Agroecology as a tool to cool the planet

Early results of Farm Carbon Calculator measurements on Peri-Urban farms

Farm Carbon Calculator

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Exploratory measurements of carbon emissions and removals were calculated by seven agroecological market gardens as part of research into the role of agroecological food production in delivering health and net zero. Although further research is required, with a much larger sample over a longer time period, early results suggest that such farms are able to sequester carbon while also producing high quality fresh produce and providing valuable opportunities for health generating public engagement.

About Pathways for an Agroecological Urbanism (PAU)

Pathways for an Agroecological Urbanism (PAU) and the Farm Carbon Calculator (FCC)

PAU was a one year scoping study funded by Agrifood for Net Zero (2024-25). It brought together the organisations Centre for Agroecology Water and Resilience at Coventry University, Urban Agriculture Consortium, the Permaculture Association and Landworkers' Alliance. They worked with 10 agroecological projects to identify the benefits of agroecology and the institutional barriers to its wider adoption. The Farm Carbon Calculator was used as a tool to measure the balance between carbon emissions and removals at seven of the ten agroecological projects.

Agroecological Actors in Bristol and Leeds

The PAU project involved five 'Agroecological Actors' (AAs) in each of the two city regions of Bristol and Leeds. In Bristol, four AAs were either peri-urban market gardens or organic farms in the rural hinterland. One AA was a community kitchen, using produce from agroecological farms around Bristol to provide meal packs and cooking classes for vulnerable young adults. In Leeds, two AAs were market gardens located on city farms, one was an urban mushroom farm, one was an organic farm in the rural hinterland of Leeds and one was a fruit growing project, utilising land across the Leeds area. Only seven of the nine farms took up the opportunity to use the Farm Carbon Calculator.

An indication of potential

Four out of the seven AAs showed their carbon removals to be greater than their emissions. For simplicity, we have only shown the four best results in the infographics in order to show the levels of carbon sequestration that are possible when agroecological, organic, nature friendly, soil-building and permaculture principles are applied.

Comparison with large scale, conventional horticulture

Unfortunately it was not possible to find results from large scale, conventional vegetable production with which to make an accurate comparison. Field scale production often occurs on rented land scattered between different farms and is highly specialised, compared with the broad range of crops produced by agroecological growers. The only comparative figures it was possible to obtain were for brassica production. The average CO2e emissions/tonne of yield for conventional brassicas was 0.31, whereas the average CO2e/tonne yield for the seven agroecological farms in PAU was -3.93. However the variations between how the different farms applied the FCC mean this figure should be used cautiously.

The value of further research

While these results are of limited value, they suggest that FCC is a useful tool for quantifying carbon balance. Repeating this work with a larger sample of growers would provide a more robust set of results. Furthermore, repeated FCC measurements every 3-5 years will enable land managers to monitor carbon dynamics. Guided by the results, adjustments can be made to improve carbon removals and climate resilience in response to changing conditions.

Agroecology as a tool for cooling the planet

PATHWAYS FOR AN AGROECOLOGICAL URBANISM (PAU)*

Results for all seven PAU Farms and details on the use of the FCC

Limitations of Methodology

The scope of this study meant it was only possible to undertake single sets of soil samples, rather than the full programme of soil testing that would provide more accurate results. Hence, these results are a suggestion of potential CO2e removals, rather than the outcome of a full study of carbon removals. Furthermore, variations in how the FCC was applied mean the headline results hide a level of complexity that the infographic cannot reflect. We share the results of all seven farms in the table below, together with explanations about why the results are so varied.

Variations, diversity and low carbon choices

Results varied based on whether the FCC was applied to the whole farm, or just a market garden within a farm. This determined whether carbon removals by woodland, hedgerows and field margins on the wider farm were included, significantly improving carbon sequestration potential.

Other practices, such as crop type or the import of woodchips, contributed to carbon emissions, meaning that these farms performed less well than the others. For example, one participant is producing gourmet mushrooms on a straw based substrate. As mushrooms respire in the dark and don't photosynthesise, they are net emitters, making it hard to compare them with other vegetable crops. The import of woodchip, for use on paths and then, when composted, on beds, is counted as a carbon emitting action, due to the carbon released in chipping wood, transporting it to site and when it decomposes. However, alternative path materials or soluble nitrate fertiliser (the manufacture and emissions from which emit greenhouse gases), which might replace the woodchip compost used for soil fertility, would result in higher CO2e emissions.

