Farm Carbon Cutting Toolkit

The evidence behind our soil carbon project

Scientific evidence to support the recommendations for best practice made in FCCT's soil carbon project.

National (and global) levels

Greenhouse gases – current levels of atmospheric CO2 this year exceeded an unprecedented level of 400ppm[1]. Warnings of runaway climate change in this century are starkly laid out by the IPCC in their latest report[2]. Farming is responsible for approximately 8% of UK national emissions[3], though this rises to 19% when all imports to the farming system are included[4]. Carbon sequestration potential ranges from 2%[5] to 20%[6] of total anthropogenic emissions.

Legal targets – the UK Government is legally committed to reducing greenhouse gases (GHGs) by 80% on 1990 levels, by 2050[7]. The UK agricultural sector is committed to a reduction of 3 million tonnes of CO2e by 2020, of which carbon sequestration in soils is considered a major mechanism[8].

Food security – soil underpins the production of all arable, livestock and horticultural food products. These soils must have adequate organic matter levels, minimum target levels of 3-5% have been set[9]. Current soil organic matter levels in the UK are considered to be well below these levels[10]. Enhancing food security is especially important in the face of intensifying climate change[11].

Soil fertility – a reliance on artificial fertilisers is both incompatible with climate change targets, but also exposes food production to resource depletion, especially phosphorous, oil and gas[12]. Furthermore, by applying artificial fertilisers soil carbon levels can fall further through lack of organic matter and reduced soil microbial activity[13].

Offsets – imported products for agriculture are a source of significant GHG emissions[14]. For example, imported soy grown on land cleared from rainforest (e.g. Brazil) could be substituted to a large degree by forage from carbon rich soils in the UK.

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1 www.CO2now.org
2 *IPCC AR5 synthesis report* http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPMcorr2.pdf
3 *Agriculture Industry: UK Greenhouse Gas Action Plan* http://www.ahdb.org.uk/projects/documents/GHGAPDeliveryPlan04April2011_000.pdf
4 *How low can we go?*, Audsley et al, FCRN (2009)
5 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)
6 *Greenhouse gas mitigation potential in agriculture*, Smith, P. et al, Royal Society (2007)
7 *Climate Change Act*, 2008 http://www.legislation.gov.uk/ukpga/2008/27/contents
8 *Agriculture Industry: UK Greenhouse Gas Action Plan* http://www.ahdb.org.uk/projects/documents/GHGAPDeliveryPlan04April2011_000.pdf
9 *Soil fertility and fertility use efficiency*, Bradshaw T. http://www.nuffieldinternational.org/rep_pdf/1341908377Bradshaw-Tom_edited-report-for-2011-for-publishing.pdf
10 UK Soil degradation http://www.parliament.uk/briefing-papers/POST-PN-265/uk-soil-degradation-july-2006
11 *IPCC AR5 synthesis report* http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_SPMcorr2.pdf
12 *How low can we go?*, Audsley et al, FCRN (2009)
13 *Soil carbon and organic farming*, Azeez, Soil Association (2009)
14 *How low can we go?*, Audsley et al, FCRN (2009)

National asset – healthy and fertile soils are one of the nation's greatest assets.

Society and landscapes

Food - soils with higher carbon levels produce food with higher nutrient density[15], and those with higher biological activity produce food with higher trace element levels[16]. Food quality, in terms of nutrient density and pesticide toxicity is lower now than before widespread industrialised agriculture[17]. Furthermore, food security is improved by increasing soil carbon levels[18].

Water – in soils with higher carbon levels (especially when combined with cover cropping) water quality is improved[19], water holding capacity is increased substantially[2021], drought resistance is better, soil erosion is reduced, water courses have less sedimentation and the risk of flooding is also reduced[2223].

Biodiversity – below soil biodiversity, in carbon rich soils, is far higher than soils with low carbon levels[24]. As soil underpins the farmland ecosystem, biodiversity above ground is also likely to be higher[25]. Furthermore, an approach to farm management that considers more than just yields would also likely result in better management of hedges, woodland and non-cropping areas on farm, all of which are valuable and long-term carbon stores. The well-being of people who experience wildlife from farms is improved.

Farm level

Soil quality – low soil organic matter (carbon) levels leads to compaction, waterlogging and drought. Higher soil carbon levels makes soils more workable, which in turn reduces the power required for cultivations and also reduces weed burdens[2627]. Organic matter has very positive impacts on soil structure, fertility and workabilty[28].

Soil fertility - good soil carbon levels produce good soils, with good fertility levels[2930]

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15 *The benefits to agriculture and the environment of rebuilding soil carbon,* Richmond, R. http://www.nuffieldinternational.org/rep_pdf/1341667362Rob-Richmond-edited-revised-report-2011-for-publishing.pdf

16 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

17 Organic farming, food quality and human health

18 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)

19 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)

20 *Are mob grazed cattle the perfect arable break?*, Chapman, T. http://www.nuffieldinternational.org/rep_pdf/1348746792Tom-Chapman-2011-report_.pdf

21 *Carbon and Catchments,* Jones, C. http://www.amazingcarbon.com/PDF/JONES-Carbon&Catchments%28Nov06%29.pdf

22 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

23 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)

