degraded farmland is bad for business

The natural environment has been an under appreciated asset in the UK's food production system. The health of our soils, water and pollinator populations are vital to keep agriculture productive, so we degrade natural systems and assets at our peril.

More than half of England's most productive farmland is found in the Anglian river basin, a region rich in fertile peat soils.[1] Many of the country's biggest farms with the highest revenues are found here, with average annual farming incomes of more than £300,000 per farm,[2] not including additional subsidy payments. It is England's breadbasket, producing more than a quarter of our wheat and barley, half of our sugar beet and much of our horticultural produce.[3]

**"Only 16 per cent of the East Anglian peat stock existing in 1850 still remains, and up to 21 millimetres of top soil is lost every year."**

Food production in the region has been supported through extensive land drainage over centuries, allowing farmers to cultivate more of the land. There is a huge diversity of soils, with clay or heavy soils dominating, and sandy soils prevalent near the coast. But, as the land has been drained and farmed, soils have been depleted. Only 16 per cent of the East Anglian peat stock existing in 1850 still remains, and up to 21 millimetres of top soil is lost every year.[4,5]

Farming has been successful despite the region being one of the driest parts of the country. It receives 600 millimetres of rain a year, 70 per cent of the national average.[6] Farmers are required to be inventive in minimising their use of water. Nevertheless, they are among the country's most intensive water users; in the Cam and Ely Ouse catchment, more than 7,000 cubic metres of water is used per square kilometre for irrigation, far more than any other catchment in the country.[7] Over 50 per cent of water bodies, including rivers, lakes and groundwater, have been heavily modified in the region, much of it for the benefit of agriculture.[8]

This degradation of soil and water resources is creating risks and costs for a range of businesses:

**Farms.** Poor soil management creates direct costs of £246 million per year for agriculture, through soil erosion, compaction and loss of organic matter.[9] Even in a moderate drought, crops that rely on rain or irrigation, using water abstracted from rivers and aquifers, can lose as much as 15 per cent of daily gross value added (GVA). For potatoes, this would rise to nearly 60 per cent, while the value of strawberry crops could be wiped out completely.[10]

**Water companies.** Pollution from agriculture, including nitrate fertilisers and pesticides such as metaldehyde, is one of the principal causes of water bodies failing to meet environmental and human health regulatory standards. Eighty four per cent of surface waters and 51 per cent of groundwaters in the Anglian river basin are designated as Nitrate Vulnerable Zones.[11] Anglian Water spent over £325 million in 2016-17 on treating water to ensure it met regulatory standards.[12]

**“Maintaining the long term capacity to produce food from our best, most productive farmland, whilst managing the land sustainably, should be a national priority.”**

Food and drink businesses. Food manufacturers could lose up to 75 per cent of daily GVA in the face of severe droughts, resulting from shortages of both agricultural commodities and water.[13]

Declines in soil and water, population growth and climate change are major threats to the future of food production in the Anglian river basin. In the future, water demand is projected to increase, while it is expected that summer droughts will intensify. Summer river flows in this area could be as much as 80 per cent lower in 2050, according to the Environment Agency, increasing the importance of groundwater in agriculture.[14] Climate change is expected to accelerate soil losses, with every rise in temperature of one degree centigrade increasing the rate of loss by 30 per cent.[15]

Soil erosion and the loss of organic carbon will severely undermine farmland productivity. Net agricultural margins for arable agriculture in some parts of the Fens are projected to drop from £480 per hectare in 2012 to £30 per hectare in 2080.[16]

Maintaining the long term capacity to produce food from our best, most productive farmland, whilst managing the land sustainably, should be a national priority. It will require transformation in the short term management of soil and water. Part of the responsibility for this should sit with farmers. However, farming is, for many, a precarious profession; food prices have been going down while the share of the final price paid to farmers has been dropping, meaning they are receiving a decreasing share of a diminishing pot.[17] Furthermore, there is a strong argument that all private companies generating profit from farmland should contribute to the maintenance of that land.

The economics of food production are not working to support natural assets, such as the soils on which the sector relies. Water companies, and, ultimately, householders, are paying to manage the consequences. There is a pressing need for new approaches, capable of leveraging the resources and expertise of farmers, food businesses and water companies, which can deliver genuinely sustainable land management, so we can have food production that enhances, rather than degrades, the environment.

# 2
# How a new market mechanism could help

Although good work is being done to improve the state of our natural assets, it is fragmented, under resourced and frequently relies on voluntary action. It typically involves a combination of three approaches: farm advice programmes, such as Catchment Sensitive Farming, food and farming environmental accreditation schemes and water company catchment management schemes.

**Catchment Sensitive Farming (CSF).** This programme raises awareness of diffuse water pollution from agriculture in high priority areas for water quality in England, by giving free training and advice to farmers. It has had some success in changing farmers' behaviour, but the impacts are complex. Evaluation shows that only a third of farmers believe they are able to influence water quality, while those that have received CSF advice are more likely to perceive barriers to taking action than those that have not.[18]

**Accreditation schemes.** These schemes set out farm management best practice guidelines or metrics, to which farms sign up to receive accreditation. This can result in substantive environmental and revenue improvements for individual farms; a survey of LEAF (Linking Environment and Farming) Marque farms revealed that 36 per cent had generated extra revenue as a result of being in the scheme, 64 per cent reported improved soil condition and 66 per cent reported improved farm biodiversity.[19] But the performance of different schemes is mixed, improvements are often incremental and there is no way to scale up the gains across multiple farms or whole catchments.

**Catchment management programmes.** These are incorporated into water company business plans and use interventions at the farm level to reduce the need for downstream water treatment. This often involves providing advice and engagement via Catchment Sensitive Farming, but also investing money directly in land management change. Some more sophisticated, market-based approaches are starting to emerge, most notably EnTrade.

---

### EnTrade

This online platform created by Wessex Water uses reverse auctions to fund cover crops programmes on farmland. Once the auction has closed, bids are ordered by EnTrade by their cost per unit reduction (for example by £/kg of nitrogen), with the lowest priced bidders being successful.

