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INSTITUTE FOR SUSTAINABILITY LEADERSHIP

Commercial gains from addressing natural capital challenges in the dairy sector

Doing business with nature

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Publication details

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This document is part of a series of 'Doing business with nature' publications; these identify challenges and opportunities for companies whose future growth depends on a healthy and sustained supply of nature's goods and its services, known as 'natural capital'. The rationale for investing in sustainable natural capital management is set out in Doing business with nature: Opportunities from natural capital and has been further developed through commodity-specific Action Research Collaboratories (ARCs) for Dairy in the UK and Ireland (described here) and for Cotton.

The authors would like to thank all members involved in this Action Research Collaboratory (ARC) for their input.

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Executive Summary

With a wide array of commitments to create a more sustainable dairy industry, farmers and others have sought clarity as to which approaches businesses could support at the production level to help deliver these commitments.

Six leading companies partnered with the University of Cambridge Institute for Sustainability Leadership to make an important first step. Representing different perspectives upon the dairy value chain, each company recognised that more sustainable use of natural resources creates a more resilient dairy industry by providing opportunities for increasing productivity, reducing input costs and mitigating risks.

The companies shared a common commitment, therefore, to reduce barriers to the improvement of natural capital management in dairy production systems. Through this Action Research Collaboratory (ARC) ten practical management interventions were evaluated for evidence of their ability to contribute towards targets to halt degradation of water, biodiversity and soil and deliver benefits to farmers and the public. By investing in evidence-based management interventions that enhance natural capital, companies would be better able to protect the long-term security of their supply chains, sustain commercial growth and create additional social benefits.

Investing in sustainable management interventions generates value through increased yields and several evidence-based options are available to farmers wanting to reduce their natural capital impact and reduce their vulnerability from its degradation.

However, there are also many more that could have a positive impact, but the evidence is limited or inaccessible.

Although there has to date been little guidance for businesses to navigate their way through a bewildering array of potential interventions, here we provide a framework and the first steps towards creating a compiled and accessible evidence base that can help farmers and agronomists make more informed decisions.

This work is particularly timely with the UK Government developing its 25 year food and farming plan to "encourage enterprise and boost productivity" and, similarly, an environment plan for the nation's natural capital to "identify our most important and threatened environmental assets, and focus policies on delivering better environmental outcomes."

These two plans have interdependent goals and the work described here highlights the potential commercial gains that can be made by adopting practices that reverse declines in the natural capital upon which the industry depends.

DECREASED COSTS

REDUCED RISKS

ENHANCED BRAND

REVENUE GENERATION

Collaboratory Members:

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YARA

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1. Introduction

The dairy industry is consolidating and intensifying and facing huge pressure, which must be addressed alongside natural capital* concerns

Three million dairy cattle from forty-nine thousand holdings in the UK and Republic of Ireland deliver fourteen per cent of the European Union's milk production[1#]. The UK alone has the tenth largest dairy sector in the world, producing over two per cent of the world's milk[2] and in the UK and Ireland, over ninety-nine per cent of adults consume dairy products, an important source of nutrients[3,4].

The dairy industry fundamentally relies upon the natural environment. However, in a recent assessment across all land types, thirty per cent of assessed ecosystem services that are delivered in the UK are in decline[5]. In farmland, the past sixty years has seen increased soil erosion, decreased soil fertility and reduced diversity of birds and pollinators[5]. The dairy industry, in particular, can have considerable impacts on the environment, degrading the very natural capital upon which it depends: pollution of waterways with dairy effluent and agrochemical run-off, compaction and erosion of soils, and reduction in biodiversity value can all prevail in systems that are not well managed.

Furthermore, the UK dairy industry has in recent years suffered from marginal or even negative profit margins worsened by high input costs, competition between retailers, global oversupply and, since 2014, Russian dairy import bans[2,6-9]. During 2005-2010 the number of dairy farms decreased by twenty-eight per cent in the UK and Republic of Ireland[10,11]. However, the average herd size and per cow milk yields have increased in the same period, allowing the total amount of milk produced to remain relatively stable or increase over the last decade[2,10,11]. These figures indicate a consolidating and intensifying sector, but analyses of Milkbench+ data from the UK show that it is production cost, rather than per cow milk yields, that is the main driver of profit and efficient, profitable milk production is possible for all major dairy farming systems[9].

A sustainable dairy industry must improve or maintain water, biodiversity and soil quality, meet social expectations for landscapes, environmental impacts and production of safe and nutritious food, and offer farmers a good standard of living[12]. Despite the industry's difficulties, opportunities remain to be exploited to enhance natural capital stocks to benefit the industry.

