Heckington Fen Solar Park

EN010123

Environmental Statement | Volume 3: Technical Appendices

Appendix 16.1: Farming Report, Savills

Applicant: Ecotricity (Heck Fen Solar) Limited

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APPENDIX 16.1 FARMING REPORT, SAVILLS

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Heckington Fen Energy Park

Report for the Examining Authority and Secretary of State

Contents

1. Introduction

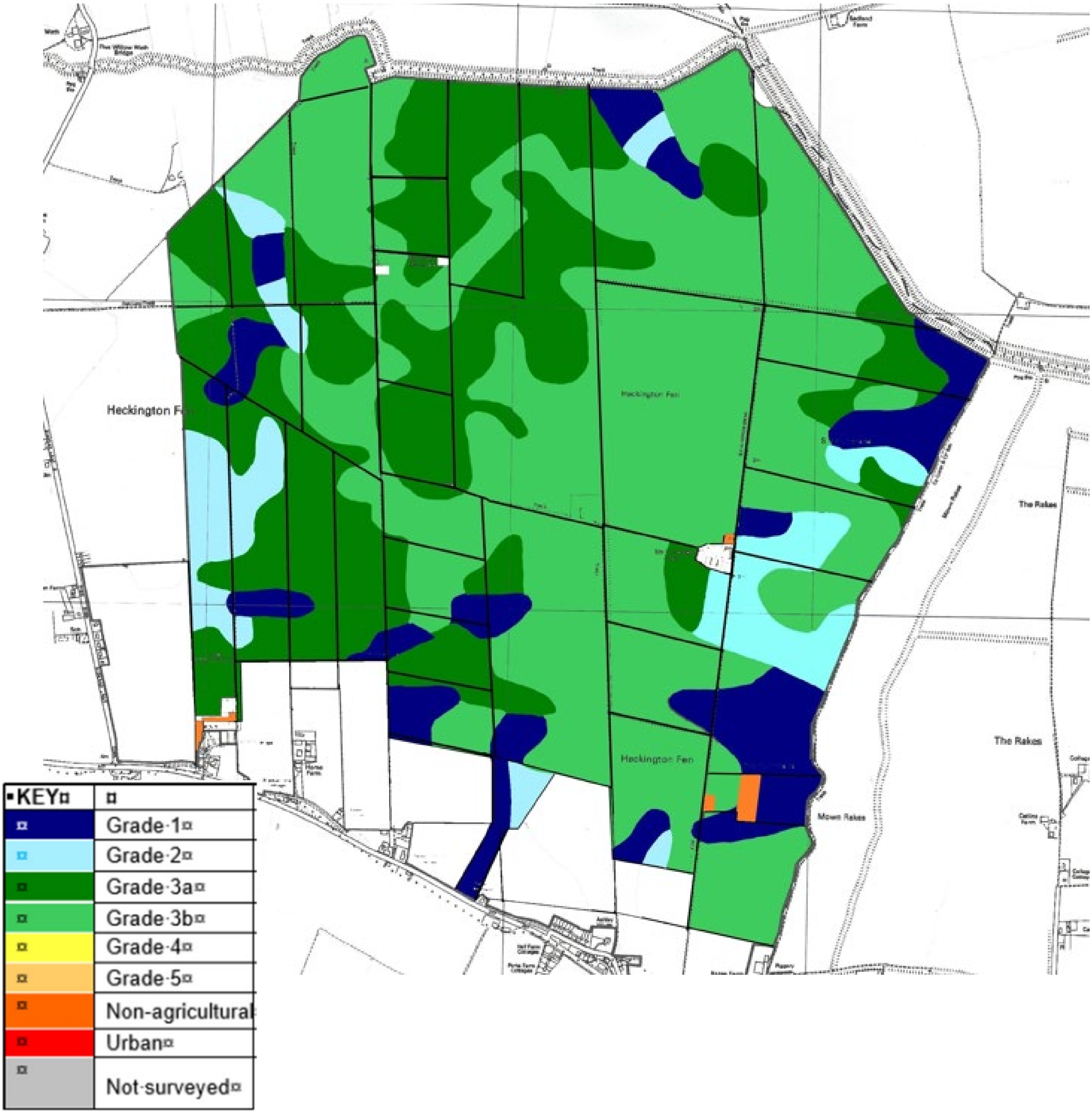
This report has been commissioned by Ecotricity (Heck Fen Solar) Ltd in relation the Heckington Fen Energy Park, which comprises three elements: the Energy Park, cable route to, and above ground works at, the National Grid Bicker Fen Substation. This report focuses on the Energy Park site only.

The purpose of the report is to consider the Agricultural Land Classification (ALC); the practical farming implications of the ALC and the wider farm management considerations that determine the cropping and land use to provide a background to potential loss of farming land for the duration of the proposed solar farm.

The report has been completed by Duncan Winspear of Savills Food and Farming and Christopher Miles, a rural chartered surveyor and Director at Savills. Duncan gained a 1st class BSc Hons degree in Agriculture from Newcastle University. He has undertaken a post graduate diploma in Farm Business and Rural Management from Harper Adams and has worked as a farm consultant for 15 years. He is a Fertiliser Advisers Certification and Training Scheme (FACTS) qualified advisor, and on day –to-day basis gives detailed technical advice on farm cash flows and budgets, soil management, crop and grass nutrition and overall farm business decisions. Christopher is a qualified Chartered Surveyor with 30 years' experience at Savills advising Farmers and Landowners on strategic business planning including the sale and purchase of farms and estates. He has been a director of Savills for over 10 years and is on National Farms and Estates board. The site was visited by Duncan Winspear on 13th May 2022, when he met the Farm Manager and the Agronomist for the landholding to discuss the current farming operation in detail.

2. The Site

The site area is shown below, it is located to the north of the hamlet of East Heckington and the A17 road. The site boundary has been modified, following the responses from the PEIR consultation:



3. Agricultural Land Classification of the Site

The land across the Site is predominantly Grade 3a (Good) and 3b (Moderate). This can be seen in Table 1 below with 30.5% (160Ha) and 50.6% (265Ha) Grade 3a and Grade 3b respectively, giving a total of 81.1% of the site as being Grade 3. These figures are based on a detailed of survey of the site, including further survey work which was completed in September 2022 by Kernon Countryside Consultants.

ALC Grade	Heckington Fen (Ha)	Heckington Fen (% of total site)
Grade 1 (Excellent)	58	11.1
Grade 2 (Very Good)	39	7.4
Subgrade 3a (Good)	160	30.5
Subgrade 3b (Moderate)	265	50.6
Grade 4 (Poor)	0	0
Grade 5 (Very Poor)	0	0
Non-Agricultural/Other Land	2	0.4
TOTAL	**524**	**100**

Table 1: ALC for Heckington Fen

There are 34 fields on the Site and of these, 2 fields are predominately Grade 1 and Grade 2, the rest being predominately Grade 3 (Appendix 1).

4. Details of the Current Farming System

The farming system on the Site, is entirely combinable cropping, focused on winter feed wheat (Appendix 2). In the past oilseed rape (OSR) and field beans have been grown as break crops. As experienced on many other farms in the region (Appendix 3) cabbage stem flea beetle and general soil conditions have resulted in OSR crop failures, so it is no longer grown.

Due to OSR losses and the less economically desirable nature of field beans, the farm has moved over to growing permanent wheat. The cropping this year is 100% KWS Crispin which is a hard feed wheat variety suitable for late drilling which assists the farm in controlling its blackgrass infestation.

A significant factor in the cropping choice now being focussed on wheat is that the farm has a significant blackgrass population (Appendix 4). Blackgrass is a perennial grassweed which is very difficult to control and the spray chemistry that is employed against it cannot be used in barley and oats. The recent spray records show that the herbicide programme is based on Atlantis (sulfonylurea) Liberator (flufenacet and diflufenican), both of which are herbicides that are used when grassweeds, such as blackgrass are a particular problem.

Blackgrass tends to be most competitive with wheat crops planted in September and October so drilling of the wheat is delayed until the end of October and November, sometimes later. This necessary strategy does, however, bring weather risk into play as the heavy land is easily waterlogged, preventing conventional drilling and sometimes curtailing operations entirely. In some recent seasons ground conditions have dictated that wheat has had to be "spun" onto the land with a centrifugal spreader and then harrowed in, resulting in marginal yields well below the national average.

The land is farmed as a single block, see the cropping maps (Appendix 2). Farming land by block is a common practice as it optimises efficiency of labour and machinery, the purchasing of seed, sprays, fertiliser and other inputs as well as storage and sales of the product.

The principal buildings on the land are grain stores at Six Hundred Farm and Elm Grange reflecting the requirements for the production of combinable crops (Appendix 5).

The Farm Manager confirmed that the straw from the wheat crops is typically baled and taken away which was clear from their being no straw residue on the soil surface. Some paper waste and sludge material has been applied over the years to try and benefit the organic matter levels in the soil.

