Arable (Cereals) Towards Net Zero

What are the key emission challenges influencing the Arable sector?

Nitrogen use efficiency

The main challenge for the arable sector is emissions of nitrous oxide. Emissions from the cultivation of soils, along with the production and application of mineral nitrogen fertiliser, is the largest source of nitrous oxide emissions from the sector (Figure 1). Emissions are dependent primarily on the nitrogen quantity applied and the timing and application method used. Losses of nitrogen in run-off also negatively impacts water quality.

Fossil fuel use

The major source of carbon dioxide emissions from the sector is from the use of fossil fuels (primarily diesel) on-farm. Diesel used in agricultural machinery, transportation and in fans and heaters used for grain drying all contribute to an arable farm's emissions.

Decreasing soil health and organic matter

Arable soils are particularly at risk of degradation. It is estimated that the UK has lost 84% of its fertile topsoil since 1850[1]. The loss of soil structure, texture and organic matter has occurred as a result of highly mechanised systems, compaction, erosion and the inappropriate or sub optimum timing of cultivations. Degraded soils are a source of carbon dioxide emissions as soil carbon is lost in the decomposition of organic matter.

Where should you start to prioritise reducing emissions on your farm?

Approximately 3,211,000 ha of cereal crops were grown in the UK in 2021 comprising almost 70% of all arable land[2]. The key greenhouse gas emissions arising from the cropping sector are (in order of impact) nitrous oxide, carbon dioxide and then methane.

Managing land and rotations through adapting resource inputs can have a significant effect in reducing greenhouse gas emissions from arable farms. Typically, 50–60% of the emissions of a conventional farm are directly linked to N fertiliser use[3]. Quantifying the impact of existing management by completing an annual carbon footprinting report will help your farm to understand emission hotspots and prioritise actions[4].

Priorities you should identify for your farm include increasing productive efficiency whilst reducing inputs alongside improving soil and crop health, increasing carbon storage through changing and adapting land management practices, and thirdly, reducing reliance on fossil fuels.

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There are eight practices listed which could support your farms immediate action to reduce emissions which include:

1. Low carbon abated nitrogen fertiliser
2. Precision techniques and avoiding excess nitrogen
3. Reducing intensity of cultivation – no-till/min-till
4. Maintaining ground cover – using cover/companion cropping
5. Use of manures, green manures and composts to build organic matter
6. Rotations incorporating for nitrogen fixing/soil improvement/diverse leys in rotation for nitrogen fixing legumes, soil improvement
7. Integrating grass leys into rotations and fertilising using grazing animals
8. Use of biostimulants when added to crops or the rhizosphere

What practical steps could you take?

These steps can be applied anywhere, on organic or conventional farms and revolve around 3 simple principles[5]:

1. Minimising disturbance of the soil;
2. Growing cover crops and retaining crop residues so the soil is always covered; and
3. Using diverse crop rotations (which could also create opportunity to collaborate with local livestock farmers to use grazing animals).

To assist in the integration of these principles, the following steps are suggested for incorporation into arable carbon reduction plans:

What is the practise?	Why would this be of benefit to your farm?	How can I do this well?
Maintaining ground cover – using cover/catch in arable rotations	Cover and catch crops provide a canopy to protect the soil, recycle nutrients, build soil organic matter and to combat weeds, pests and diseases[6]. They also improve water retention, act as a natural flood management system and a buffer for nitrate losses. These can also have added benefits of nitrogen fixation to reduce emissions from artificial fertiliser. There is also a financial benefit to this step and improvements in efficiency showed an increase in margin of £64/ha to £150/ha (dependent on soil type) when incorporating cover crops[7].	Ideally late summer/early autumn establishment. Consider end use to select choice of cover mixes – forage rye, vetch, white clover, black oats and/or companion crops to fix nitrogen within the soil. Considering overwintering of stubbles along with the use of cover crops.
Diverse leys in rotation for nitrogen fixing legumes, soil improvement	Incorporation of grain legumes in rotation can provide a disease break for cereals and oilseed rape[8]. Reducing need for artificial fertilisers due to nitrogen fixation and can be a versatile option concerning establishment and drilling. The rapid increase in pricing of fertilisers requires resilience building actions which can reduce costs of production as well as lowering carbon emissions and/or building soil carbon[9].	Recommended as part of a 6-year rotation to reduce pest and disease build up. Winter beans are better on heavier land. Select legumes based on end use and land/soil type. Selecting pilot areas of the farm to 'trial' will reduce reliance on artificial fertilisers associated with the manufacture and application of inorganic fertilisers.
Adopting regenerative principles	Based on five core principles of minimising soil disturbance, maximise crop diversity, keeping the soil covered, maintaining a living root year-round and integrating livestock[10]. Incorporating cover crops and green manures will increase soil organic carbon content, increase nitrogen fixation, improve water retention – acting as a natural flood management system and building resilience in soils to drought[11]. These actions contribute to reducing the degradation of soils and can have a meaningful impact within 5–7 years.	Reviewing soil health and fertility through detailed soil analysis and selecting 'problem' fields for depth soil pits. Adapting cultivation practices and reducing 'passes'. Keeping soil covered and using cover crops in rotations. Extending rotations and incorporating as much plant diversity as possible[12].