To date, EnTrade has procured measures on more than 3,000 hectares of land for almost 150 tonnes of nitrogen for its customers. Wessex Water has run five auctions on the platform since June 2016 to protect Poole Harbour and United Utilities has run an auction in seven safeguard zones in the Cheshire area.

---

“Significant barriers prevent the private sector from taking more concerted action to address environmental challenges.”

## Brexit opportunities

Leaving the EU will create new drivers for action, including potentially increasing the amount of money available to support environmental improvements on farmland, if, as expected, the government allocates a greater share of future farm payments to deliver environmental public goods. This would open up greater opportunities for adopting a more collaborative approach based on ecosystem services, providing a foundation on which new market mechanisms could be introduced, leveraging additional private sector investment to complement publicly funded agri-environment schemes.

## Barriers to action

Despite the existence of these approaches, the following barriers, prevent the private sector from taking more concerted action to address environmental challenges:

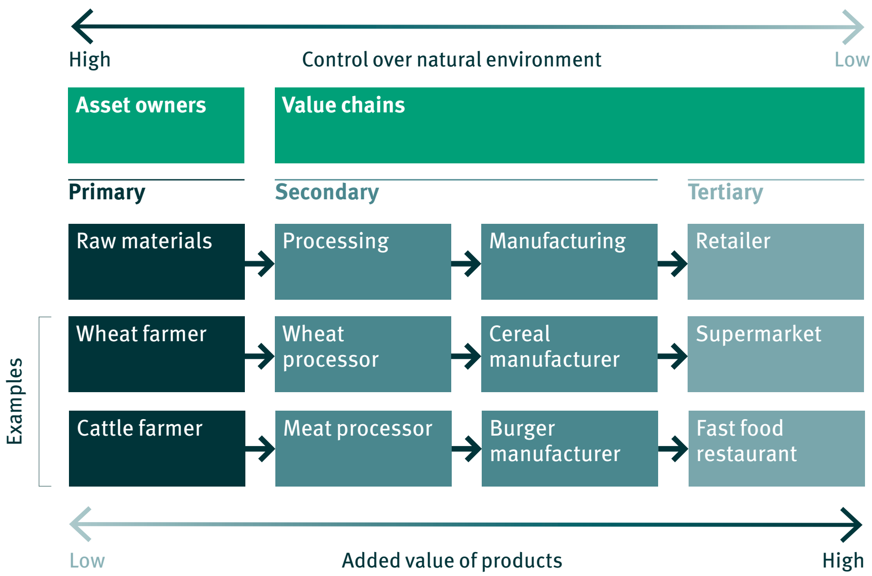
**Unequal distribution of knowledge, money and control.** As demonstrated in the graphic opposite, while farmers control how the natural environment is managed, they often do not have the resources to transform their farming practices and restore farmland ecosystems, which are held by their customers and downstream value chains.

**Environmental systems are complex and unpredictable.** It is often difficult to predict the impact that changing management will have on farmland ecosystems. Furthermore, the full benefits of restoration, such as reducing pollutant concentrations in groundwater, can take decades to materialise. For regulated businesses like water this uncertainty makes it hard to justify investment, for instance in restoring farmland rather than establishing a nitrate removal facility.

**Most ecosystem services are free.** Even where pricing mechanisms exist, they do not reflect the true value of natural capital. The cost of water abstraction licences is set at a level which pays for the administration of the system, not the value of the water resources used.

**Beneficiaries of soil and water improvements are dispersed and uncoordinated.** Multiple companies across different sectors have a stake in how individual catchments are managed, either because they buy goods from there, such as agricultural produce, or because they use or manage the local water resources. Of these beneficiaries, currently only water companies are legally required to invest in conserving them, meaning they bear a disproportionate burden of the costs relative to their share of the benefits.

## Control vs value in food production




Green Alliance and the National Trust have previously proposed the concept of a Natural Infrastructure Scheme (NIS). This is a private marketplace in which transactions are agreed, based on avoided costs. Buyers pay farmers for the creation and maintenance of natural infrastructure on farmland to reduce the amount of money they are spending to manage flood risk or clean up water.[20] We believe this approach has the potential to address some of the barriers set out above, in the following ways:

> **"The contract would enable a more equitable balance of risks between buyers and sellers"**

**Price discovery.** Customers of the scheme can determine what it is worth to them, based on its ability to mitigate or avoid defined business costs. Suppliers (ie farmers) could work out what their break-even point is, based on known amounts of agricultural outputs per hectare and costs. Where buyers would save more than is needed by sellers to break-even, there is space to trade.

**Delivery at catchment scale.** It could provide a mechanism to co-ordinate multiple farmers in the same location. A substantial land area covered by the scheme is likely to be an important factor in building the confidence of buyers, helping to overcome the uncertainty associated with the fluctuation of natural systems and increasing willingness to participate in a NIS transaction.

**Payment for outcomes.** The contract would enable a more equitable balance of risks between buyers and sellers, by ensuring sellers commit to delivering an outcome sought by the buyers, based on following an agreed land management scheme.

**Co-ordination of purchasers along value chains and across sectors.** It creates a mechanism to enable water companies, food and drink supply chain companies, and other business sectors to club together to purchase ecosystem services, pooling shared risks to benefit from lower costs.

**Binding private agreements.** It is a model built around delivering large scale projects, guaranteed under long term contracts, giving certainty to buyers and sellers, and enabling environmental and financial benefits to build over time.

The next section will apply this approach to solve problems of soil loss and water quality in the Anglian river basin, to assess whether long term, binding, private agreements of this kind could create a step change in funding for environmental restoration.