A summary of the results for all seven farms is shown in the table below.

Tonnes	Carbon emissions	Carbon removals	Balance (calc. here)	Notes explaining key differences in results
Bristol				
Lush Greens	6.79	-4.02	2.77	Woodchip imports counted as carbon emissions, so therefore prevented the farm being seen as carbon negative.
Sims Hill	31.87	-56.45	-24.58	Whole farm audited
The Community Farm	15.2	-35.19	-19.99	Whole farm audited
Three Hares	19.71	-52.05	-32.34	Whole farm audited
Leeds				
Kirkstall Valley Farm	11.22	11.37	-0.15	Only market garden audited
The Mushroom Emporium	5.98	0	5.98	Mushrooms respire without photo-synthesising, hence no sequestration
Meanwood Valley Urban Farm	6.46	-4.1	2.36	Only market garden audited

Best results from Farm Carbon Calculator data

The Farm Carbon Calculator is a tool for comparing how different types of agriculture can impact the climate, based on amounts of CO^2 and other greenhouse gases being emitted and removed.

Farm Carbon Calculator

Here are the Farm Carbon Calculator (FCC) results for four agroecological farms and a brief description of the farms.

See overleaf for a full picture of the results from all seven farms, the complexities of gathering data from diverse contexts, and explanations of some of the terms.

PROFILES

KEY

Sims Hill Shared Harvest CSA
North Bristol
3 acres, 3 part time growers. Weekly boxes for 160 members. Growing, cooking and nature connection with diverse volunteers and groups. Offers veg for help (workshare scheme). Permaculture and non-certified organic / natural methods.

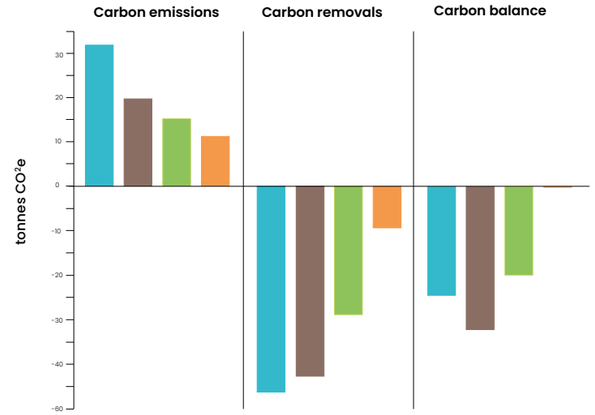
Three Hares Farm
Winford, Bristol
A 2.5 acre market garden, a walnut tree orchard, flower nursery and meadow, all on a 37 acre farm. 3 part time growers, supplying shops, restaurants and 40 weekly veg boxes. Certified Organic.

The Community Farm
Chew Valley, North Somerset
9.15 acre market garden on a 13 acre farm, 4 growers, 600 weekly veg boxes to households (including produce from other farms). Offers nature connection, events, training and volunteering. Certified Organic.

Kirkstall Valley CSA
Leeds
3.5 acres, 2 growers, 130 member shares, volunteering, school visits, produce and events for less privileged communities. Chemical-free and natural methods. Sliding scale (cost) and trial options for members.

Emissions, removals, balance (tonnes CO^2e)

Preliminary testing suggests that all four farms are removing more CO^2e than they emit while also producing food*



* These results were generated from a single organic matter sample from each farm. A more detailed programme of soil testing is necessary to verify these results (please see notes on p6 for more details)

Details of emissions and removals (tonnes CO^2e)

Emissions				
Fuels	1.58	3.91	0.7	0.62
Materials	4.25	0.28	8.45	0.15
Capital purchases	0	8.72	0	8.9
Crops	1.26	2.29	1.17	1.54
Waste disposal	0	0	0	0.01
Land use	24.76	0	9.38	0
Distribution	0	0	0	0
Processing	0.02	0	0	0
Total Emissions	**31.87**	**15.2**	**19.71**	**11.22**
Removals				
Trees (e.g. woodland, agroforestry, in field trees)	-29.93	0	17.45	0
Countryside Stewardship	0	0	-14.62	0
Field margins (uncultivated)	-2.02	0	0	
Hedgerows	-1.67	-7.5	-14.74	0
Perennial crops	-0.03	0	-5.24	0
Soil organic carbon	-22.8	-27.69	0	-11.37
Total removals	**-56.45**	**-35.19**	**-52.05**	**-11.37**
Carbon Balance	**-24.58**	**-19.99**	**-32.34**	**-0.15**