5. Factors other than ALC Affecting Cropping Choices

5.1. Drainage

Regardless of the crops grown, one of the main factors determining the success of agricultural arable performance is drainage. Whilst water is essential for crop growth, too much of it can reduce crop yields by restricting plant growth, physically damaging the crop, or impeding field access by machinery. The benefit of improved drainage is the potential mitigation of these constraints (Appendix 6).

When assessing Wetness Class for the ALC, the following is stated in the MAFF guidance and has been used for the ALC assessment of the land. "*This assumes that soils have an appropriate underdrainage system and that there are satisfactory outfalls (see assumption (2), page 8 of MAFF guidance). It is not suitable for soils which are affected by high groundwater tables which cannot be drained effectively. Such soils can only be assigned objectively to a wetness class on the basis of long-term dipwell measurements. In the absence of such data the assessment of wetness class requires specialist knowledge and needs to take account of profile morphology, climate, site characteristics, prevailing water levels and time of year.*" (Appendix 7).

It is understood from the Farm Manager that much of the land was drained in the 1970/1980s with capital grants from MAFF. These drains consisted of clay pipes with no gravel in-fill and are now coming to or beyond the end of their working life. The returns from farming do not justify reinvestment in the drainage, given the recent very rapid increase in material and transport costs. The Agricultural Budgeting & Costing book for 2022 states that trenching with plastic pipework being laid and in-filling can cost in the region of £4.50-£8.50/m. As this was published pre-the recent materials/fuel/labour cost increase, it would be reasonable to expect this to be at the higher end of the scale, if not beyond (Appendix 8).

As detailed by Kernon Countryside Consultants in the Detailed Agricultural Land Classification, the soil on the site is made up of the Wallasea 2 Association, which is extensive clay with a greyish brown topsoil over greyish or grey and ochreous mottled subsurface horizons. These soils are slightly permeable and respond to underdrainage with gravel in-fill. Drained soils are occasionally waterlogged (Wetness Class II) but undrained soils are waterlogged for long periods in winter (Wetness Class III or IV).

Given that the drains are coming to or beyond the end of their functioning life the land is moving towards being waterlogged for long periods in winter, as will an undrained soil of the Wallasea 2 Association.

The inherent nature of the soil and the deterioration of the drainage system has directed the focus onto winter cropping, as the land is generally too wet to travel on and cultivate in spring. The most economically viable options for winter crops are limited to cereals, meaning it is not possible to grow potatoes or other vegetables on the land, as they require land to be cultivated and planted in spring. Additionally, the equipment required for potato/beet planting and harvesting tends to be heavier which again, requires the land to be free of waterlogging as to not get stuck or bogged down and to prevent soil compaction.

5.2. Land is farmed according to the worst soil type in a field / block

The land on the Site is “block cropped”. This is the common practice of farming multiple contiguous fields with the same crop to maximise physical efficiency and economies of scale. Being able to move across a block of fields with the same crop type and variety being grown in it means that the machinery, equipment, seed, fertiliser, spray products and methods do not need to be changed for a different crop type, minimising “down time”.

Where there are areas of better soil within a block it is not, in general, economically or physically practical to farm these minority areas differently to the majority. This means that a block is farmed according to its most limiting characteristics rather than its most favourable.

For example, looking at the Grade 1 ALC area that forms part of a field at the northern end of the Site, experience has shown that after the winter period the adjoining Grade 3 land will be too wet to travel on in spring with a tractor. The only way the Grade 1 land could be cropped separately for a spring crop, such as potatoes, would be by accessing the parcel on foot. Given the labour shortages and rising labour costs in agriculture, this would be impractical and uneconomic (Appendix 9). As a result, this area of Grade 1 land does not get farmed separately for a different crop it has to be farmed according to the ground conditions for the neighbouring Grade 3 land.

5.3. Weed and pest burden are not considered as part of the ALC

The farm has a significant population of blackgrass. Current herbicides are reasonably effective in controlling blackgrass in potatoes and other root crops, but it can result in an increase in the level of weeds in the following crop. Blackgrass is a growing problem across arable soil in the UK (Appendix 10). Typically, one of the strategies of reducing blackgrass levels on a farm is to reduce the amount of soil disturbance when establishing a crop (Appendix 11).

If a root crop was grown on land with blackgrass, there would be more disturbance and, as a result, more blackgrass than if it remained in cereal production. This is due to the root crops being planted in beds or ridges formed from the soil and harvesting techniques which involve a lot of soil movement. Root cropping would therefore increase the weed risk for the next crop, in turn further reducing the range of crops which can be economically grown on the land.

5.4. Buildings Available

The farm buildings to store the grain from the Site are located at Six Hundred Farm, Elm Grange and Rectory. There are grain stores with drive on floors and concrete and steel panel sides. If the farm was to move to other crops, such as root crops and vegetables there would need to be significant investment in building alterations, storage and packing facilities. Root crops and field vegetables are required to be stored in a climate-controlled environment to prevent spoilage from pests and fungal rots (Appendix 12). The capital expenditure on these new facilities at the current costs of labour and building materials against the return from crops sold is simply not viable.

5.5. Irrigation

Other than cereal crops, the majority of broad acre crops grown in Lincolnshire, such as potatoes, carrots or onions require irrigation in order to allow them to reach their potential and to improve their marketable appearance as irrigation improves skin finish and reduces the risk of potato scab, a bacteria found in the soil (Appendix 13).

There is no water availability currently in the catchment area that covers Heckington Fen and additional irrigation abstraction licences would be required (Appendix 14).

6. Wider Factors in Determining the Cropping of the Land

It may be useful to understand the context of the agricultural land classification of this site in the context of how it relates to the farming economy for the region and beyond. The following tables show how the ALC of the Site compares to Lincolnshire as a whole and on a national level. Table 2 shows the ALC for the county (source shown at Appendix 15). It can be seen in Table 3 that on balance the Site has a larger proportion of Grade 3 land (at a total of 81%) compared to 50% for the whole of the county. In addition to this, the Site has a much smaller proportion of Grade 1 and 2 land at a total of 18.4% for the Site, compared to 44% across Lincolnshire as a whole.

ALC Grade	Lincolnshire Area (Ha)	Lincolnshire Area (% of total)
Grade 1 (Excellent)	75,757	12
Grade 2 (Very Good)	186,750	32
Grade 3 (Good/Moderate)	296,246	50
Grade 4 (Poor)	7,448	1
Grade 5 (Very Poor)	0	0
Non-Agricultural/Other Land	25,619	4.3
TOTAL	591,821	**100**

Table 2: ALC for Lincolnshire

ALC Grade	Area (% of Heckington Fen)	Area (% of Lincolnshire)
Grade 1 (Excellent)	11.1	12
Grade 2 (Very Good)	7.4	32
Grade 3 (Good/Moderate)	81.1	50
Grade 4 (Poor)	0	1
Grade 5 (Very Poor)	0	0
Non-Agricultural/Other Land	0.4	4.3
TOTAL	**100**	**100**

Table 3: ALC for Heckington Fen compared to Lincolnshire

Moving to look at England as a whole, it is clear how the composition of agricultural land differs from that of Lincolnshire. Table 4 shows that a total of 354,562 ha is Grade 1 in England. The total area of Grade 1 land in Lincolnshire is 75,757 ha – making up over 20% of all the Grade 1 land in England. This illustrates that there is a high level of excellent arable land in the county when compared to the national level. This further emphasises the fact that the pressure on Grade 3 land for agricultural production is not as prominent as an area where the availability of very good and excellent agricultural land is not as high.

ALC Grade	Area (Ha of Heckington Fen)	Area (% of Heckington Fen)	Area (Ha of England)	Area (% of England)
Grade 1 (Excellent)	58	11.1	354,562	2.72
Grade 2 (Very Good)	39	7.4	1,848,874	14.18
Grade 3 (Good/Moderate)	425	81.1	6,290,210	48.23
Grade 4 (Poor)	0	0	1,839,583	14.10
Grade 5 (Very Poor)	0	0	1,100,305	8.44
Non-Agricultural/Other Land	2	0.4	1,608,926	12.34
TOTAL	**524**	**100**	**13,042,459**	**100**

Table 4: ALC for Heckington Fen compared to England

The ALC for England as a whole can be seen in Appendix 15.

Given the large amount of Grade 1 and 2 land in the county, there is not a significant advantage in restricting the use of this Site for arable production when there is such a high proportion of better quality land in the local region.

Additionally, demand for areas that can grow crops that are particularly suited to Grade 1 and 2 land, but cannot be grown on Grade 3 land, is declining in the long term; largely down to farmers responding to a range of economic factors which are reflected in Appendix 16.

6.1. Risk and return on capital

With the changes to support for farming businesses, the most significant of which is the removal of the Basic Payment by 2028 (Appendix 17), those enterprises that require a higher amount of working capital are becoming exposed to higher risks. The Basic Payment (Appendix 17) is a flat rate area based payment that has equated to £92 per acre in lowland England until 2021 (2021 being the first year of the payments reducing). Therefore, given the practical limitations as detailed above, the risk compared to the reward of trying to grow non-combinable crops on the dispersed areas of Grade 1 and Grade 2 land is too great to be realistically viable.

This can be illustrated when the gross margin as a proportion of total turnover for winter feed wheat is compared to that of main crop potatoes.