1.1 Responses and gaps

Any discussion around natural capital and dairy must be set against the background of price volatility and tight profit margins and the response framed within the constraints that these conditions impose. Can an industry with such price volatility undertake long-term planning for natural capital and, if so, how?

The dairy sector has united to respond positively to such challenges with a series of visions and commitments, such as the *Dairy Roadmap, Compete to Grow* and *Tried and Tested* initiatives[13-15]. Whilst existing initiatives have achieved significant progress , future work is needed to embed natural capital in their operations. There are a multitude of potential management interventions and it is not always clear to what extent different interventions will contribute to each of the natural capital challenges or how they will impact dairy farming profits in the short and long-term.

* 'Natural capital' is an economic characterisation of the limited stocks of physical and biological resources found on Earth. It refers to the limited capacity of ecosystems to provide vital services such as clean water, crop pollination or productive soils (i.e. the contributions of ecosystems to human well-being).

This report aims to identify opportunities to better manage the dairy industry's natural capital impacts and dependencies. We use specific elements of natural capital (water, biodiversity and soil) and a particular region (UK and Republic of Ireland) to focus the work and produce tangible recommendations.

2. Key issues for dairy and natural

Sustainability in dairy requires a farming system that improves or maintains natural capital

Sustainable use of natural resources can create a more resilient industry by providing both short and long-term opportunities for increasing productivity, reducing input costs and reducing risk.

1. Market drivers for increasing sustainability in the dairy value chain include the environmental and ethical concerns of shoppers, which must be managed alongside consumer demands for quality and price.
2. Traceability to monitor quality and manage supply chain risk is crucial and is increasingly helping businesses to demonstrate their sustainability credentials to consumers and manage investor perceptions.
3. Many businesses are considering better management of natural capital now to maintain yields and profitability into the future, particularly through reducing on-farm input costs.
4. Businesses must comply with current environmental legislation and industry leaders are avoiding further shocks by making sure that their business is anticipating future requirements.

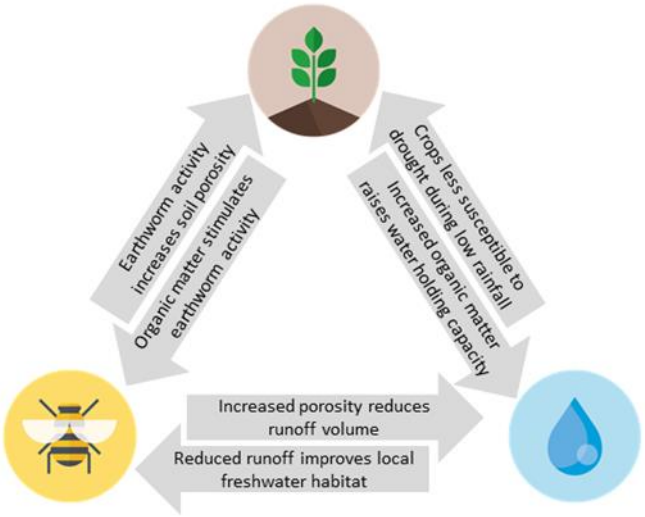


Figure 1. A schematic showing an example of the linkages between water, soil and biodiversity. Increasing soil organic matter through, for example, reduced tillage can have a series of interconnected effects on water, biodiversity and soil that can, in turn, increase the drought tolerance of the agricultural system. See here.

Given the interlinked nature of water, biodiversity and soil, most management interventions will affect all three to some extent, as well as farm profitability (Figure 1). In order to prioritise investments, businesses need to understand which agricultural practices and management interventions should be applied and scaled to maximise positive impacts upon water, biodiversity and soil and the benefits that flow from them. This will help them to secure wider societal benefits such as clean water, whilst also enhancing long-term economic sustainability, through reduced costs or increased productivity, which is vital given the sector's crisis.

Making informed decisions to safeguard the natural resources that dairy production depends upon is vital to ensure the industry's long-term security but requires a strong evidence base. Six companies that sit along the dairy value chain were convened by the University of Cambridge to form a Dairy Action Research Collaboratory (ARC) to fill gaps both in understanding the relationship between dairy and natural capital and in evaluating the evidence for the effect of management interventions on natural capital challenges. This section explores relationships between dairy and water, biodiversity and soil to highlight dependencies that dairy farming has on each of these natural capital elements, as well as the impacts.