# 3
# Improving soil and water with a Natural Infrastructure Scheme

Joanne Coates/ Millennium Images, UK

Diffuse pollution by agriculture affects 47 per cent of water bodies in the Anglian river basin district.[21] This includes phosphates, nitrates and pesticides such as metaldehyde. Regulatory standards exist for the application and management of many substances, and this should remain the principal tool for managing pollution. In November 2017, the government announced new farming rules for water, to come into force in April 2018.[22] These will create new obligations for farmers to retain soils on their land, and avoid applying fertilisers if there is a risk of pollution.

This approach to regulation, based on using minimum standards to limit harm, has not been noticeably effective in reducing diffuse agricultural pollution. In this chapter, we look at whether the Natural Infrastructure Scheme (NIS) could increase the impact of regulation by creating a revenue stream for farmers from good soil and water management. The value of this approach would be to move to a system where farmers are motivated by the financial gains possible from increasing the health of their land.

**"The value of this approach would be to move to a system where farmers are motivated by the financial gains possible from increasing the health of their land."**

### Our inquiry: a market for avoided nitrate emissions

Many farmers rely on nitrogen fertilisers to maintain good crop yields. Leaching and run-off is a significant cause of raised nitrate levels in water, which can have implications for the health of humans and aquatic species. Nitrogen from artificial fertilisers is a higher leaching risk than organic sources of nitrogen; if nitrogen is generated slowly by the mineralisation of organic matter, there is more chance of its uptake by crops. Fertiliser application limits are in place for farmers in Nitrate Vulnerable Zones, but the overall scale of the problem is not diminishing.[23]

We look at the ways in which the NIS model could improve nitrate management on arable farms in eastern England. In particular, at the scope to increase the area of productive farmland managed for the benefit of the environment, and to extend the involvement of food and drink sector companies in funding environmental improvements to farmland used by their supply chains.

Focusing only on one environmental indicator, nitrate levels, is a simplification of the complex ways in which agriculture interacts with the natural environment. However, EnTrade's experience has demonstrated that this could be a useful entry point to change the terms under which farmers engage with environmental protection. It should, therefore, be possible to scale-up the impact of these approaches, building on achievements so far, provided the new programmes reflect the scientific uncertainties and the measures used are beneficial for a range of environmental problems.

### Improving nitrate management in agriculture should be a win-win

Fertiliser use costs farmers significant sums. For winter wheat, nitrate fertiliser costs £102 per hectare per year; the average farm in this region is 189 hectares, meaning the annual average cost is around £19,000 (see table below).

**“Many water companies are starting to make use of upstream catchment management to cut nitrate levels.”**

## Dealing with soil degradation: the cost to farmers of business as usual

| | |
|---|---|
| Annual average costs for arable farms of soil compaction, erosion and organic matter depletion[24] | £5,584 |
| Annual average cost per farm of nitrate fertiliser for winter wheat[25] | £19,278 |

Nitrates are a problem in both surface and groundwater, caused by surface run-off into rivers, and leaching through soils into underground aquifers. Groundwater infiltration can take years, meaning that many of the problems experienced today are the result of historical land management. There are legal limits to the concentrations of nitrates permitted in drinking water. As a result, water companies invest huge sums of money managing the nitrate levels in water. Chemical treatment and blending of water from multiple sources are common strategies. However, many water companies are starting to make use of upstream catchment management to cut nitrate levels.

There are a range of options for disrupting or avoiding emissions of nitrates to water. They include:

**Silt traps.** These are constructed at field margins to capture surface run-off and prevent sediment and nutrients from entering surface water.

**Treatment wetlands.** These are a more sophisticated version of silt traps, using biological treatment to capture soil and nutrients from water, and can have additional environmental benefits, such as providing wildlife habitats.

**Cover crops.** Planting cover crops between winter and spring crops in arable rotations helps to prevent soil erosion and run-off, and can increase soil nitrogen levels and soil organic matter.

**Ley pastures within arable rotations.** These build soil organic matter, by incorporating green manure or temporarily grazing livestock.

**Technology or practices,** such as zero or minimal tillage, retain organic matter, soil structure and soil biology, prevent oxidisation of soil carbon and avoid creating channels that increase run-off.

**Avoiding inappropriate cropping** on vulnerable soil types or slopes reduces soil erosion and the risk of nutrient leaching.

**Breaking up excessively large fields** with hedges, beetlebanks, shelterbelts and agro forestry, helps to reduce soil erosion and maintain the soil’s ecosystem.

**Intelligent nutrient application** to match crop needs, maximises uptake by the crop, avoiding excess nitrate leaching into water bodies.

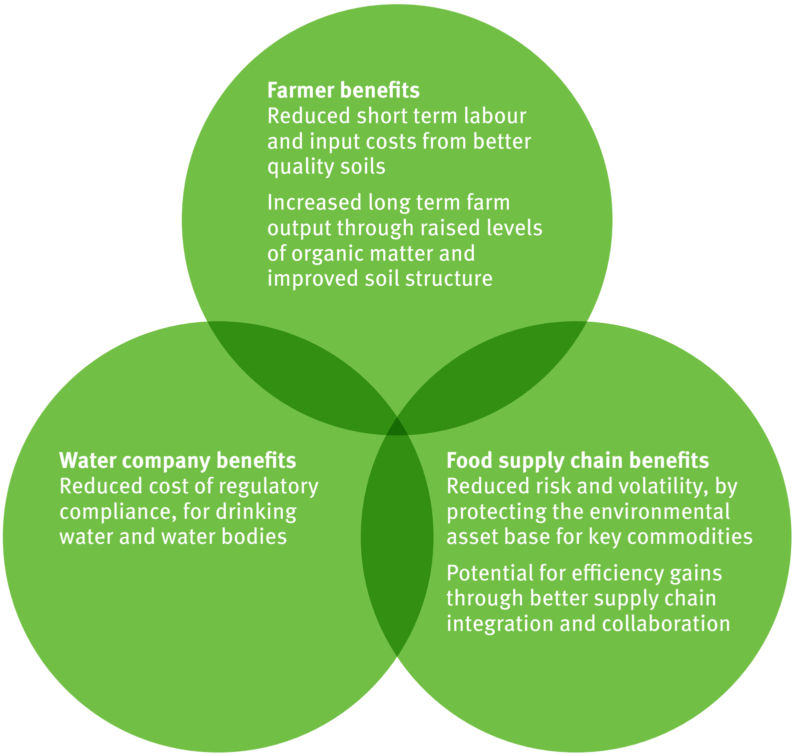
**“Cover crops hit the ‘sweet spot’ of providing benefits to farmers, water companies and food supply chains.”**

Improved irrigation practices, timed and managed to deliver only the water the crop needs, can reduce leaching of nitrates from the root zone.