£ Per Acre	Wheat	Potatoes
Turnover	884	3285
Variable Costs	371	1702
Gross Margin	513	1555
Gross Margin as a % of Turnover	**60%**	**45%**

Table 5: Margins for Wheat and Main Crop Potatoes

A full breakdown of the figures provided in Table 5 can be seen in Appendices 18 and 19.

6.2. Inflation in Agriculture

The costs of production for all agricultural enterprises have increased dramatically in the last year or so, further emphasising the above point of risk vs reward. In the period from the start of 2022 to November 2022 the price index for agricultural inputs in the UK increased by 27.3% which, when compared to the price index for UK agricultural outputs (18.4%), shows these increases are not relative. Appendix 18 shows the main contributing factors to agricultural inflation over the 12 months to November 2022.

As an example, diesel usage for a combinable cropping system (a farming system focused on cereal crops, such as wheat, barley and oilseed rape) is around 100 litres per hectare, for potatoes the diesel usage is over 300 litres per hectare and the doubling in diesel prices in 12 months further makes combinable cropping a preferred choice for farming businesses

Labour

Both the availability and cost of labour has increased pressure on UK agriculture in recent times. Looking at industry data for the labour requirements of various crops, cereals, at 18 hours per hectare, are the most labour intensive of combinable crops (Appendix 19) but are an order of magnitude lower than the 200 hours per hectare (Appendix 20) required for early potatoes.

In addition to the labour requirements for potatoes, the nature of the cultivation operations are extensive and time-consuming, and the high demand for fertiliser, spraying and irrigation meaning that even if the land was suitable to grow a wider range of crops, it may not be viable once input and overhead costs have been accounted for.

One agricultural enterprise which can be run in parallel to a solar park on the same area of land is sheep farming. From a labour perspective, sheep farming is comparable to that of cereals at 3.5 hours per head per year (1,898 hours per year total based on an average sheep flock size of 568 ewes, compared to 1,890 hours per year for cereals). This can be seen in Appendix 21. The planned sheep enterprise could be made up of 4 ewes per hectare, so approximately 2,000 breeding ewes. At a typical rearing percentage of 1.65% lambs per ewe, this equates to 3,300 lambs being produced per year.

7. Farming Options for the Solar Panel Area & Historical Context

A solar park on the Site would allow the land to continue to be used for normal agricultural purposes. Unlike land given over to housing, industrial or infrastructure development this site would continue to be farmed for the lifetime of the solar park and beyond on an uninterrupted basis.

The solar panel area will be grassland and grazed by sheep. Research in the USA and Australia has found that overall lamb production from sheep grazed in solar sites at least matches the output from sheep grazed in conventional fields. The American study found that although forage was reduced due to some shading by the panels (Oregon State University, 2021) individual performance per sheep was greater, as the water loss and weather impacts on the sheep was reduced by the protection afforded by the panels (ABC Rural, 2022).

At a stocking rate of 4 ewes per hectare, a considerable new farming enterprise could be created while at the same time providing a site for clean energy generation. No arable jobs would be lost as the Site is a small part of the landowner's holdings and no labour reduction is planned.

7.1. Farming History

The soil type at the site, Wallasea 2, is associated with winter cereals and grassland, as detailed by LandIS ("LandIS, is a substantial environmental information system operated by Cranfield University, Bedfordshire, designed to contain soil and soil-related information for England and Wales") (LandIS, 2007) (Appendix 22).

Based on local information from the Farm Manager and Agronomist, prior to the current ownership the land was let to farming tenants who utilised a system which reflected the capability of the land, giving it over to grassland and livestock as well as some winter cereal rotation.

At the Site, as well as the grain stores there are also buildings for livestock which, while not used with the current cereal system, demonstrate that traditionally the land has been used for grazing as well as combinable crop production (Appendix 23).

7.2. Farming After Removal of Solar Panels

At the end of the solar electricity production on the Site, the solar panels and the posts that support them could be removed at a time of year that fits with moving the land back to cereal production or the land may continue with sheep and other livestock grazing.

The panels and infrastructure could be removed in summer, when ground conditions would be good to travel, and if any compaction occurred on the Site this could be remedied with a subsoiler (Carter and McKyes, 2005) which is commonly utilised by the farm already as part of soil management.

This would then give plenty of time for the land to be cultivated for a wheat crop to be planted in the autumn, or grass leys to be rejuvenated, which would allow more livestock to be farmed at a higher stocking rate per hectare.

8. Environmental Implications of the Current Farming System and the Planned System

On balance, the carbon emissions from an arable system producing mainly wheat are higher than that of an extensive sheep enterprise. Appendix 24 shows the CO2e for the farm, taking figures for the fuel and input usage – 436 CO2e per year. This has been compared a sheep flock run across the same area (Appendix 25) – 184 CO2e per year.

This does not take into account carbon sequestration as this requires more in-depth data analysis encompassing organic matter and soil composition, however, it is largely accepted that grassland sequesters more carbon than arable land (Appendix 26) which further supports the transition from arable production to a solar park.

The current system also involves significant chemical and fertiliser applications as detailed at Appendix 27. These chemicals are applied in a responsible manner, but such artificial and high carbon footprint additives will be greatly reduced by moving to a low input sheep farming.

With the land down to pasture there will be no artificial fertiliser applications whereas under the current system an average of over 270 tonnes of artificial fertiliser is applied to the Site each year. The sheep grazing will act as the main form of grassland management and weed control with only very occasional knapsack spraying of weeds on small areas), compared with over 6,000 litres of chemical herbicides and fungicides being applied to the Site per year in the course of the current cereal production.

Vehicle movements and overall diesel usage will also be greatly reduced by moving to sheep grazing and clean energy generation compared to combinable cropping. The current system uses 70 litres of diesel per hectare (Appendix 27), whereas for a sheep unit diesel use per hectare is around 46 litres (Appendix 28) which should be reduced further via economies of scale efficiencies on a site this size.

There are concerns around the long-term sustainability of arable farming without livestock in the system, particularly around resilience of soils being reduced due to organic matter declining over time. Moving over to grazing with sheep will build up the organic matter in the soil and increase its resilience for the long term (Appendix 29). Increasing soil organic matter is a key part of the latest farming support schemes in England for which the Government is providing financial assistance, the Sustainable Farming Incentive (Appendix 30), so the change in farming system is in line with government policy for the agricultural sector in general.

9. Summary

The reality of farming the land on the Heckington Fen Site is that the focus of the farming enterprise has to be feed wheat production. Although there are some areas of Grade 1 and Grade 2 land at the Site, the majority of the land is Grade 3, at 81.1% of the site. Due to the scattered nature of the better ALC grades across the site, it is not possible to farm these more productive soils in isolation, for practical and economic reasons the land has to be block cropped and farmed in such a way as to reflect the quality of the majority of the land (Grade 3).

The actual capability of the land is further limited by the age of the drainage system present, when combined with the weed burden in the fields, it means that feed wheat production or grazing livestock are the most suitable enterprises. The solar panel installation will allow a sheep enterprise to be developed that will mean agricultural output from the land can continue, and the land being moved into being planted with grass for sheep grass, and away from arable cropping will improve the soil resilience over time.

A sheep enterprise will ensure that food production continues on the Site whilst reducing, diesel and chemical usage per hectare. The move to sheep grazing, reflects the historic land use of the Site which was mixed farming, being a combination of cereal production and grassland.

10. List of references/sources of information

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AHDB, (2021)[redacted] B.pdf

Bayer, (2020). Fine tuning drill openers to minimise [redacted]

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Morris, Joe (1992). Agricultural land drainage, land use change and economic performance. , 9(3), 185–198.