2.1 Water

The large water requirements of dairy farming are well-suited to the climate of the UK and Ireland but climate change may increase seasonal water scarcity in some areas, presenting significant risks to business[16-18]

Dairy farms can impact water supplies in two ways: depleting the quantity availability or degrading its quality[16]. In the British Isles, however, dairy farming has relatively low impacts on water quantity due to a combination of factors including that water availability is generally high and agriculture forms a small proportion of total abstraction; that rain-fed grass yields are high and form a large proportion of dairy herd diets, consequently lowering drinking requirements (compared to cows fed greater amounts of dry matter); that there is a relatively low proportion of irrigated crops in concentrated feeds; and that there is a high proportion of by-products in diets (e.g. from brewing)[16,17]. Although the large water requirements of dairy farming are well-suited to the current climate in much of the UK and Ireland, climate change may lead to increased seasonal water scarcity in some areas, which may present a significant risk to businesses[16-18]. Efforts to increase the efficiency with which water is used has the added incentive of reducing on-farm costs[19].

Dependencies
The majority of water used in dairy farms is for livestock drinking, plate coolers and washing of equipment and buildings[17,19]

Impacts
Although decreasing, water pollution remains a serious problem in dairy farming[20]

Business implications
Increasingly farmers and water companies are working together: water companies help fund on-farm interventions to reduce pollution and benefit from overall cheaper water treatment costs

Leading businesses want to ensure that they stay ahead of future water regulation

Single Payment Scheme subsidies are now more closely linked to compliance with EU environmental standards

Box 1: Quick facts on dairy and water

Water pollution from agricultural activities is a serious problem and dairy farming is responsible for thirty-seven per cent of the serious agricultural pollution incidents in England[20]

If not appropriately managed, pollution from dairy slurry and dirty water can contaminate waterways, harming wildlife and presenting a clean-up cost to water utility companies[21,22]. Although regulation and its enforcement is vital, education and incentivised or voluntary uptake of pollution control measures are also important[23].

For example, the Catchment Sensitive Farming scheme aims to reduce agricultural water pollution in England through education of farmers[24], whilst Single Payment Scheme (SPS) subsidies are now more closely linked to compliance with EU environmental standards, rather than just production, as in previous versions of the Common Agricultural Policy[23].

The costs of mitigating downstream water quality are exemplified by the case of South West Water, who found that reducing pollution entering water courses in agricultural landscapes was sixty-five times cheaper than treating polluted water downstream[25].

"Agricultural run-off can pollute rivers and the water we abstract, creating a significant clean-up cost for water companies. If pesticides and fertiliser inputs are not well-managed and run-off is high, then water companies have to pay higher water treatment costs, while farmers are, literally, pouring money down the drain. Therefore efforts to improve the management of natural capital represent a win-win for farmers and water companies as well as providing benefits to aquatic biodiversity and recreational users in our waterways."

Chris Gerrard, Climate Change and Biodiversity Manager, Anglian Water

2.2 Biodiversity

Biodiversity is the variety of life found on earth and can be measured at the level of genes, species or even ecosystems

Grazing is vital to retain grassland habitat that many species, such as nesting waders, require[26]. Dairy herd dung left on pasture is used by a diverse array of invertebrates, including important insects, providing food resources to birds, whilst hedges are known to be a critically important habitat for invertebrate, bird, mammal and plant species in the UK[22,27-30].

Field edges, in both organic and conventional dairy farms, have higher pollinator diversity than field centres and can also host beneficial invertebrates[22,31,32]. However, intensive grazing can reduce plant diversity and pollinator resources, as well as decrease invertebrate and bird abundance or diversity in grasslands[22,33]. Dairy farming can also have negative impacts on aquatic biodiversity through the pollution of water sources, as described in section 2.1. Organic material in surface waters can cause eutrophication, loss of oxygen in the water and death of fish and other aquatic species.

"Nestlé recognises the significant impact that its supply chain has on biodiversity so we have piloted a project with our dairy suppliers in Scotland where marginal areas of a farm are set aside to improve habitats for the local wildlife. These have been successful and a good example of this is at West Cairngarroch farm in Wigtownshire where, due to its coastal location, certain areas of land are kept free from cultivation and livestock during the summer months and then grazed with cattle in winter to minimise economic loss to the farmer whilst maintaining and benefitting the natural coastal habitat. We are now looking to roll this project out more widely."