### The all round benefits of cover crops

The mix of measures included in the scheme would vary depending on local needs and hydrology. All measures would be effective at reducing emissions to surface water, as they involve either reducing the volume of nutrients applied to the land, or creating a physical barrier to run-off into rivers. For improvements to groundwater quality, measures which reduce the application of nutrients have the highest likelihood of being effective, reflecting the importance of water leaching through soil into the aquifer.

Of the options available, cover crops hit the ‘sweet spot’ of providing benefits to farmers, water companies and food supply chains.




A variety of cover crops provide different benefits and are used for different purposes. Catch crops reduce nutrient losses via run-off and leaching. Others act as a green manure, returning fresh organic material to the soil to increase soil biological activity and improve soil health and function. Some help to combat pests and weeds. The major types and characteristics of crops are described opposite.

| Type of cover crop[26] | Characteristics and benefits |
|---|---|
| Brassicas<br>eg mustards, radishes, turnips | Autumn sown brassicas grow rapidly and provide good ground cover and deep rooting. This can mitigate leaching risks and improve soil structure. |
| Legumes<br>eg vetch, clovers | Legumes fix nitrogen, which can benefit following crops and raise fertility; the amount of nitrogen fixed depends on the species, growth and temperature. Legume roots can help to improve soil structure. |
| Grasses and cereals<br>eg oats, rye, rye grass | These are effective at tackling erosion by quickly establishing ground cover. Vigorous rooting helps to build soil structure. |

Water companies are already recognising the value of cover crops as a way to manage water pollution. United Utilities ran an auction on EnTrade (see page seven) during the summer of 2017 that resulted in farmers submitting bids to eliminate 7,500 kilogrammes of nitrates from farmland surrounding groundwater boreholes.[27]

The challenge will be to scale up the use of cover crops to capture their full environmental and financial benefits, by reversing long term soil degradation and eliminating the need for capital intensive nitrate removal facilities.

### Going with the grain of farming: alternative cropping

While cover crops can offer significant benefits, to date, resistance among some farmers, particularly in the east of England, has limited their uptake. Reductions in nitrate emissions can also be achieved through alternative cropping, such as substituting winter barley for winter wheat. A scheme combining cover crops with lower input commodity production could increase the likelihood of farmer buy-in, and increase the benefits of the scheme, compared to using cover crops alone.

## A Natural Infrastructure Scheme thought experiment: using cover crops and low input cropping to improve soil and water quality

To explore how a NIS could be used to improve soil and water quality, we have made a calculation, based on illustrative costs for a fictional catchment with the characteristics of the Anglian river basin.

These characteristics are:

- A significant problem with groundwater nitrate levels. Due to historical nitrate use, concentrations in the aquifer are projected to keep rising until the late 2020s.

- Current treatment for the public water supply is to blend abstracted groundwater with low nitrate water. But the water company has plans to construct a new nitrate removal plant in the late 2020s.

- There is a major manufacturing business in the catchment that abstracts groundwater for use in its processes.

- Farms in the catchment are significant suppliers of cereals to major UK food and drink manufacturers.

The business as usual approach would entail substantial costs and risks for a range of private companies. It also would not address the underlying causes of deteriorating soils and polluted water. The NIS agreement would address these problems at source, reducing current costs and protecting against future related liabilities. We have calculated the following costs, based on current typical operating charges:

**Cleaning up drinking water: the cost to water companies of business as usual[28]**

| | |
|---|---|
| Current energy, chemical and other operating costs for water blending | £30,000 per year |
| Capital cost of refurbishing existing treatment plant | £1 million after five years |
| Capital cost of building a dedicated nitrate removal plant to manage future pollution | £5 million, projected to be incurred in ten years' time |
| Operating costs for a new nitrate removal plant | £100,000 per year |

**"The business as usual approach would not address the underlying causes of deteriorating soils and polluted water."**

## The natural engineering alternative

It is not possible to draw a robust link between fertiliser application to a particular area of soil, and nitrate levels in the aquifer, given the difficulties of mapping all pollution pathways into groundwater. A 'payment for outcomes' agreement would, therefore, not be possible. However, as EnTrade's example shows (see page seven), there is scope for payments to farmers for improvements to groundwater quality based on reducing fertiliser application. This could either be because of the proximity to boreholes; or on the basis that the scale of reduction is so large as to give a sufficiently high degree of confidence that it will benefit the aquifer.

We have looked at the implications of an agreement based on a group of farms agreeing to reduce nitrate application to their land to a level calculated by the water company as sufficient to keep nitrate levels in the aquifer within regulatory limits over the next 15 years.

Participating farms would agree to:

- move from growing winter wheat to a spring sown cereal crop, and plant cover crops over winter, on 50 hectares per farm;

- plant winter barley instead of winter wheat, but commit to reducing fertiliser application by half against usual levels, on another 50 hectares per farm;

- the agreement would remain in force for 15 years.

The main signatories to this example contract would be a selling consortium of ten farmers and a purchasing consortium, including the local water and sewerage company, a local manufacturing business with a water abstraction licence and three food and drink sector businesses.

## What the scheme means for sellers

### Cover crops

The farmers would move from growing winter wheat to a spring sown cereal crop, and plant cover crops over winter.