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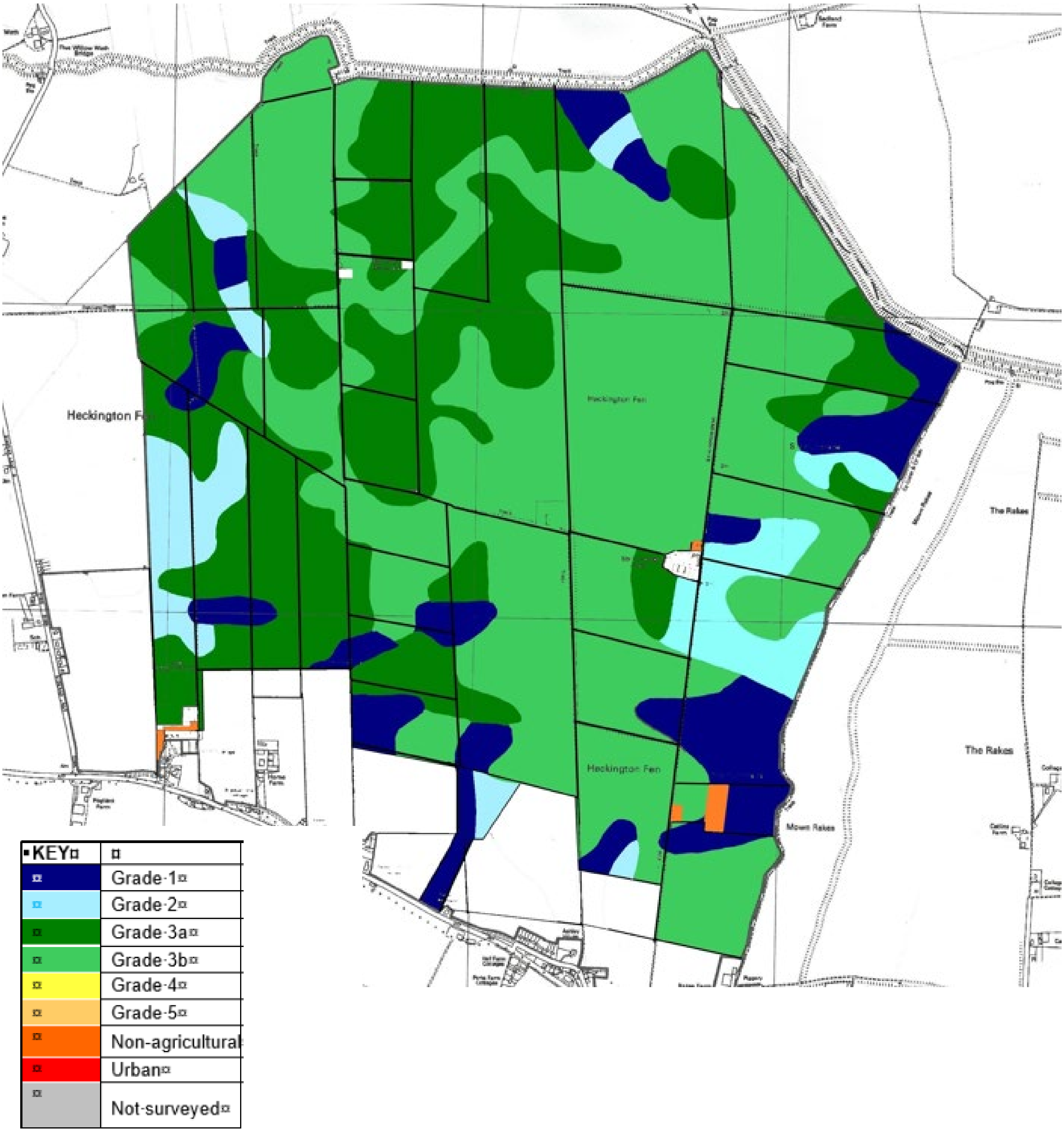
UK Governments. (2022a) [redacted]

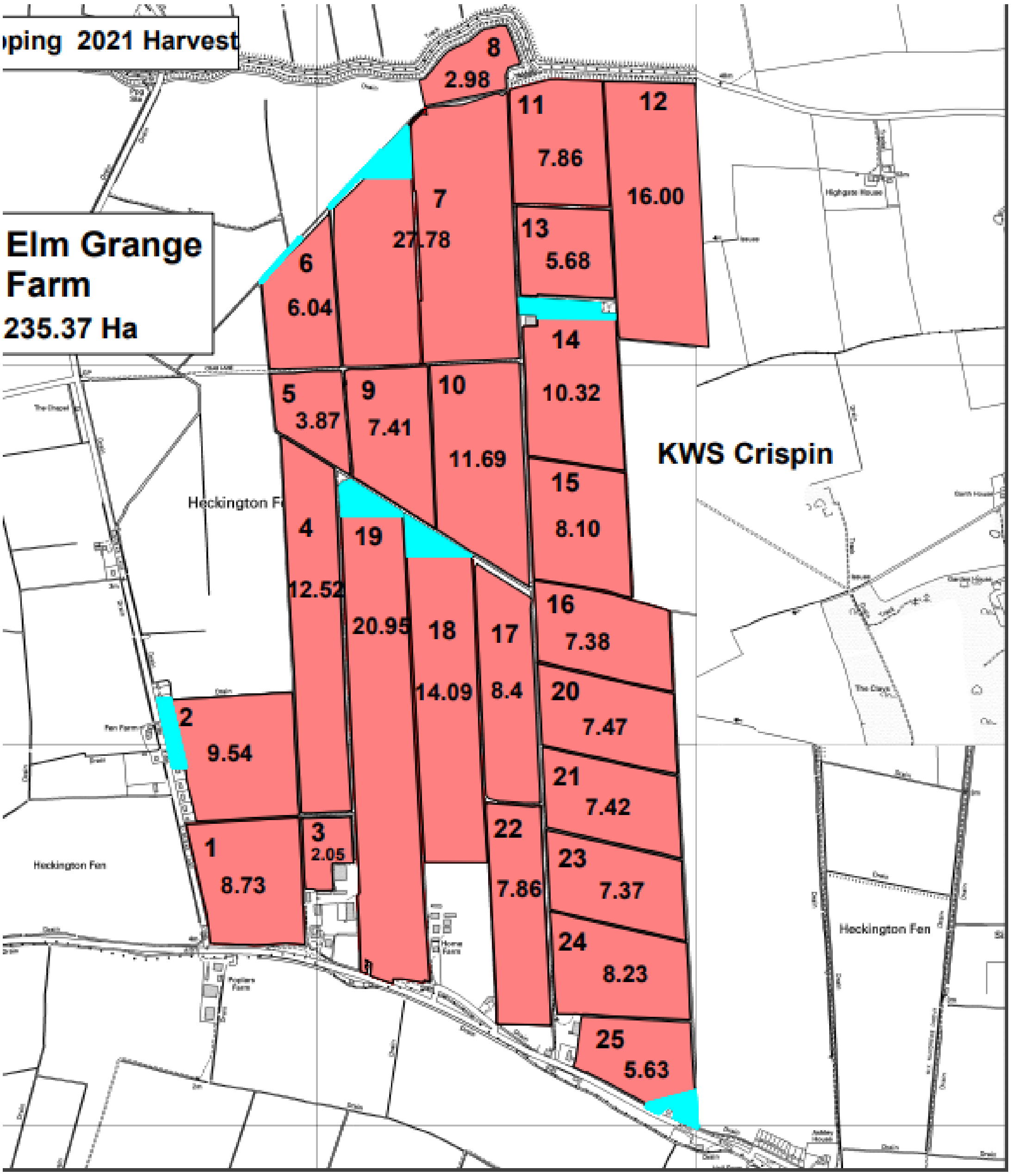
UK Government, (2022b). https://www.gov.uk/guidance/delinked-payments-replacing-the-basic-payment-scheme#:~:text=BPS%20will%20end%20after%20the,by%20the%20end%20of%202027

https://www.gov.uk/government/publications/sustainable-farming-incentive-full-guidance/sustainable-farming-incentive-full-guidance

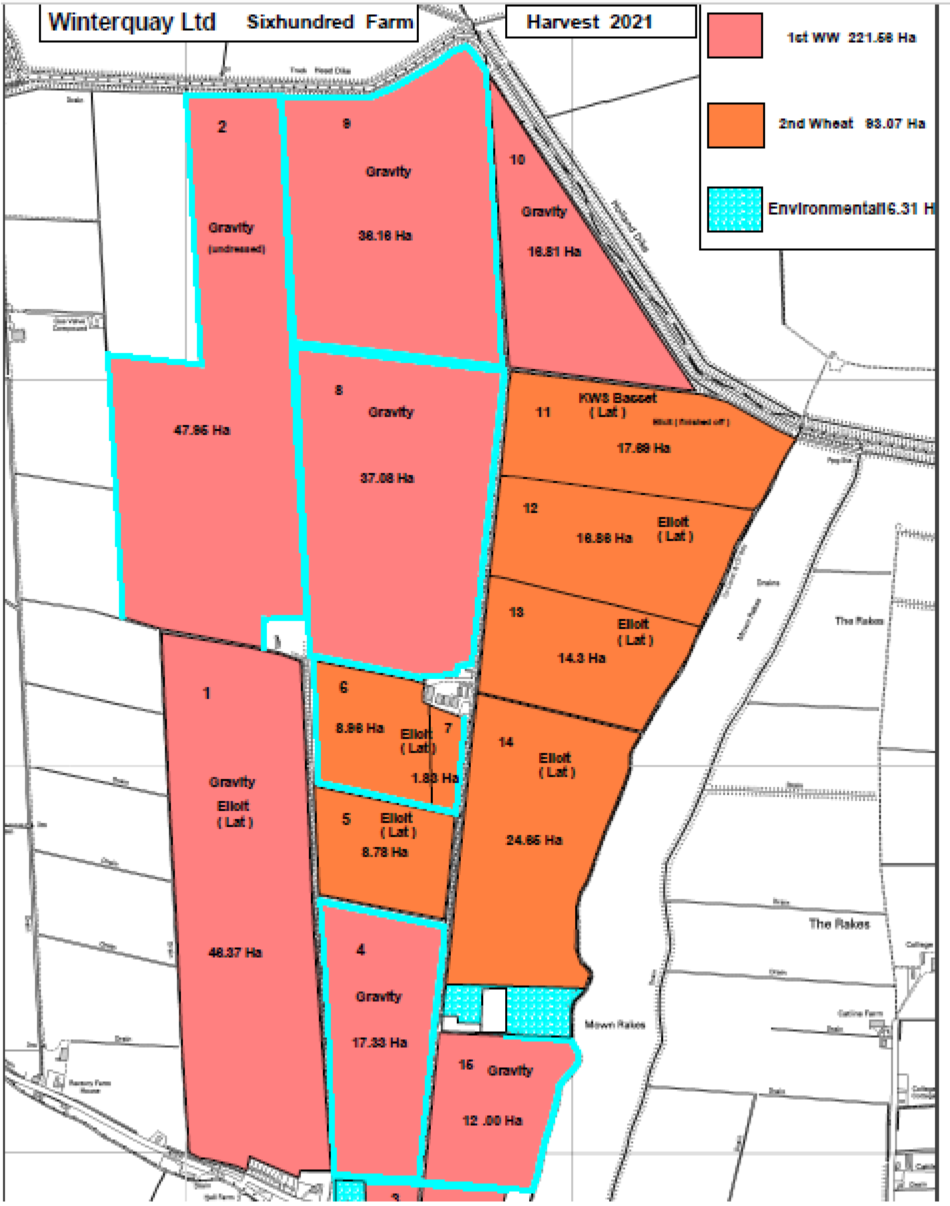
Appendix 1
Heckington Fen Agricultural Land Classification Map