24 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

25 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

26 *The benefits to agriculture and the environment of rebuilding soil carbon,* Richmond, R. http://www.nuffieldinternational.org/rep_pdf/1341667362Rob-Richmond-edited-revised-report-2011-for-publishing.pdf

27 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

28 *The benefits to agriculture and the environment of rebuilding soil carbon,* Richmond, R. http://www.nuffieldinternational.org/rep_pdf/1341667362Rob-Richmond-edited-revised-report-2011-for-publishing.pdf

29 *Are mob grazed cattle the perfect arable break?*, Chapman, T. http://www.nuffieldinternational.org/rep_pdf/1348746792Tom-Chapman-2011-report_.pdf

30 *Soil carbon and organic farming,* Azeez, Soil Association (2009)

Lower inputs of artificial fertilisers are needed if soil carbon levels are elevated[31]; therefore farmers save costs and reduce their GHG emissions significantly. For example one tonne of ammonium nitrate creates over 7 tonnes of CO2e in production and application[32].
Profitability – costs are reduced through lower inputs of bought-in fertilisers, lower cultivation costs and weed burdens and a reduced need for irrigation. Meanwhile income can be increased through better fertility levels and water availability, and therefore productivity[33], with a possible future subsidy payment for carbon sequestration[34].

Policy context

A large reduction in GHGs from agriculture needed
The Agriculture GHG Action Plan aims to cut UK agricultural GHGs by 3 million tonnes by 2020. Wider targets of 80% GHG reduction by 2050 has been laid down by the UK Government; agriculture needs to play its part.

UK farm land has low soil organic matter levels
On UK arable soils between 1980 and 1995 18% of SOM was lost[35]. The negative trend in soil quality should be of great concern to all farmers and society as a whole.

Information levels are inadequate
To enact change, farmers and growers require access to straight forward information, independently produced and practically focussed. There is a severe lack of such information on soil carbon aimed at UK farmers and growers.

No organisations doing this work in UK
"Communicating carbon sequestering practices to farmers and incentivising their uptake" was an area identified as of critical importance by a FCRN group discussion in 2010[36]. Yet, despite increased interest in this area in the past five years, no organisation has emerged to take information forward to farmers in an accessible way.

Sequestration essential
Whilst essential, a reduction in GHGs will not be enough to get atmospheric CO2 levels back to 350 parts per million (ppm), a level that climate scientists believe is a level required to avert severe climate change impacts[37].
Therefore carbon sequestration is essential; farming and forestry only the only two main industries in the country that can achieve biological sequestration on any significant scale. Indeed it could contribute as much as a 50ppm draw down of atmospheric CO2 by 2100[38].

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31 *The role, analysis and management of soil life and organic matter in soil health, crop nutrition and productivity*,Watson et al, IOTA (2009)
32 Farm Carbon Calculator http://cffcarboncalculator.org.uk/
33 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)
34 *Zero Carbon Britain 2030* http://www.zerocarbonbritain.com/
35 *Soil fertility and fertility use efficiency*, Bradshaw T. http://www.nuffieldinternational.org/rep_pdf/1341908377Bradshaw-Tom_edited-report-for-2011-for-publishing.pdf
36 *Soil carbon sequestration workshop:Summary of discussion*, Food and Climate Research Network (2010)
37 http://350.org/
38 *Agriculture and Climate Change: The potential for carbon sequestration*, Lal, R., International Food Policy and Research Institute (2009)

Supportive quotes

“Agriculture and other land management practices have a positive role to play in climate change mitigation because there is significant potential to remove CO2 from the atmosphere by the process of photosynthesis and storage as living biomass (vegetation) or as soil organic matter (carbon sequestration)”

Agriculture Industry UK GHG Action Plan

“The technical potential of carbon sequestration in world soils may be 2 billion to 3 billion mt per year for the next 50 years. Thus, the potential of carbon sequestration in soils and vegetation together is equivalent to a draw-down of about 50 parts per million of atmospheric CO2 by 2100. ”

Rattan Lal, Director of the School of Environment and Natural Resources, Ohio State University

“In summary increasing soil carbon levels improves soil structure, makes it less prone to erosion, easier to work and reduces problematic weed pressure.”

Rob Richmond, dairy farmer and Nuffield Scholar

“As the organic matter rises and the soil becomes more fertile, the land grows more forage and stocking rates – the total carrying capacity of the land – increase.”

Tom Chapman, Nuffield Scholar

“Increasing soil carbon can significantly improve levels of biological activity, nutrient cycling, aggregate stability, resistance to erosion and ultimately biodiversity, productivity and profitability. Improvements in soil carbon levels can also reduce the impact of dryland salinity, virtually eliminate sedimentation in rivers and streams, vastly improve water quality and restore perennial streamflow.”

Christine Jones, Amazing Carbon

“ The soil carbon sequestration potential is large and deserves to be incorporated into the post-Kyoto regime.”

The carbon sequestration potential in agricultural soils

“The status of farmers and land managers in societies will be enhanced as their responsibility as stewards for a stable climate is recognized and rewarded. And society will reconnect in a new way with its ancient roots in the cultivation of land for food.”

Mitigating climate change through food and land use, Worldwatch report 179

“Certainly the first thing you can say is that the single best thing you can do for soil is to increase soil organic matter. That’s the best thing you can do. And any way that you can do that is going to benefit soils.”

Tom Thompson