The agreement would apply to 50 hectares per farm, ie 500 hectares across the ten farms. The location of the area on each farm under cover crops could shift from season to season, to give flexibility to farmers and avoid potential problems from a single cropping pattern over a long period of time. As the average farm in the Anglian river basin district is 189 hectares, over 70 per cent of the farm would remain available for cereals or other food production.[29]

The principal decision facing the farmers would be the terms under which to trade-off short term reductions in agricultural yields against the range of benefits, both short and long term, provided by cover crops. A simple summary is included below.

### Decision making factors for farmers

- ✓ Reduced fertiliser costs. Spring wheat requires nearly 20 per cent less nitrate than winter wheat.[30]
- ✓ Improved long term yields, resulting from improvements to soil structure and organic matter content.[31]
- ✓ Improved long term yields through reductions in blackgrass, a pervasive weed that can out compete winter wheat.[32]
- ✗ Reduced agricultural income. Yields from spring cropping are approximately 30 per cent lower than from winter cropping.[33]
- ✗ Additional year on year costs from the planting and management of cover crops.

We have calculated the net cost of adopting this system at less than £15,000 per farm per year, as set out in the following table. Scaled up across ten farms over 15 years, the total net cost would be £2.2 million.

## Farm costs incurred and avoided by cover crops

| | | Per farm per year | Per farm over 15 years | Across ten farms over 15 years |
|---|---|---|---|---|
| **Costs incurred** | Planting, cultivating and terminating cover crops[34] | £5,750 | £86,250 | £862,500 |
| | Reduction in farming income from yield reduction[35] | £15,600 | £234,000 | £2,340,000 |
| **Costs avoided** | Fertiliser reduction[36] | £1,100 | £16,500 | £165,000 |
| | Soil degradation | £5,584 | £83,758 | £837,585 |
| **Total net cost** | | £14,666 | £219,992 | **£2,199,915** |

### Winter barley

The farmers would plant a crop of winter barley in place of winter wheat. The agreement would apply to a further 50 hectares per farm every winter, covering 500 hectares across the ten farms. As with the cover crop, the location of the area on each farm under winter barley could shift from season to season.

Farmers would agree to reduce fertiliser application by half against usual levels. This would reduce yields by approximately 20 per cent, partially offset by reductions in fertiliser costs.[37]

We have calculated the net cost of adopting this system at around £3,300 per farm per year, shown in the table opposite. Scaled up across ten farms over 15 years, the total net cost would be around £840,000.

The total net costs across the ten farms for the cover crops and winter barley would be just over £3 million over 15 years.

“It is assumed this scheme would be sufficient to prevent nitrate concentrations in groundwater breaching regulatory limits in the late 2020s.”

### Farm costs incurred and avoided from winter barley[38]

| | | Per farm per year | Per farm over 15 years | Across ten farms over 15 years |
|---|---|---|---|---|
| Costs incurred | Reduction in farming income from yield reduction | £5,841 | £87,615 | £876,150 |
| Costs avoided | Fertiliser reduction | £2,550 | £38,250 | £38,250 |
| Total net cost | | £3,291 | £49,365 | **£837,900** |

If adopted at this scale, the scheme could deliver significant environmental gains. For these hypothetical farm businesses, we estimate it could lead to a reduction in ammonium nitrate fertiliser application of over three million kilogrammes across 1,000 hectares over 15 years, based on nitrate savings of 40 kilogrammes of nitrogen per hectare of cover crops, and 85 kilogrammes per hectare of winter barley.

## What the scheme means for buyers

### Water company

For this catchment, it is assumed this scheme would be sufficient to prevent nitrate concentrations in groundwater breaching regulatory limits in the late 2020s. This would deliver huge financial savings by keeping nitrate concentrations below the critical point at which a new nitrate removal plant would be the most cost effective way to meet standards for drinking water. Extending the life of the existing treatment infrastructure, based around blending water from multiple sources would save roughly two thirds of the projected costs of building the nitrate removal plant, representing a saving of £4.5 million over 15 years (see the following tables).

## Water company water treatment costs under business as usual

| | Operating costs (£/year) | Capital investment costs (£) | Number of years | Total costs over 15 years |
|---|---|---|---|---|
| Years 1-10: blending water from multiple sources<br><br>Assumes capital investment after five years to refurbish plant. Operating costs cover energy and chemical input costs | £30,000 | £1,000,000 | 10 | £1,300,000 |
| Years 11-15: new nitrate removal plant | £100,000 | £5,000,000 | 5 | £5,500,000 |
| **Total** | | | | **£6,800,000** |

## Water company water treatment costs if purchasing the NIS

| | Operating costs (£/year) | Capital investment costs (£) | Number of years | Total costs over 15 years |
|---|---|---|---|---|
| Continuation of blending water from multiple sources<br><br>Assumes two rounds of capital investment into plant refurbishment over 15 years | £20,000 | £2,000,000 | 15 | £2,300,000 |

### Food and drink companies

While the water sector faces the highest short term costs, the food and drink sector is also significantly exposed to risks from deteriorating soil and water quality. This could result in increased costs, in the short term. We have shown above how poor soil management can increase farm costs by around £5,000 per year. It should be noted that there are soil management standards, within the cross compliance regime for existing farm payments, that would have implications for how much of this cost could, or should, be passed onto customers.

The principal case for investing to improve environmental outcomes from farming would, therefore, be based on the value of long term resilience, in terms of reducing disruptions to supply and minimising volatility or price shocks along supply chains. Increasingly, we are seeing examples of UK food businesses taking steps like this.