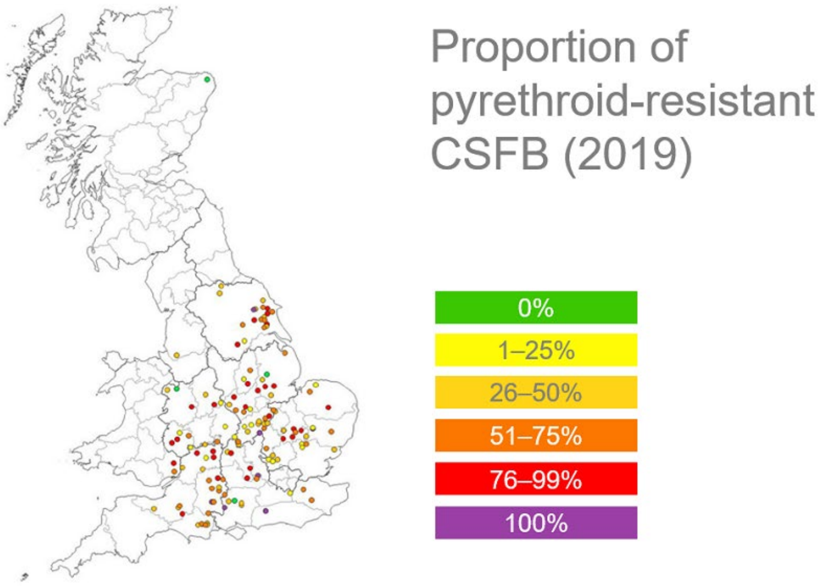
Appendix 2
Cropping Map



Appendix 2 Continued



Appendix 3
Cabbage Stem Fleas Beetle Resistance Map



Appendix 4
Photo to show blackgrass prevalence in the wheat crop

Appendix 5
Grain Stores

Appendix 6
Agricultural land drainage, land use change and economic performance. Experience in the UK – Joe Morris 1992 (page 1)

Agricultural land drainage, land use change and economic performance

Experience in the UK

Joe Morris

Public investments in flood alleviation and arterial drainage have been an important element of government support to agriculture in the UK. Drawing on an evaluation of 22 agricultural land drainage schemes, this article reports on the use of regression and discriminant analysis to explain the uptake of benefits by individual farmers and the resultant economic performance of the drainage investments. The greatest benefits and the best-performing drainage schemes involved rapid land use intensification and change. Four types of schemes were identified: high cost–low impact schemes, grassland intensification schemes, land use change schemes, and arable intensification schemes. Cost-benefit analysis did not appear to provide reliable predictions of actual costs and benefits, although it had been applied to more recent marginal schemes. Economic performance was greatest where the initiative for schemes and subsequent maintenance came from farmers themselves, especially through the actions of formal or informal drainage groups. The study confirmed that socioeconomic as well as technical factors are important influences on land use and farming practice.

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[1]J.K. Bowers, 'Cost-benefit analysis of wetland drainage', *Environment and Plan-*
continued on page 186

The purpose of agricultural drainage is to remove the problems caused by excess water whether due to waterlogging or flooding. Better drainage can improve yields, reduce costs, and allow changes in land use and farming practice which increase the added value of farm output. In the UK, where soils and climate usually make excess water a constraint on farming for much of the year, central and local government financing of river flood alleviation and arterial drainage has been and remains an important part of agricultural support. The overall justification has been to help meet the policy objectives of reliable food supply at reasonable prices, fair rewards to those engaged in farming, and support to the rural economy.

During the early 1980s the oversupply of indigenous farm commodities, spiralling costs of agricultural support, pressure on public funds, growing concern about the impact of intensive farming on environmental quality and consequent changes in agricultural policies led to a call for more objective and open appraisals of proposed drainage schemes.[1] Up to this point there had been little attempt to evaluate the efficacy of previous investments in land drainage. Casual observation, however, suggested considerable variation in the extent and timing of farmer uptake benefits, and the resultant performance of schemes. In this context, studies were carried out during the period 1981 to 1986 to identify and explain drainage benefits and farmer uptake, with a view to improving the accuracy of pre-investment appraisals.[2]

This article reports on the links between agricultural drainage, land use and economic performance of investments in land drainage. In the discussion, 'land drainage' – the responsibility mainly of formal drainage organizations – refers to flood alleviation and arterial works. 'Field drainage' – the responsibility of farmers – refers to the installation of underground pipes and other actions to evacuate excess water from the soil.

0264-8377/92/030185-14

[redacted]

Appendix 7
Ministry of Agriculture, Fisheries and Food Agricultural Land Classification of England and Wales, Revised guidelines and criteria for grading the quality of agricultural land October 1988

Agricultural Land Classification of England and Wales

PROCEDURE FOR ASSESSING WETNESS CLASS

Introduction

This method assumes that soils have an appropriate underdrainage system and that there are satisfactory outfalls (see assumption (2), page 8). It is not suitable for soils which are affected by high groundwater tables which cannot be drained effectively. Such soils can only be assigned objectively to a wetness class on the basis of long-term dipwell measurements. In the absence of such data the assessment of wetness class requires specialist knowledge and needs to take account of profile morphology, climate, site characteristics, prevailing water levels and time of year.

Pg 37 of the above guidelines

[redacted]

Appendix 8
Drainage Costs

CONTRACTING 7.4.

Operation	*Price Range*
FARM MAINTENANCE	
Flail hedge-trimming (5-6m) (70-90hp)	40.00-55.00/hour
Hedge laying (manual)	16.50-22.00/metre
Dry stone walling (excl.materials, 1.1-1.4m. high)	90.00-130.00/sq metre
Tractor and mounted saw bench	35.00-45.00/hour
Operator plus chain saw	25.00-35.00/hour
Trenching, laying plastic pipework, in-filling with soil	4.50-8.50/metre
with permeable back fill .... add	1.50-2.00/metre
Mole draining (single leg)	95.00-115.00/hectare
Ditch excavation	40.00-50.00/hour
360 hydraulic excavator	42.00-55.00/hour

Appendix 9
Press report on the impact of the labour shortage in UK agriculture and Parliamentary Report

£22m worth of fruit and veg wasted due to labour shortage

Michelle Martin
August 15, 2022 1:16 pm

According to a new survey by the National Farmers' Union (NFU), £22 million worth of the 2022 fruit and vegetable harvest has been wasted because of a labour shortage in the first half of the year alone.

Furthermore, as the survey represents around a third of the UK horticulture sector, the NFU estimates that the overall value wasted accumulates to more than £60 million.

The survey, of 199 growers across England and Wales, revealed that 40% of respondents suffered crop losses as a result of labour shortages. 56% of respondents reported a fall in production, and expect a further fall in 2023 of 4.4%.

[redacted]

House of Commons Environment, Food and Rural Affairs Committee Labour shortages in the food and farming sector Fourth Report of Session 2021–22 Report, together with formal minutes relating to the report Ordered by the House of Commons to be printed 29 March 2022:

Summary page 3

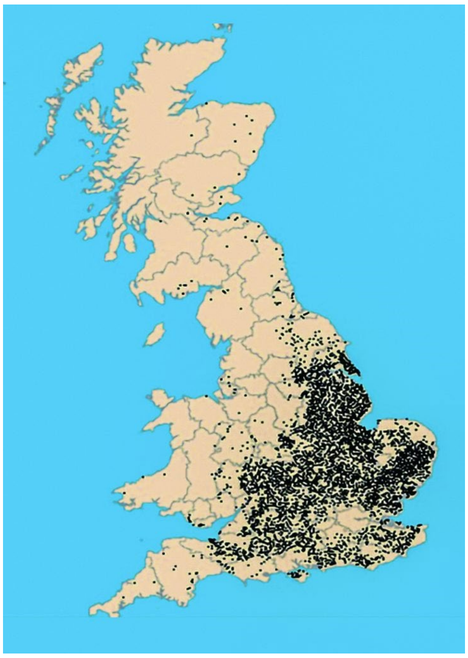
Summary

The food and farming sector has been suffering from acute labour shortages due principally to Brexit and the covid-19 pandemic. In August 2021, the number of vacancies was estimated to be 500,000 out of 4.1 million roles in the sector. We found clear evidence that labour shortages have badly affected the food and farming industry - threatening food security, the welfare of animals and the mental health of those working in the sector. Businesses have been badly hit, with the pig sector being particularly affected. The food sector is the UK's largest manufacturing sector but faces permanent shrinkage if a failure to address its acute labour shortages leads to wage rises, price increases, reduced competitiveness and, ultimately, food production being exported abroad and increased imports.