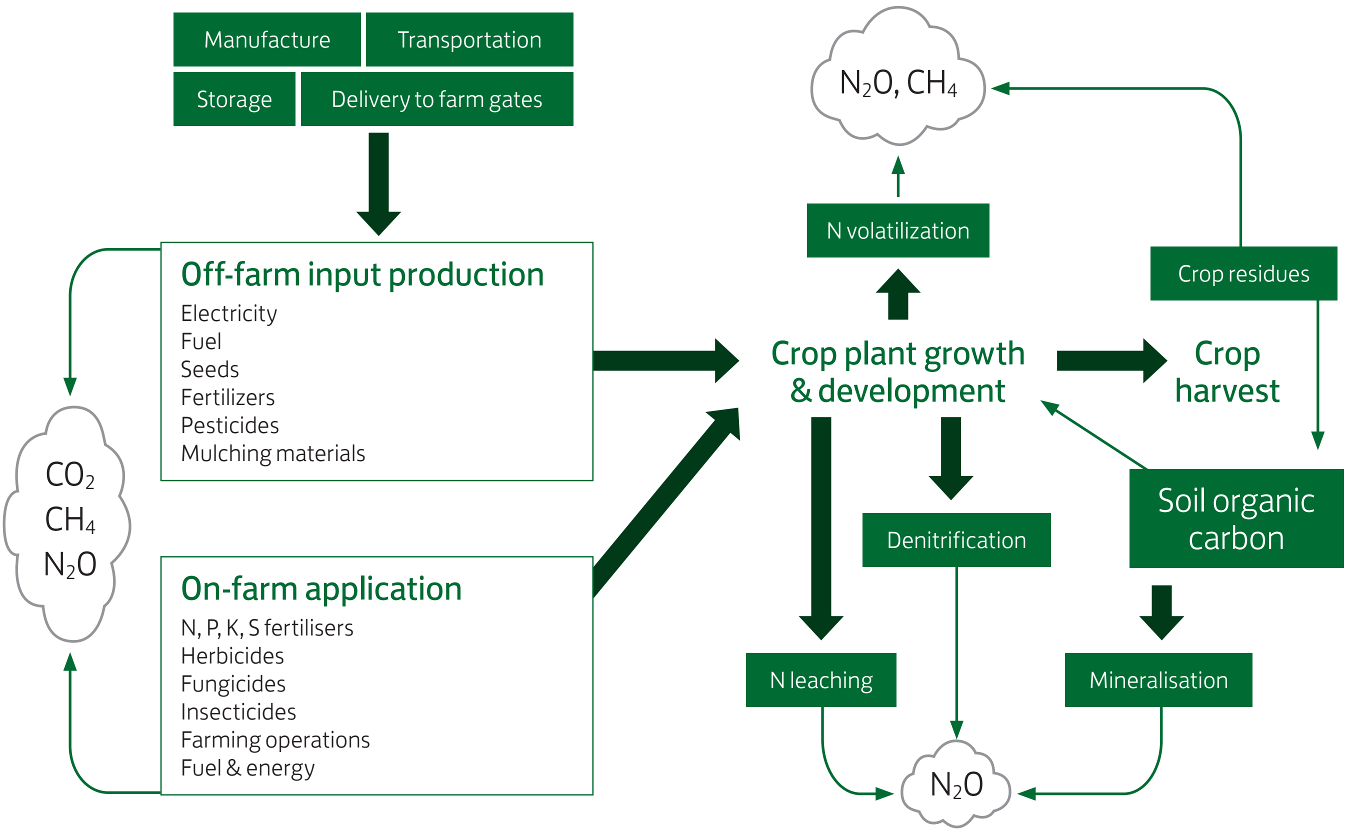
What's next? What should I look at beyond two years?

Looking ahead, further actions which seek to reduce the impact of fossil fuels (for machinery and energy) as well as building levels of carbon within the soils will prove critical. These actions align with changing environmental support measures being introduced across all devolved nations of the United Kingdom. They contribute to improving biodiversity as well as increasing the productivity of arable farms.

Examples of actions you could consider investigating and plan for change on your farm include:

- Biochar is a potentially useful soil and feed amendment for increasing yield and health of crops, livestock and soil. Biochar is a complex material and could contribute to increasing soil sequestration as well as improving the health of soils[13].
- Silvoarable agroforestry is the integration of trees with crops within the same field. The crops may be arable, horticulture crops or woody biomass. Trees in silvoarable systems are usually planted in rows and the crops are grown in the intervening alleys[14].
- Living mulches and intercropping includes several common farming practices but there is potential for wider integration within existing farming systems[15]. It requires the establishment of a perennial forage legume to provide protection for the soil as a semi-permanent ground cover. This practice can deliver key service benefits for improving productivity through weed control and increase N supply, whilst reducing the herbicide requirement[16].
- Biomethane/non-fossil fuel machinery of the future which could draw on green hydrogen power which can be produced by using surplus renewable energy (e.g. solar or wind), to power the electrolysis process that splits water into hydrogen and oxygen atoms. If agricultural equipment powered by green hydrogen fuel cells were to become commercially viable, this technology would be considered as 'net zero'.

Figure 1: Major sources of greenhouse gases from crop production[6]



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