Robin Sundaram, Supplier Development Manager, Nestlé

Dairy farming accounts for a large area of land in the British Isles, which, along with careful management, offers considerable potential for enhanced biodiversity stewardship

Dependencies
Biodiversity enhances pollination of crops such as clover, for livestock feeds

Impacts
Intensive grazing can reduce plant animal diversity in grasslands[22,33]

Agricultural run-off in waterways can cause eutrophication and death of fish and other aquatic species

Business implications
Many farms rely on subsidies for which compliance with environmental regulations is required

Well-managed dairy farms may benefit from brand enhancement through positive stewardship of biodiversity

Box 2: Quick facts on dairy and biodiversity

There are three well-recognised ways in which positive biodiversity stewardship may benefit dairy farmers. First, reducing damage to the environment can enhance brand reputation; if UK and Irish milk develops a reputation for environmentally sustainable production and positive stewardship, then, with suitable education campaigns and collaboration with retailers, consumer preferences could help the UK dairy industry compete with cheaper imports. Second, incentives such as the SPS subsidies, Countryside Stewardship payments, or payments for carbon mitigation may enable farmers to diversify their revenue streams such that managing land for nature can enhance farm profitability, particularly during times of milk price volatility.

Third, it will help farmers avoid fines and/or tightening of restrictions. The relationship between the dairy industry and biodiversity is less well understood than that with fresh water supplies or fertile soils. The link between biodiversity and profitability is weaker in the absence of regulations, price premiums or government subsidy schemes. However, biodiversity can benefit dairy farming through, for example, the pollination of crops, such as white and red clover, which provide high protein forage that increases milk yields whilst simultaneously lowering nitrogen fertiliser requirements[34,35]. In addition, soil health is dependent upon the biodiversity within it, which can increase the infiltration rate and storage capacity of rainwater.

2.3 Soil

It can take thousands of years for a fertile topsoil to be created but, without careful management, this can be eroded, compacted or depleted of nutrients in timescales ranging from hours to years[36]

Soil health is crucial to efficiently producing forage for the cows, whether these are primarily pasture-fed or fed mostly on conserved forage or imported feeds. A recent report by DairyCo showed that an increased reliance upon home-grown forage can improve dairy financial performance and that grazed pasture can be the most efficient dairy feed if grown and utilised effectively[2,37].

This is based on reduced input costs (rather than increased yields), so it requires good soil fertility and structure to support forage growth[2].

"At Yara, we are passionate about natural resource and economic efficiency. To achieve both goals, on-farm resources need to be utilised to protect the in-built fertility of the soils. Where a gap remains between nutrient supply and crop demand, careful and efficient fertiliser use can maximise economic returns and minimise long-term natural resource degradation."

Mark Tucker, Marketing and Agronomy Manager, Yara

Dependencies
Soil health is crucial to efficiently producing forage for livestock, whether these are primarily pasture-fed or fed mostly on conserved forage or imported feeds.

Impacts
Over compaction of soils arises from dense stocking rates and farm traffic and can severely impact yields[38,39]

Business implications
Increasing home-grown forage can improve dairy financial performance[36]

Reduced chemical fertiliser needs from well managed soil resources

Box 3: Quick facts on dairy and soil

Just thirty per cent of grassland soils in England and Wales are in good condition[40]

Compaction of soils is a major issue, causing decreased fertility and increased input costs that, on dairy farms, can arise from dense stocking and livestock movement (e.g. particularly through gateways and around water troughs) or from farm machinery traffic[22,38,39,41].

Soil erosion is another serious issue associated with trampling of ground by livestock, particularly around watercourses and in poorly drained or waterlogged fields[23,42]. Soil erosion can also be higher when maize is grown for feed because it is harvested in autumn when the ground is frequently wet and soils are then left exposed to rainfall until the spring[42].

Recent research has also highlighted that increased feed prices and availability of extended-season clover varieties has extended grazing times into wetter seasons, which is likely to lead to further degradation of soil and water health through increased soil compaction and erosion[40].

"The economic pressures of farming and food production have seen farmers becoming increasingly reliant on chemical inputs, leading many, driven by short-term economics to ignore the essential value of healthy soils. The challenge for every farmer is to preserve the natural capital within healthy soils sustainably while increasing business efficiency."

Robert Craig, JRC Craig & Son, Dolphenby Farm, Cumbria
Winner of the Farmers Weekly: Dairy Farmers of the Year 2014 Award

3. An evidence-based approach to evaluate natural capital impacts

Clearer guidance is needed for businesses to make informed decisions regarding more sustainable management of interlinked natural capital

A wide variety of management interventions are proposed by various stakeholders to achieve various environmental outcomes. Solutions that reduce waste such as precision farming look promising in terms of minimising negative impacts on the environment and maximising efficient resource use but will require significant capital investment. Questions around the impact of year-round housed dairy farms upon natural capital are important. On the one hand, they might be expected to improve water quality management and reduce soil compaction from cattle but, on the other hand, the conversion of grasslands into cereal crop production for fodder may have negative impacts through reducing suitable habitats for farmland biodiversity.