What is CO^2e? CO^2e means tonnes of carbon dioxide equivalent. It is used to standardise the impact on the climate of different kinds of greenhouse gases that are emitted (e.g methane, nitrous oxide) making the overall climate impact of a farm easier to assess.

- / + numbers: Positive numbers mean CO^2 emitted into the atmosphere, negative numbers mean CO^2 removed from the atmosphere

AFN Network+

An explanation of method and terms

The Farm Carbon Calculator (FCC) has been designed for farmers to monitor the carbon dynamics of their farm over time. The best results come from using it every 3-5 years to measure changes in CO2e emissions and removals resulting from alterations to farm management. In PAU, the participating growers just used the FCC once. Instead of having "baseline" soil organic matter (SOM) and soil bulk density (SBD) measurements from 3-5 years ago, they had to test soil of the same soil type on land adjacent to their cultivation plots as a proxy. A repeat of this exercise every 3-5 years, would provide results reflecting actual changes in soil carbon, indicated by measurements of SOM and SBD.

The FCC works by providing a standardised audit of all the inputs, outputs and soil carbon processes occurring on the farm as a result of the way it is managed. Emissions are based on data modelled for all the inputs (fuels, inventory of machinery, infrastructure etc) and outputs, such as crops (eaten or decomposed) and waste, as well as land use change, such as cultivating permanent pasture. Removals include the sequestration achieved by the growth of trees, hedgerows and perennial crops, as well as soil carbon storage in the grassland leys and field margins encouraged by Countryside Stewardship. Removals also rely on modelled data to convert the figures for land use (e.g. areas of woodland, field margins, hedgerows) into tonnes of carbon removed. The only direct measurements the farmer is required to provide are soil test results for Soil Organic Matter (SOM) and Soil Bulk Density (SBD).