## Companies taking action in the Anglian river basin

### Coca Cola

Coca-Cola Great Britain and Coca-Cola European Partners have been working with WWF and the Rivers Trust since 2012 across several major catchment areas in East Anglia where the sugar beet used in Coca-Cola's drinks is grown, including the Cam Ely Ouse and Broadlands. The water sensitive farming programme is designed to aid supply chain sustainability, while protecting and replenishing England's unique chalk stream rivers as part of Coca-Cola's global water stewardship commitments. The partnership helps to fund farm advisers to support farmers in improving soils and reducing run-off pollution, including the creation of on farm infrastructure such as silt traps. Since 2012, this work has helped to improve over seven kilometres of river, engaged over 2,000 farmers and is on target to replenish over one billion litres of water by the end of 2018.[39]

### Tesco

Courtauld 2025 is a voluntary industry commitment with more than 100 signatories working to improve the resource intensity of the UK food and drink sector. This includes work in East Anglia to reduce water use in the supply chain. Tesco, one of the signatories, funded the purchase of a 'BE Wonder Wheel', a piece of machinery towed behind a tractor to shape the soil in potato beds and reduce run-off from irrigation and rainfall events. The wheel is offered to growers to trial for free.

Food and drink companies participating in the scheme could be direct purchasers of the winter barley covered by the agreement. While they would be paying a premium, they would be assured of the resilience and sustainability of these suppliers. They could also be purchasers of the crops grown on farmland not included in the agreement (89 of the 189 hectares on each farm). Or, as is currently the case, they could fulfil corporate commitments to improve the environmental performance of their wider supply chains.

## What a transaction might look like

The difference between the savings the water company would make and the costs to farmers would be in the region of £1.5 million. We have termed this 'the space to trade' and have split it equally between buyers and sellers, allocated across the five purchasing companies. The results are summarised below.

| | Average annual NIS contribution | Total 15 year NIS spending |
|---|---|---|
| Water company | £165,000 | £2,475,000 |
| Local manufacturer | £25,000 | £375,000 |
| Food & drink sector company | £20,000 | £300,000 |
| Food & drink sector company | £20,000 | £300,000 |
| Food & drink sector company | £20,000 | £300,000 |
| Total 15 year contract value | | £3,750,000 |

For the water company, the payment to the farm consortium would be on top of ongoing expenditure on the existing water blending facility of £2.3 million, giving a total cost over 15 years of £4.8 million. This would represent a saving on the business as usual cost of £2 million.

## Summary of total benefits

| | |
|---|---|
| Farmers | This could return total profits for the farm consortium of over £700,000 across 15 years. If allocated equally, this could increase profits by nearly £5,000 per farm per year. |
| Purchasers | The water company could achieve savings in the region of £2 million over 15 years. |
| Environment | A local manufacturer requiring clean water could protect its long term access to a water resource vital to its operations.[40]<br><br>Food and drink sector companies could reduce exposure to risks from shortages from strategically important suppliers, caused by water shocks and chronic declines in farm productivity.<br><br>Improvements in the quality of groundwater and associated aquatic ecosystems, through avoiding the application of over three million kilogrammes of fertiliser over 15 years.<br><br>Soil enrichment from increased biodiversity and organic matter content. |

> **“Even highly profitable arable farms in eastern England could increase their profits further by managing their land for soil and water quality.”**

## Could this work in practice?

This inquiry suggests that a private market in avoided nitrate emissions could be possible, and could deliver benefits for farmers, the UK’s food and drink sector and the natural environment. It demonstrates that, under the right circumstances, even highly profitable arable farms in eastern England could increase their profits further by managing their land for soil and water quality.

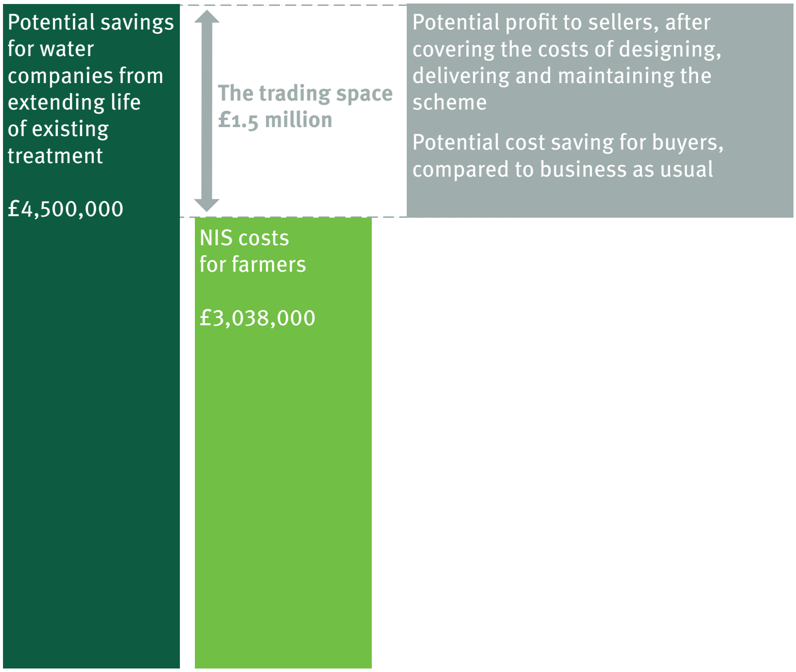
However, the financial case will vary considerably according to local conditions. Notably, we have assumed the aquifer would show demonstrable quality improvements within ten years. There are also uncertainties as to the exact scale of soil nitrate reduction that a large scale cover crop programme would deliver.

Securing participation by food sector companies would also be challenging. Much of the UK’s food system works on a ‘just in time’ basis with short term contracts for suppliers. Strategic long term environmental investments, on the basis of 15 year contracts, would go against current purchasing practices.

The example clearly demonstrates the potential for water companies to reduce their costs, and for farmers and their customers to increase their resilience. There is also a public and business interest in reversing the loss of non-renewable environmental assets like soil. Above all, there is a clear gap in terms of perceptions of risk and actions by farmers to address them. As stated in chapter one, some Fenland farmers risk losing £450 per hectare of value per year over the coming decades from soil degradation.

In spite of these barriers, as we have outlined, the case for thinking ambitiously to find ways around them, and to make transactions under a Natural Infrastructure Scheme possible, is strong. The next chapter outlines some of the ways the government could support the emergence of this type of market.