We found that labour shortages across the sector were causing crops to go unharvested and left to rot in fields, healthy pigs to be culled, and disruption to the food supply chain's just-in-time delivery model. Our key recommendations are:

[redacted]

Appendix 10
Blackgrass Map for UK



Blackgrass prevalence UK Map: [redacted]

Appendix 11
Blackgrass Control – Bayer, (2020). Fine tuning drill openers to minimise disturbance

Drilling a crop with minimal disturbance is often the aim for farmers dealing with **black-grass**, but short of changing the drill, what practical steps can they take to reduce disturbance?

As part of the **Black-Grass Task Force**, Philip Wright recommended that Paul Drinkwater replace the standard openers with Borgault VOS versions on his Vaderstad Rapid drill to reduce disturbance in autumn 2019.

"When drilling, if you move soil sideways and it doesn't return back then you are moving too much for black-grass control," says Mr Wright. "You need the slot to be covered as well as good seed to soil contact without disturbing so much soil that black-grass is kicked into life, particularly between the rows where there is less crop competition."

[redacted]

Appendix 12
AHDB, Potato store managers' guide 2021

Introduction

Potato storage is a key element of modern-day potato production, looking to fulfil the demands of many markets. It can be practised successfully but it must also be acknowledged that storage poses a risk. Its success depends on how well that risk is managed and, ultimately, whether the customer for the crop in question is delivered the quality for which they are prepared to pay.

So, ensuring a store runs efficiently is a critical part of managing the potato production system. Inevitably, there are cost pressures on all components of the supply chain and, therefore, it is just as important to minimise operating costs in storage as it is to maximise returns from the enterprise.

To this end, having good control of the store is crucial so that it only incurs cost when delivering a benefit. This control extends to such aspects as servicing and calibrating the store equipment before use, loading the store correctly, operating the ventilation system and ensuring the airflow is optimised, minimising air leakage, and so on.

Store management is a complex process and there are multiple points at which problems and inefficiencies can occur and jeopardise the prospect of success.

This guide seeks to provide guidance throughout the various steps of the store management process, but it should not be read in isolation.

It should be remembered that the crop in the store came from a field where there was opportunity to influence many attributes that affect how the crop performs in store, from simple decisions, including choice of variety, to more complex issues, such as the impact of chronological age on dormancy break and the need for sprout suppression. Another major factor in storage success is whether the crop has an adequately 'set' skin, as, without this, storage of potatoes is seldom straightforward.

It is also intended that this third edition of the guide be used in conjunction with new decision support tools that AHDB plans to develop in the near future. Keep up to date with the ever-changing range of online assistance tools by visiting the AHDB website at **ahdb.org.uk**

[redacted]

Appendix 13
DEFRA – Irrigation Best Practice Water Management for Potatoes A Guide for Growers

1 Introduction

Water is a vital component of potato production. It is essential to maximise both yield and quality. Irrigation early in the growing season minimises common scab, maximises tuber number and encourages crop canopy growth. It allows tubers to grow at an optimum rate, and at the end of the season it can allow harvesting with minimal crop damage.

Water has to be applied in the right amounts at the right time in order to achieve the right crop result. At the same time, the application of water should avoid waste of a valuable resource and be in sympathy with the environment as a whole.

This Best Practice Guide aims to address the key aspects of water and irrigation management appropriate to potato production. Emphasis is given to correct management of water application, both in terms of scheduling and field equipment. This Guide also focuses on the crop quality aspects of irrigation, especially as it affects diseases, pests, disorders and damage.

Environmental considerations are playing an increasing role in the production and marketing of all crops, including potatoes. Careful and effective irrigation management will form part of these considerations, as well as helping the grower to continue producing profitable potato crops.

Horticulture and Potatoes Division

Department for Environment, Food and Rural Affairs

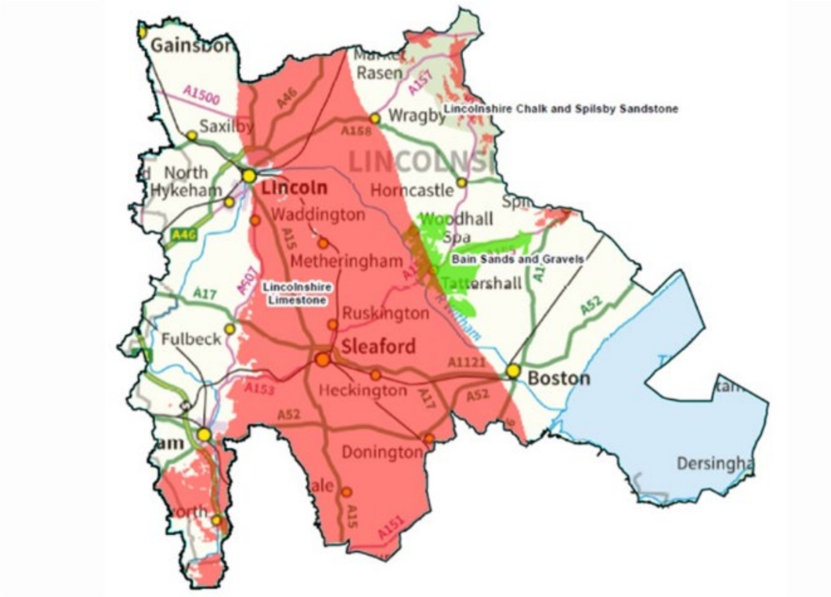
December 2005

Appendix 14
Groundwater Availability for the Region

The groundwater availability map shows in this catchment that there is no water available for new consumptive abstraction in:

- the Lincolnshire Limestone.
- the Lincolnshire Chalk and Spilsby Sandstone

There may be water available for consumptive abstraction in the Bain Sands and Gravels.



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https://www.gov.uk/government/publications/witham-abstraction-licensing-strategy/witham-abstraction-licensing-strategy#Catchment-background

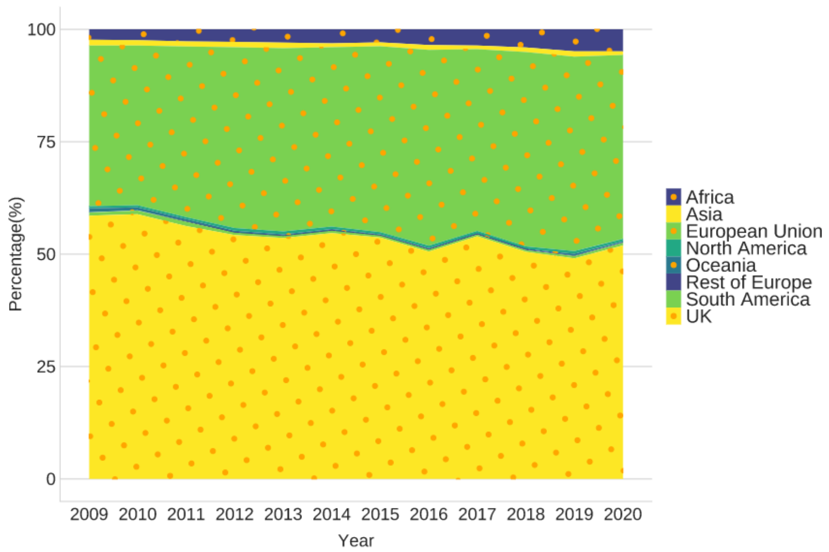
Appendix 15
ALC for England

England ALC Grade	Area (Ha)	Area (%)
Grade 1 (Excellent)	354,562	2.72
Grade 2 (Very Good)	1,848,874	14.18
Grade 3 (Good/Moderate)	6,290,210	48.23
Grade 4 (Poor)	1,839,583	14.10
Grade 5 (Very Poor)	1,100,305	8.44
Non-Agricultural/Other Land	1,608,926	12.34
TOTAL	**13,042,459**	**100**

Table i: ALC for England

[redacted]

Appendix 16
Demand for areas that can grow crops suited to grade 1 and 2 land, but not grade 3 land



Source: HMRC

93% of domestic consumption of fresh vegetables was fulfilled by domestic and EU production, reflecting the importance of geographical proximity for importing fresh produce of relatively low value. UK production to consumption has declined slightly over the last decade, while reliance on EU and African supply sources has increased.

https://www.gov.uk/government/statistics/united-kingdom-food-security-report-2021/united-kingdom-food-security-report-2021-theme-2-uk-food-supply-sources#united-kingdom-food-security-report-2021-theme2-indicator-2-1-9

Appendix 17
Delinked payments; replacing the Basic Payment Scheme

https://www.gov.uk/guidance/delinked-payments-replacing-the-basic-payment-scheme#:~:text=BPS%20will%20end%20after%20the,by%20the%20end%20of%202027

Farm Support - England

Post-Brexit farm policy in England is based on a radical change in support. Direct aid in the form of the Basic Payment Scheme (BPS) will be phased-out over the course of an 'Agricultural Transition' through to 2027. It will be replaced by payments for 'public goods' – services that agriculture can provide to society that are not delivered by the market.