These are complex issues and require much greater research effort. Other methods specifically designed for managing one aspect of natural capital may have unknown effects on other natural capital factors.

For instance, how does controlled traffic farming (which aims to minimise soil compaction) affect biodiversity or water? There is little guidance for businesses to navigate their way through this array of potential management interventions. Even less is available to allow businesses to understand how the choice of farming system, such as switching from conventional to organic or housed systems, will affect progress towards natural capital and financial goals.

The Cambridge Institute for Sustainability Leadership, through the work of its UK Dairy ARC, aimed to help companies along the dairy value chain identify a more optimal mix of cost-effective farm and landscape level management interventions that would respond to these natural capital challenges.

"We need to assess the different farming systems available to ensure the seasonal nature of the dairy industry is reflected and that the natural cycles on which it depends are safeguarded. Our markets need to better reflect the actual economic and natural capital costs arising from year-round milk production."

Mark Taylor, Managing Director, Lactalis McLelland

3.1 Reviewing the evidence for decision making

The companies involved in the Dairy ARC submitted over ninety potential interventions and selected ten to focus on and evaluate for their contribution to securing natural capital. For each of these ten, a systematic review was conducted, to reveal ninety-one studies that provided evidence of the effect on water, biodiversity and soil of the management interventions.

The purpose of this review was to study the evidence for natural capital impacts of management interventions that a business may be considering. The evidence would highlight whether those interventions had previously been successful in providing positive impacts on water, biodiversity or soil. As well as concerns around natural capital, the businesses involved identified further categories that they wanted to consider when assessing possible management interventions. The management interventions are summarised in section 4.2. The full Technical Report can be accessed here.

3.2 Summary of management interventions

1. Loosening of compacted grassland soils
2. Cereal-based whole-crop silage
3. Nitrification & urease inhibitors on pasture
4. Fencing waterways
5. Year-round housed dairy system
6. Anaerobic digestion of on-farm dairy wastes
7. Precision agriculture on pastures
8. Controlled traffic farming
9. Tree shelterbelts
10. Fertilising pasture with selenium

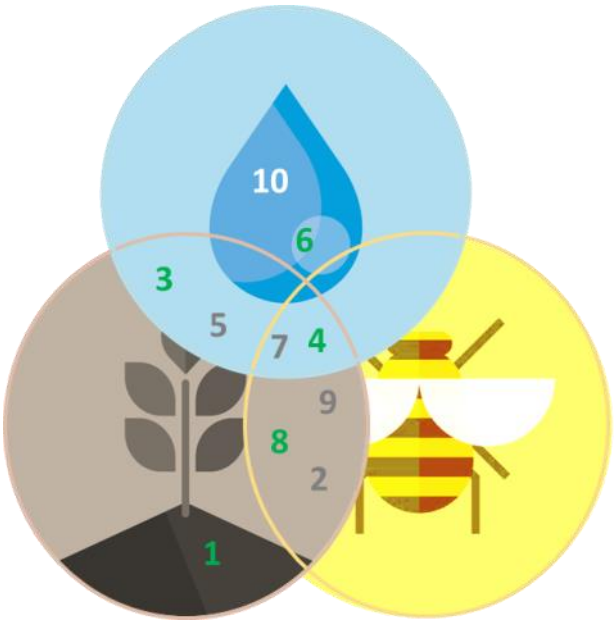


Figure 2: The ten analysed dairy farming interventions are grouped by their positive impacts upon natural capital. Numbers in grey indicate limited evidence for one or more of water, biodiversity or soil. Numbers in white indicates that trials found no evidence that it degrades natural capital, but no evidence that it improves it either (ie neutral). See Technical Report for further information.

3.2.1 Impacts on natural capital

Effects on natural capital were reviewed systematically (see technical report) and the following icons indicate whether an intervention has a *positive* or *likely positive* impact on each natural capital element. If bordered by a dashed line, there is *limited evidence* for a *positive* effect:

	Water: Including water quality (Ql.) and/or quantity (Qn.)
	Biodiversity: Including diversity (Div.) and/or abundance (Abd.)
	Soil: Including structure (Str.) and/or fertility (Ft.)