## The NIS involves a small outlay for buyers compared to the savings they would gain




**Potential savings for buyers**
Extending the ten year lifespan of current water blending infrastructure to 15 years.
Eliminating the need for a capital intensive nitrate removal plant.
**Total £4,500,000**

**NIS costs incured by sellers**
Planting and cultivation costs.
Reductions in farm revenue from lower yields.
(Minus lower fertiliser and soil degradation costs).
**Total £3,038,000**

# 4
# What the government can do to kickstart the market

Our inquiry suggests that private markets for clean water and soil protection could deliver long term financial benefits for farmers, water companies, the food and drink sector, and water dependent manufacturing companies.

However, given the uncertainties outlined in chapter three, government support will be needed to facilitate the emergence of the conditions for large scale transactions of this kind.

The following actions would provide incentives and brokerage:

**Create a new regional governance model for land use and water.** This would entail appointing a body with appropriate legal authority to sanction land management that results in excessive soil loss or nutrient leaching and stress to water resources. This could be done through better co-ordination of existing regulatory, charitable and trade bodies. It would probably require new powers or institutions at a regional or catchment level with the authority to broker and enforce agreements. This would help to ensure sustainable land management by creating a mechanism to resolve disputes or tensions between the production of public and private goods from privately owned farmland.

**Introduce financial incentives to support investment in improving farmland ecosystems.** This could include the Natural Capital Allowance model, previously proposed by Green Alliance, which would make investments into environmentally beneficial land management eligible for tax relief.[41] This could potentially increase the environmental gains from future farm payments for environmental public goods, by using public money to leverage additional private investment.

**Consult on ways to ensure commercial land management enhances, rather than depletes, environmental assets.** This could include exploring a regulatory component, such as soil and water management rules that go beyond those due to come into force in 2018. It could also include measures to stimulate market demand for land in good environmental health, such as requirements for landowners or managers to file natural capital accounts, either on an annual basis or when land is sold.

Innovative farmers are already leading the way in showing how sensitive soil management can increase farm profits. These proposals could help to close the gap between the highest and lowest performing farms, supporting food production while, at the same time, restoring and protecting our natural assets for the future.

# Endnotes


[1] Environment Agency, 2009, *Water resources strategy. Regional action plan for Anglian region*

[2] Rural Business Research, *Farm Business Survey. Cropping: Output from agriculture excluding subsidies and agri-environment payments,* www.farmbusinesssurvey.co.uk/DataBuilder/

[3] Environment Agency, December 2009, *River Basin Management Plan, Anglian River Basin District. Annex C: Actions to deliver objectives*

[4] Committee on Climate Change, 2016, *Written evidence SHI0046 to the Environmental Audit Committee*

[5] J P Holman, 2009, *An estimate of peat reserves and loss in the East Anglian Fens*

[6] Environment Agency, 2009, *Water resources strategy. Regional action plan for Anglian region*

[7] J W Knox et al, 2015, *Research to develop the evidence base on soil erosion and water use in agriculture. Final Technical Report*

[8] Environment Agency, 2015, *River Basin Management Plan, Anglian River Basin District. Table 5: Number of water bodies in the river basin district*

[9] A R Graves, et al, 2015, 'The total costs of soil degradation in England and Wales', *Ecological Economics*, 119, 399-413

[10] Water UK, 2016, *Water resources long term planning framework (2015-65). Technical report*

[11] Environment Agency, 2015, *River Basin Management Plan, Anglian River Basin District. Table 11: Nitrate vulnerable zone protected areas extent*

[12] Calculation by Peter Fane and Simon Ward for Green Alliance, September 2017. Regression analysis based on data reported in: Anglian Water, 2015, *Totex cost assessment at PR19: draft for discussion*

[13] Water UK, 2016, *Water resources long term planning framework (2015-65). Technical report*

[14] Environment Agency, 2009, *Water resources strategy. Regional action plan for Anglian region*

[15] Committee on Climate Change, 2016, *Written evidence SHI0046 to the Environmental Audit Committee*

[16] A R Graves, and J Morris, 2013, *Restoration of Fenland peatland under climate change. Report to the Adaptation Sub-Committee of the Committee on Climate Change*, Cranfield University

[17] Department for Environment, Food and Rural Affairs (Defra), 2016, *Agriculture in the UK 2015,* 'Table 6.2 Farmers' share of the value of a basket of food items'

[18] Environment Agency, *Catchment Sensitive Farming Evidence Team, 2014, Catchment Sensitive Farming Evaluation Report: Phases 1-3 (2006-2014)*

[19] M Reed, N Lewis, and J Dwyer, 2017, *The effect and impact of LEAF Marque in the delivery of more sustainable farming: a study to understand the added value to farmers,* The CCRI

[20] A Francis, S Armstrong Brown, W Andrews Tipper, N Wheeler, 2016, *New markets for land and nature: how Natural Infrastructure Schemes could pay for a better environment*

[21] Environment Agency, 2015, *River Basin Management Plan, Anglian River Basin District*

[22] Defra, 2017, *Farming rules for water – getting full value from fertilisers and soil*

[23] Nitrate Vulnerable Zone rules set maximum limits for application of nitrate fertilisers. For winter wheat, this is 220kgN/ha; for winter barley it is 180kgN/ha: Gov.uk *Using nitrogen fertilisers in nitrate vulnerable zones*, www.gov.uk/guidance/using-nitrogen-fertilisers-in-nitrate-vulnerable-zones

24 Graves et al, 2015, op cit, have calculated that arable farming is responsible for nearly £165 million of the £246 million annual costs incurred by UK agriculture from soil degradation:

| | Erosion | Compaction | Organic matter loss |
|---|---|---|---|
| Total cost | £39,874,000 | £203,691,000 | £3,507,000 |
| Share accounted for by intensive arable | 2% | 17% | 0% |
| | £10,766,000 | £34,627,000 | £0 |
| Share accounted for by extensive arable | 48% | 49% | 13% |
| **Costs** | **£19,140,000** | **£99,809,000** | **£456,000** |