The section that follows gives the detail of the Agricultural Transition as it is currently known, including proposals for new schemes. It is then followed by a summary of the current BPS in England as it will continue in an amended form to 2027 as part of the Transition. Finally, the current set of 'Rural Development' schemes are outlined as, again, many of these will continue to operate in the short term.

The Agricultural Transition

The Agricultural Transition commenced in England in 2021 and will take place over seven years, during which time direct (BPS) payments will be progressively reduced. By 2028 there will be no direct payments. Defra released its Path to Sustainable Farming document at the end of November 2020 giving details on changes to English farm support. A further consultation took place from May to August 2021 on areas such as Lump-Sum payments and De-Linking (see below).

Phase-Out of the BPS

From 2021, the BPS will continue (possibly re-named in the future) but with some rule changes and, importantly, with a reduction in payments. These deductions will get progressively greater through to 2027.

PHASING

All payments will see reductions compared to the current BPS, starting in 2021. The rates are set out in the tables below. Deduction percentages beyond 2024 have not yet been set. The rates for 2025 onwards are therefore ABC estimates.

Payment Band①	2021	2022	2023	2024
up to £30,000	5%	20%	35%	50%
£30,000-£50,000	10%	25%	40%	55%
£50,000-£150,000	20%	35%	50%	65%
Over £150,000	25%	40%	55%	70%

Payment Band ①②	*2025*	*2026*	*2027*	*2028*
up to £30,000	*65%*	*80%*	*95%*	*100%*
£30,000-£50,000	*70%*	*85%*	*100%*	*100%*
£50,000-£150,000	*80%*	*95%*	*100%*	*100%*
Over £150,000	*85%*	*100%*	*100%*	*100%*

① the reductions work in bands like Income Tax ② the rates for 2025 onwards are ABC estimates

DE-LINKING

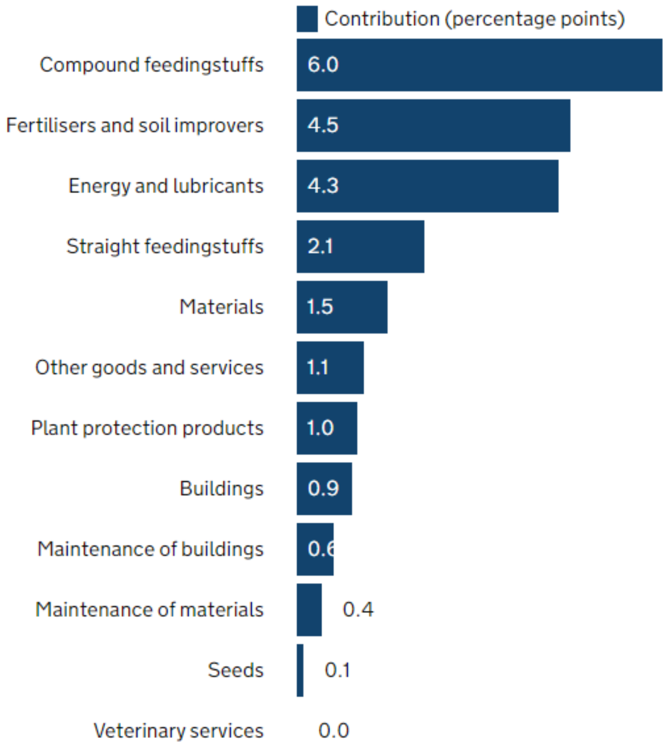
De-linking will take place in 2024. Claimants do not have to apply for it; it will 'just happen'. It will mean future BPS payments will be not be linked to the requirement to

The Rural Payment Agency (RPA) plans to replace the Basic Payment Scheme (BPS) in England with delinked payments in 2024.

BPS will end after the 2023 scheme year. RPA plans to make delinked payments each year from 2024 to 2027.

When payments are delinked, you will not need any land or entitlements to receive the payments. This will simplify the payments as they are phased out by the end of 2027.

Appendix 18
Contributions to change in the agricultural inputs 12-month inflation rate (22.6%) from November 2021 to November 2022



Agricultural Inflation January to November 2022

Figure 2: Annual average price indices for agricultural outputs and inputs to November 2022 (2015 = 100)

Figure 2 shows the annual average price indices for agricultural outputs and agricultural inputs since 2015. In 2022 (to date), the annual average price index was 18.4% higher for agricultural outputs and 27.3% higher for agricultural inputs compared with 2021.

https://www.gov.uk/government/statistics/agricultural-price-indices/agricultural-price-indices-united-kingdom-november-2022

Appendix 19
Labour requirements for combinable cropping & margin for winter wheat

Crops	Hours per Ha	(Acre) per year	Implied Enterprise Size - Ha.s	(Acres)
Combinable Crops				
Cereals	18	*7.3*	105	*259*
Oilseeds	16	*6.5*	120	*297*
Field Beans and Peas	16	*6.5*	120	*297*
Fallow (set-asid	3	*1.2*	635	*1,569*

Winter Wheat - Feed		£ per Ha	*per Ac*
Yield	9.10t (3.7t) @ £240/tonne	2184	*884*
Output		**2184**	***884***
Seed	345/sq m, 155kg (63kg) @ £0.39/kg	60	*24*
Fertiliser	185N:70P:50K kg (148:56:40 units)	582	*235*
Crop Protection	....	250	*101*
Sundries	....	25	*10*
Variable Costs		**917**	***371***
Gross Margin		**1267**	***513***

ABC (2022)

Appendix 20

Labour requirements for potatoes & margins

CROPS *cont*	Hours per Ha	*(Acre)* per year	Implied Enterprise Size - Ha.s	*(Acres)*
Roots				
Sugar Beet	33	*13.4*	60	*148*
Early Potatoes	200	*80.9*	9.5	*23*
Maincrop Potatoes	110	*44.5*	17	*42*

MAIN CROP POTATOES - WARE		£ per Ha	*per Ac*
Yield	46.0t (18.6t) @ £175/tonne including sacks	8050	*3258*
OUTPUT		**8050**	***3258***
Seed	2.80t (1.13t) @ £345/tonne	966	*391*
Fertiliser	175N:150P:275K:45Mg kg (140:120:220:36)	921	*373*
Crop Protection	....	750	*304*
Casual Labour	machine harvesting/grading @ £22.50/tonne	1035	*419*
Sacks	@ £10.00 /tonne of crop	460	*186*
Sundries	....	75	*30*
VARIABLE COSTS		**4207**	***1702***
GROSS MARGIN		**3844**	***1555***

ABC (2022)

Appendix 21
Labour requirements for sheep

LIVESTOCK

		Hours per calf place per year		
Weaned Calves	*age range (months)* -	*0 - 3*	*0 - 6*	*6 - 12*
Labour requirement per calf place	.....	21	13	6.5
Standard Work Days Equivalent:	....	*2.63*	*1.63*	*0.81*
		Hours per animal per year		
Dairy Cows	*herd size* -	*below 80*	*80 - 140*	*over 140*
Direct Labour (milking bedding etc.)	.....	35	26	23
Field Work (silage, fert, muck cart, etc.)	.....	11	9	7
Total	....	46	35	30
Standard Work Days Equivalent:		*5.75*	*4.38*	*3.75*

Other Cattle - average for summer grazing, and winter housing. Includes dairy replacements and extensively finished beef.

	age range (months) -	*12 - 24*	*over 24*
Direct Labour requirement	....	8	10
Field Work (silage, fert, muck-cart, etc.)	....	6	6
		14	16
Standard Work Days Equivalent:	....	*1.75*	*2.00*

Intensive Beef Finishing (from 6 months)

Labour requirement (for animals sold at 12-17 months)	....	5 - 9
Standard Man Days Equivalent:	....	*0.6-1.1*

Suckler Cows (includes calf to weaning)

		single	*multiple*
Direct Labour requirement	....	12	32
Field Work (silage, fert, muck-cart, etc.)	....	6	6
		18	38
Standard Work Days Equivalent:	....	*2.25*	*4.75*

Sheep

		lowland	*upland*	*other sheep > 6 months*
Direct Labour requirement	....	2.5 *	2.25	1.5
Field Work (hay, fertiliser, etc.)	.....	0.5	0.25	-
		3	2.5	1.5
Standard Work Days Equivalent:	....	*0.38*	*0.31*	*0.19*

* larger flock sizes (> 500 ewes) are likely to be below 2.0 hrs per ewe.