3.2.2 Cost of implementation

Many management interventions have costs associated with them, which can impact profitability. The relative approximate costs, determined by industry experts, were classified as:

£	**Low**: A generally affordable solution
£ £	**Medium**: The solution faces medium-level capital requirements, imposing some constraints on implementation
£ £ £	**High**: A capital-intensive solution, which could be difficult to implement due to financial requirements

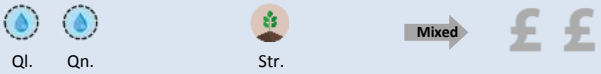
3.2.3 Yield

Yields of milk or pasture production may be affected so this was recorded when studies that were reviewed for natural capital effects also reported effects on yields:

?	**Unknown**: There is not enough evidence to assess the effect on yields
	Neutral: Evidence suggests that the intervention is unlikely to have an impact on yield
Mixed	**Mixed effect**: Some studies show increases in yields while others show decreases
	Increase: Evidence shows that the intervention increases yields

Evaluation of ten potential interventions

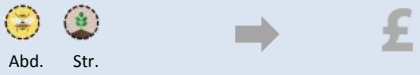
1. Loosening of compacted grassland soils



Definition: Compacted soil layers within pastures are mechanically broken up using aeration, subsoiling or ripping tools

Purpose: Increase rainwater infiltration and percolation, root growth and faster incorporation of surface-applied nutrients. Reduced water logging of soils can also help lower nitrous oxide emissions.

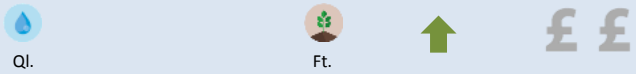
2. Cereal-based whole-crop silage



Definition: Cereals such as wheat or barley are grown for silage instead of grass or maize

Purpose: Provide food and habitat resources for increasingly scarce farmland birds

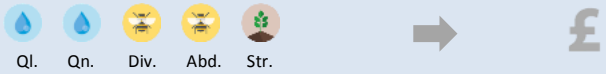
3. Nitrification & urease inhibitors on pasture



Definition: Chemical inhibitors are applied to pasture by broadcast application or incorporation into fertiliser treatment

Purpose: Reduce greenhouse gas emissions and nitrate leaching, whilst increasing fertiliser efficiency and yields

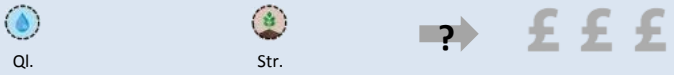
4. Fencing waterways



Definition: Fencing is constructed alongside waterways to reduce access by cattle

Purpose: Reduce faecal deposition of pollutants into streams and reduce erosion of banks, which increases sediment loads

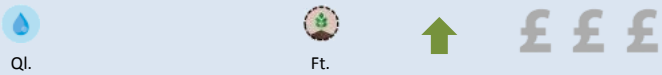
5. Year-round housed dairy system



Definition: Farming system is converted to one in which cows tend to be housed year-round, do not graze outside and require high nutrient and energy inputs

Purpose: Increase milk yields and operational efficiency, whilst controlling emissions/leaching from slurry captured indoors

6. Anaerobic digestion of on-farm dairy wastes



Definition: Organic matter in dairy slurries and effluents is broken down by bacteria to generate methane and digestate

Purpose: Produce biogas for electricity or heat and digestate for use as a fertiliser whilst reducing odours, wastewater treatment costs and greenhouse gas emissions

7. Precision agriculture on pastures

Definition: Farming practices are adopted that increase the scale of resolution at which the needs of crop units are met by, for example, measuring and responding to soil fertiliser needs at sub-field scales

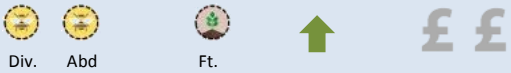
Purpose: Increase the efficiency with which fertilisers are used to increase productivity, reduce variable costs and reduce unnecessary losses of agrochemicals to the environment

8. Controlled traffic farming

Definition: Traffic is concentrated onto permanent wheel lanes and separated from the zones in which crops are grown

Purpose: Reduce over compaction of soils and direct damage to the grass sward

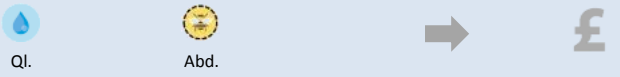
9. Tree shelterbelts



Definition: Establishing a narrow strip of trees that provide a sheltered area in the lee of the wind

Purpose: Reduce ammonia emissions when used around livestock housing or slurry pits or to provide leeward shelter to livestock when used around pastures

10. Fertilising pasture with selenium



Definition: Application of the selenium, an essential nutrient, directly to pastures for uptake in cow diets

Purpose: Increase the amount of selenium in pasture, which is beneficial for both animal and human health through improved immune system response, inhibition of prostaglandins, reduced tumour growth rates, and increased fertility

* Note that the question for this intervention is whether it has a negative effect on water, soil or biodiversity. No negative effect was found for water or biodiversity.