Based on data from the Farm Business Survey (www.farmbusinesssurvey.co.uk/DataBuilder/) we have allocated 30 per cent of the arable costs to farms in the Anglian river basin. This gives an annual cost of £5,584 per farm.

| | |
|---|---|
| Soil costs of arable (intensive and extensive) | £164,797,470 |
| Percentage attributable to Anglian river basin | 30% |
| Number of arable farmers in Anglian river basin | 8,854 |
| **Average per farm** | **£5,584** |

25 A farm of 189 hectares applying nitrogen fertiliser at a cost of £102/ha: *John Nix Farm Management Pocketbook 2018*

26 AHDB Cereals and Oilseeds, 2015, 'Information sheet 41. Opportunities for cover crops in conventional arable rotations'

27 United Utilities, 19 July 2017, 'Cheshire farmers to get close to £20,000 to grow cover crops, courtesy of United Utilities', www.unitedutilities.com/corporate/media-centre/press-releases/cheshire-farmers-to-get-close-to-20000-to-grow-cover-crops-courtesy-of-united-utilities/

28 Generic costs calculated based on data courtesy of Anglian Water and United Utilities. Between 2020 and 2025 Anglian Water will make capital investments of over £35 million, and incur over £775,000 of operational costs, managing nitrate contamination of water, spread across seven sites.

29 Rural Business Research, *Farm Business Survey*, www.farmbusinesssurvey.co.uk/DataBuilder/

30 Winter wheat requires an average of 190kgN/ha compared to spring wheat's 150kgN/ha: *John Nix Farm Management Pocketbook 2018*

31 Nitrogen (N) uptake using leguminous cover crops during autumn/winter is typically 30-100kg N per hectare, with 10-100kg N per hectare released to the following crop. A 15 year study in Italy revealed that leguminous cover crops on average increase soil organic content by ten per cent in the top ten centimetres of soil and by eight per cent in the 10–30cm soil layer. From: C A White, H F Holmes, N L Morris and R M Stobart, 2016, *AHDB Cereals and Oilseeds Research Review No.90. A review of the benefits, optimal crop management practices and knowledge gaps associated with different cover crop species*

32 Spring cropping can reduce black grass by 92 per cent compared to winter wheat. From: AHDB Cereals and Oilseeds, 2016, *Project Report No. 560. Sustaining winter cropping under threat from herbicide-resistant black-grass (Alopecurus myosuroides)*

33 Average winter wheat yields are 8.6 t/ha, compared to 6 t/ha for spring sown wheat. From: *John Nix Farm Management Pocketbook 2018*

34 V Eory et al, 2015, *Review and update the UK Agriculture Marginal Abatement Cost Curve to assess the greenhouse gas abatement potential for the 5th carbon budget period and to 2050*

| Cover crops | Costs (£/ha/year) | Total annual cost across the 50 hectares |
|---|---|---|
| Seeds | £60 | £3,000 |
| Cultivation | £25 | £1,250 |
| Termination | £30 | £1,500 |
| **Totals** | **£115** | **£5,750** |

35 Yield figures from *John Nix Farm Management Pocketbook 2018;* market price from Defra, 2017, *Agriculture in the UK 2016*

| | **Yield (tonne/ha)** | **Market price (£/tonne)** | **Annual revenue from 50ha** |
|---|---|---|---|
| Winter wheat | 8.6 | 120 | £51,600 |
| Spring wheat | 6 | 120 | £36,000 |
| **Difference in revenue** | | | **£15,600** |

36 Nitrate application figures and fertiliser costs from *John Nix Farm Management Pocketbook 2018*. Ammonium nitrate application calculated on the basis of 33 per cent N per kg of fertiliser.

| | Average nitrate application (kgN/ha) | Fertiliser costs (£/hectare) | Total cost across 50 hectares | Average ammonium nitrate application (kg/ha) | Total ammonium nitrate application across 50 hectares (kg) | Total ammonium nitrate application across 10 farms |
|---|---|---|---|---|---|---|
| Winter wheat | 190 | 102 | £5,100 | 570 | 28,500 | 285,000 |
| Spring wheat | 150 | 80 | £4,000 | 450 | 22,500 | 225,000 |
| Annual fertiliser savings | 40 | | £1,100 | 120 | 6,000 | 60,000 |
| **15 year fertiliser savings** | | | **£16,500** | | **90,000** | **900,000** |

37 Yield reduction estimate provided by John Kay, principal at Dr John Kay Agriculture & Environment

38 Winter barley fertiliser levels taken from AHDB, 2017, *Nutrient Management Guide (RB209). Updated May 2017*; yield and price taken from Defra, 2017, *Agriculture in the UK 2016*, 'Table 7.3. Barley'

| | **Fertiliser application (kgN/ha)** | **Yield (t/ha)** | **Price per tonne (£)** | **Revenue across 50 hectares** |
|---|---|---|---|---|
| Winter barley: normal fertiliser application | 190 | 5.9 | 99 | £29,205 |
| Winter barley: reduced fertiliser application | 95 | 4.7 | 99 | £23,364 |
| **Revenue reduction** | | | | **£5,841** |

39 WWF, 2017, *The Rivers Trust, Coca Cola Partnership Summary*

40 Over 140 groundwater sources were closed from 1975-2009 due to quality problems, removing over 400 megalitres from the public water supply. From: UK Water Industry Research (UKWIR), 2004, *Implications of changing groundwater quality for water resources and the UK water industry- phase 3: financial and water resources impact (04/WR/09/8)*

41 W Andrews Tipper and S Armstrong Brown, 2017, *Natural investment: futureproofing food production in the UK*

Green Alliance
11 Belgrave Road,
London, SW1V 1RB
020 7233 7433

ga@green-alliance.org.uk
www.green-alliance.org.uk
blog: greenallianceblog.org.uk
twitter: @GreenAllianceUK

The Green Alliance Trust
Registered charity no. 1045395
Company limited by guarantee
(England and Wales) no. 3037633
Registered at the above address