ABC (2022)

savills

Appendix 22
Cropping and Land Use

Cropping and Land Use

With adequate underdrainage, Wallasea and Newchurch soils are moderately easy to work. There are adequate days for safe cultivation in autumn and spring, but in north Lincolnshire the moist climate reduces the opportunity for spring cultivation, particularly in wet years, and the soils are marginal for spring-sown crops. The land is generally used for winter cereals and ley grassland, but sugar beet, peas and field brassicas are grown in the drier districts. The use of heavy machinery often causes topsoil compaction and surface wetness on the heavier soils especially Wallasea series though they can be direct drilled very successfully if subsoiled periodically. Newchurch soils which are calcareous have a more stable structure. Wisbech and Blacktoft soils are less suitable for direct drilling because of the problems associated with this system on silty soils.

[redacted]

Appendix 23
Livestock Buildings at the Site

Appendix 24
Carbon Emissions from Wheat Cropping

[redacted]

Emissions	tonnes CO_2e	%
Fuels	169.56	38.82%
Crops	112.40	25.74%
Inputs	154.77	35.44%
Total	**436.72**	**100%**

Appendix 25
Carbon Emissions from Lamb Production Cropping

[redacted]

Emissions	tonnes CO_2e	%
Fuels	50.87	27.57%
Livestock	133.63	72.43%
Total	**184.50**	**100%**

Appendix 26
Grassland Sequestering Carbon

Review

UK land use and soil carbon sequestration ☆

N.J. Ostle [a], P.E. Levy [b], C.D. Evans [c], P. Smith [d]

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Abstract

This review explores the role of land use and land use change as a determinant of the soil's ability to sequester and store carbon in the UK. Over 95 percent of the UK land carbon stock is located in soils which are subjected to a range of land uses and global changes. Land use change can result in rapid soil loss of carbon from peatlands, grasslands, plantation forest and native woodland. Soil carbon accumulates more slowly (decadal) but gains can be made when croplands are converted to grasslands, plantation forest or native woodland. The need for land for food production and renewable forms of energy could have considerable influence on UK soil carbon storage in the future. There is a need to recognise the risk of soil carbon losses occurring when land use change to increase carbon storage is offset by compensatory land use conversions elsewhere that result in net carbon release. The protection of peatland and other organic soil carbon stocks, and the management of cropland, grassland and forest soils to increase carbon sequestration, will be crucial to the maintenance of the UK carbon balance. It will be necessary to develop policy to balance trade-offs between soil carbon gains with other land use priorities. These include the sustainable production of food, bio-energy and fibre crops and livestock, water quality and hydrology, greenhouse gas emission control and waste management, all of which are underpinned by the soil.

Appendix 27
Inputs and Outputs from the Farm – current system

Bramall Properties Ltd (Solar plan analysis) Elm Grange and Six Hundreds Farms 2021.

This forms part of an analysis of the environmental impact that farming on 550 ha of land at East Heckington may have. The farms use of products together with cultivations and the resulting fuel use forms part of this analysis. The total amounts of products used on these farms in 2021 harvest year is recorded on an agricultural management software called Gatekeeper. For harvest 2021 the farms produced 4342 tonnes of feed wheat for compound animal feed use as the land does not suit the production of high-quality milling wheat for direct human consumption though some 1421 tonnes of this feed wheat did make a low biscuit grade grist. The previous break crop of harvest 2020 was oilseed rape and was grown on a specialist supply contract for industrial non- food use and was exported to a German processor.

Inputs.

Seeds with chemical dressing 121 tonnes

Chemical fertiliser 272.5 tonnes

Fungicides 2,194 litres

Herbicides 3,387 litres

Adjuvants/additives 532 litres

Herbicide powders 8kg

Land work diesel use.

550 ha of deep soil cultivation	16 litres of diesel/ha	8,800
550 ha of drilling with press	16 litres of diesel/ha	8,800
550 ha sprayed six times	3 litres of diesel/ha	4,950
550 ha fertiliser spread three times	5 litres of diesel/ha	8,250
550 ha combined	30 litres of diesel/ha	16,500
Includes 290 tractor trailer trips from field to stores.		
Total diesel used by the farm within the site boundary		47,300 litres

Does not include such as the following, lorries collecting produce, lorries delivering chemicals and other inputs, men and farm machinery journeys outside the site boundaries, maintenance crews, hedge and ditch cutting.

Grain lorries movements.

The farm recorded a total cereal production of 4342 tonnes which required 150 lorries to collect the crop; 300 journeys in total (coming and going) by 18 wheel articulated vehicles along the A17 and beyond.

Appendix 28
Inputs and Outputs from the Farm – Sheep System Example

The first Welsh case study farm is an upland farm classified as SDA (severely disadvantaged area). Its altitude ranges from 230-305 m and a very high percentage of its land can be described as improved and fertile. The lambs are sold from early July until the following January, ranging in age from 4-10 months and on average 6-7 months. For the calculation of emissions from lambs and their excreta, it was assumed that they stay on the farm for 6.5 months. Calves were assumed to stay on the farm for 12 months. All soils on the farm are mineral. All lambs sold were assumed to travel to the slaughterhouse at a distance of 13 miles. All cattle were assumed to be sold at a market 7 miles from the farm. The farm has a Tir Gofal agri-environmental agreement. The farm grows 4.9 ha of cereals and 8.1 ha of forage crops. Table 3 gives a description of the farm and lists annual inputs and outputs.

Table 3. Description of Welsh case study farm 1.

Farm details	
Total area of farm (ha)	129.5
Number of ewes	800
Number of lambs sold per year	747
Average live weight of lambs sold (kg)	39
Number of cattle	49
Number of calves	44
Distance to slaughterhouse (lambs) (miles)	13
Distance to market (calves) (miles)	7
Energy use	
Diesel use (including diesel used by contractors) (l $year^{-1}$)	5986
Petrol use (l $year^{-1}$)	415
Electricity use (kWh $year^{-1}$)	7400
Fertiliser	
Nitrogen (kg N $year^{-1}$)	12559
Phosphorus (kg P $year^{-1}$)	3649
Potassium (kg K $year^{-1}$)	3697
Sulphur (kg $year^{-1}$)	168
Organic nitrogen (kg N $year^{-1}$)	970.6
Pesticides	
Herbicide (l $year^{-1}$)	5
Insecticide (l $year^{-1}$)	5
Feed	
Concentrate (kg dry matter $year^{-1}$)	71170.8
Silage used (t $year^{-1}$)	1063
Other feed (kg $year^{-1}$)	3424
Straw or other bedding (t $year^{-1}$)	33.5

Diesel use of 5,986 litres over 129.6 hectares, equates to approximately 46 litres per hectare of diesel

Appendix 29
Grassland Increasing Soil Resilience

A B S T R A C T

Intensive arable cropping depletes soil organic carbon and earthworms, leading to loss of macropores, and impaired hydrological functioning, constraining crop yields and exacerbating impacts of droughts and floods that are increasing with climate change. Grass and legume mixes traditionally grown in arable rotations (leys), are widely considered to regenerate soil functions, but there is surprisingly limited evidence of their effects on soil properties, resilience to rainfall extremes, and crop yields. Using topsoil monoliths taken from four intensively cropped arable fields, 19 month-old grass-clover ley strips in these fields, and from 3 adjacent permanent grasslands, effects on soil properties, and wheat yield in response to four-weeks of flood, drought, or ambient rain, during the stem elongation period were evaluated. Compared to arable soil, leys increased earthworm numbers, infiltration rates, macropore flow and saturated hydraulic conductivity, and reduced compaction (bulk density) resulting in improved wheat yields by 42–95 % under flood and ambient conditions. The leys showed incomplete recovery compared to permanent grassland soil, with modest gains in soil organic carbon, total nitrogen, water-holding capacity, and grain yield under drought, that were not significantly different ($P > 0.05$) to the arable controls. Overall, grass-clover leys regenerate earthworm populations and reverse structural degradation of intensively cultivated arable soil, facilitating adoption of no-tillage cropping to break out of the cycle of tillage-driven soil degradation. The substantial improvements in hydrological functioning by leys will help to deliver reduced flood and water pollution risks, potentially justifying payments for these ecosystem services, especially as over longer periods, leys increase soil carbon sequestration.

Appendix 30
Sustainable Farming Incentive

https://www.gov.uk/government/publications/sustainable-farming-incentive-full-guidance/sustainable-farming-incentive-full-guidance

Guidance

Sustainable Farming Incentive: full guidance

Updated 2 September 2022

Applies to England

Contents

1. A summary of the SFI in 2022

The Sustainable Farming Incentive (SFI) is the first of 3 new environmental schemes being introduced under the Agricultural Transition Plan. The other 2 schemes are Local Nature Recovery and Landscape Recovery.

SFI aims to help farmers manage land in a way that improves food production and is more environmentally sustainable.

Farmers will be paid to provide public goods, such as:

- improved water quality
- biodiversity
- climate change mitigation
- animal health and welfare

In 2022, SFI aims to:

- encourage actions that improve soil health
- recognise how moorland provides benefits to the public (public goods)
- improve animal health and welfare by helping farmers with the costs of veterinary advice for livestock