4. Summary and additional considerations

Very few management interventions tackle water, biodiversity and soil equally and simultaneously, so a business must decide what their priority is when considering which intervention to explore. There are also several other important considerations that will factor in the decision-making process.

"Our priorities are to minimise costs of production and maximise animal welfare and milk quality. We are increasingly identifying solutions that improve our impact on natural capital but also make good business sense. For example, we are gradually replacing our Holstein herd with Jersey cows, which have a lower impact on water quality, soil compaction and carbon emissions, but lower consumption rates and greater longevity, which has reduced our costs."

Rachael and Andrew Little, Row End Farm, Soulby, Cumbria

4.1 Geography and context

The suitability and effectiveness of each intervention is governed by the specific context in which it is applied. Understanding where they have been successful and the conditions under which they were applied is crucial (Figure 2). Physical conditions, such as climate and soils, financial circumstances and social considerations will all play an important role and should be assessed before any particular route is chosen. For this reason, expert agronomic advice is recommended as a minimum.

In most cases, the way in which a management intervention is applied will be crucial to its success. Some interventions will be more effective at certain times of year or particular rates of application that will depend upon the context, while other interventions will have a clear set of best management practices that should be followed to minimise unintended negative side effects. Again, expert help to guide best practice should be sought where necessary.

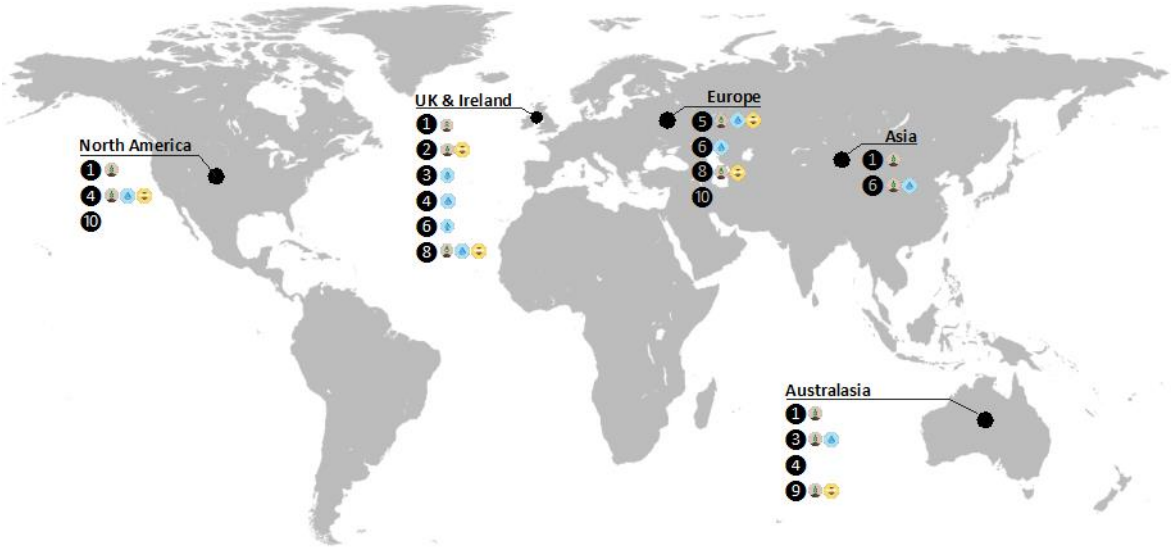


Figure 2: The geographical spread of evidence for positive impacts on water, biodiversity or soil.

4.2 Barriers to implementation

There are several further barriers that may impede the uptake of management interventions that improve natural capital:

1. Fixed capital costs may be substantial and, in some cases, the financial benefits may not be realised for many years, if ever
2. Variable costs may also be high (e.g. labour)
3. There may be a degree of uncertainty as to the natural capital benefits and how these translate to improved profits for a farmer
4. Price volatility limits the ability of farmers to make investments and secure loans for capital investment at a time when confidence in future profits is low
5. When a natural resource is not perceived to be scarce or insecure, uptake of management interventions will be slower

Farmers need confidence and evidence that a change in their farming practice is going to reduce their risks and costs in the short and long-term.

4.3 Natural capital metrics

We can only manage natural capital if we are able to measure it and monitor our impacts upon it. Key to this is considering the importance of context given the diverse availability of natural capital and unique ecosystems in different locations. There is no shortage of metrics for measuring impacts on soil, water or biodiversity (see CISL's *Metrics Selection Framework*). The Sustainable Agriculture Initiative Platform Dairy Working Group, for example, proposes that soil should be monitored for organic matter, nutrients, structure, toxicity, levels of erosion and volume of inputs per hectare[43]. For water they suggest assessing relative water stress in a region and estimating use per unit of production, while for biodiversity they recommend recording land-use change, variety of species over time, and within-species genetic diversity over time[43]. There is no single standard or approach but there is a growing interest from companies in simplifying and incorporating impact measurement into their supplier policies and standards.

"One of our biggest challenges is how to appropriately measure and report our dependencies on biodiversity, water and soil. We see our work with CISL as a starting point in achieving a greater understanding and creating positive impacts."

Audrey O'Shea, Sustainability Manager, Glanbia Ingredients Ireland

A report on the Metrics Selection Framework can be accessed here

5. Key messages and a call to action

5.1 Critical dependencies and a need for

The dairy sector depends on nature to provide vital goods and services. Clean water supplies, diverse animal and plant communities and fertile soils are fundamental to dairy production. However, many current practices are degrading the very natural capital on which they depend by polluting water supplies, depleting biodiversity and degrading soils.

Adopting more evidence based interventions at scale will improve natural capital and create a more resilient dairy industry by providing both short and long-term opportunities for increasing productivity, reducing input costs and reducing risk. These measures will also help in response to calls for the industry to become more efficient and compete in world markets. Solutions that reduce dairy waste or integrate supply chains to incorporate by-products from other industries will also help meet natural resource use efficiency targets and increase the dairy sector's price competitiveness.

"Managing water, soil and biodiversity in an integrated fashion is central to our farming strategy at Wastenage Farms as we know it not only leads to improved profitability but will also ensure our future sustainability particularly with raw materials becoming more expensive and their availability diminishing. Farmers are incredibly open and willing to share best practice and with the right kind of support we could achieve widespread adoption of a handful of these evidence-based management interventions and the necessary transformation to a sustainable dairy industry."

Peter and Di Wastenage, Wastenage Farms, Budleigh Salterton, Devon
Winners of the Farmers Weekly Awards 2015: Farmers of the Year

5.2 Opportunities

There are several evidence-based options available to farmers and if the whole dairy industry could collectively identify and support the adoption of a handful of evidence-based options at scale then it would reduce their natural capital impact and their vulnerability from its degradation. Investing in these options can generate substantial value for farmers such as increased yields. There are many more interventions that could be beneficial, but the scientific evidence of their impact on natural capital is currently limited or inaccessible.

Although there has to date been little guidance for businesses to navigate their way through a bewildering array of management interventions, here we provide a framework and the first steps towards creating a compiled and accessible evidence base that can help farmers and agronomists make more informed decisions and to provide information on the relative natural capital benefits of different options.

5.3 Leadership

There is now an opportunity for dairy leaders to turn their many ambitious environmental commitments into action by actively promoting a few of these evidence-based interventions across the industry. By sharing the lessons learned from site specific application and determining the degree to which they reverse declines in the quantity and quality of water, biodiversity and soil they will be able to highlight the contribution that the industry is making towards a healthy natural environment for the future.

"Few businesses have made a real connection to natural capital and even fewer have an in depth understanding of how addressing it can deliver real commercial gains for themselves and their industry. As natural capital challenges become increasingly apparent, we need to develop a new way of thinking and acting. We need a rigorous understanding of the water, biodiversity and soil impacts and dependencies of the dairy industry and to begin to make practical interventions."

Andy Richardson, Head of Corporate Affairs, Volac

The work between CISL and its collaborative partners that is summarised in this report has made an important start in sharing evidence, but there needs to be a much wider, collective effort by companies, research organisations, dairy associations and government to bring all of the evidence and guidance together to really help inform decisions by farmers and companies.

The group of businesses and experts involved in this collaboration calls upon those in the dairy supply chain and government to seize the opportunity to accelerate action to conserve the nation's natural capital through:

1. The establishment of a national evidence base for natural capital interventions for the dairy industry
2. Private-public partnerships to fund trials for promising interventions
3. Targeted policy support to encourage interventions that demonstrably address the goals of the UK Government's 25 year Food & Farming Plan and its 25 year Environment Plan for a healthy natural economy

Conscious, collective and evidence-based efforts are needed to enhance natural resource dependencies and deliver secure, sustainable supplies of dairy.

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