The Contribution of Soil Organic Carbon to a Farm's Carbon Balance

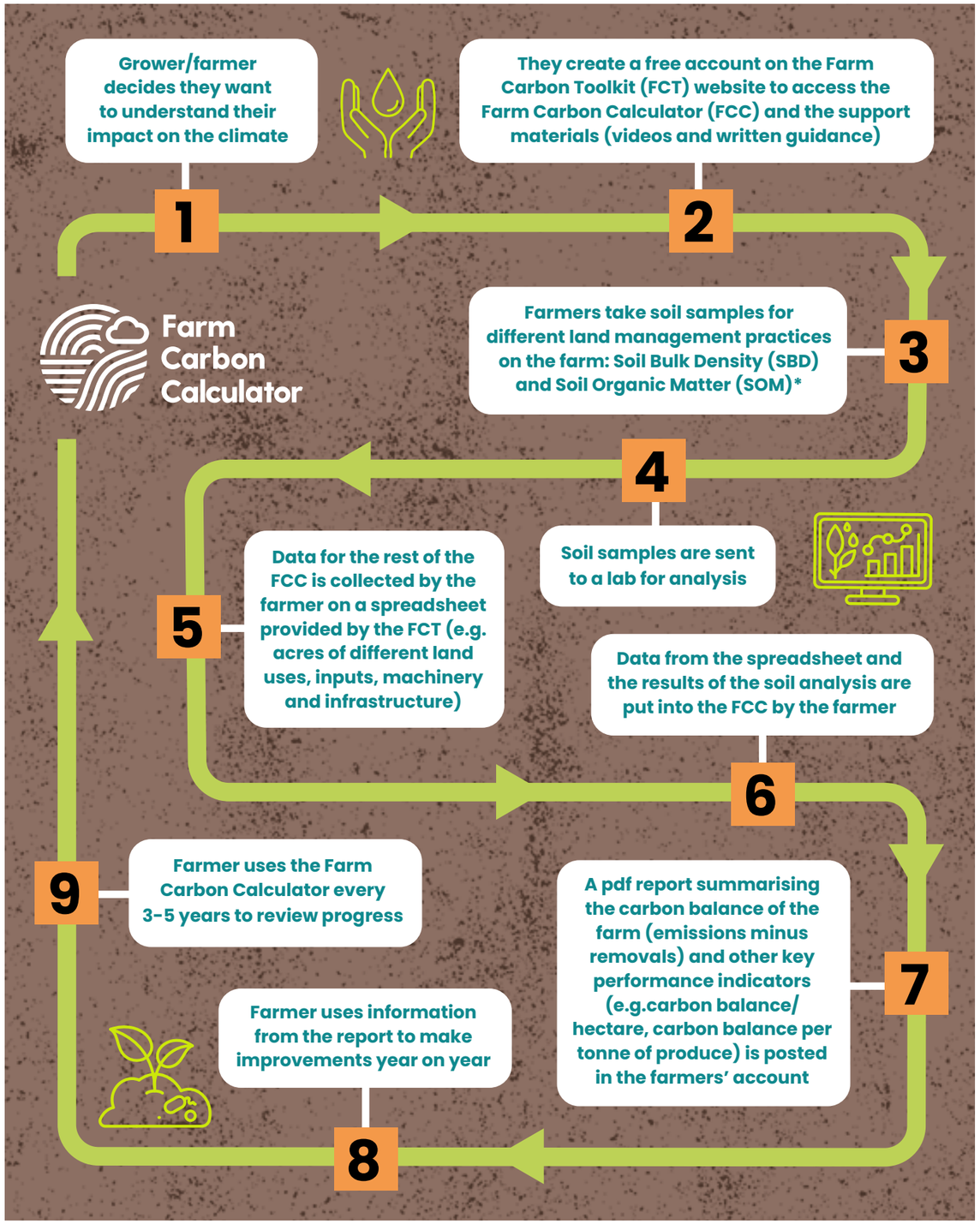
As noted on page 2 and above, the results shown in these infographics were calculated using only a single soil organic matter sample for each farm. To provide more accurate results, multiple soil organic matter samples would be taken over several years. The results shown here are therefore only a suggestion of potential removals rather than being the result of a full study of removals through soil carbon sequestration. We have therefore recalculated the results excluding the soil organic carbon as one element of removals in the table below, to find out what each farms' carbon balance is without this contribution. While soil organic carbon measurements clearly make a contribution to whether or not a farm is carbon negative or positive, even excluding soil organic carbon measurements, two out of the seven farms were carbon negative. These results suggest the value of further research to investigate the contribution of agroecological food production to carbon sequestration at the same time as producing high quality, healthy local food, opportunities for public engagement, biodiversity and other benefits.

	Carbon balance when soil organic carbon measurement included			Carbon balance when soil organic carbon measurement excluded		
Tonnes	**Carbon emissions**	**Carbon removals**	**Balance**	**Carbon emissions**	**Carbon removals**	**Balance**
Bristol						
Lush Greens	6.79	-4.02	2.77	6.79	-1.22	5.57
Sims Hill	31.87	-56.45	-24.58	31.87	-33.65	-1.78
The Community Farm	15.2	-35.19	-19.99	15.2	-7.5	7.7
Three Hares	19.71	-52.05	-32.34	19.71	-52.05	-32.34
Leeds						
Kirkstall Valley Farm	11.22	11.37	-0.15	11.22	0	11.22
The Mushroom Emporium	5.98	0	5.98	5.98	0	5.98
Meanwood Valley Urban Farm	6.46	-4.1	2.36	6.46	-0.52	5.94

How does the process work?

USING THE FARM CARBON CALCULATOR

Farm Carbon Calculator



*Ideally baseline soil sampling and analysis would have been undertaken 3-5 years before in the same places to give a point of comparison. Where this hadn't happened, samples from an adjacent field with the same soil type, being managed as the land was before being a market garden, were used as a proxy).

The Farm Carbon Calculator measurements in this booklet were undertaken as part of a larger project entitled, 'Agroecological food production for health and net-zero: Exploring implementation pathways for an agroecological urbanism' (PAU - Pathways for an Agroecological Urbanism). It was funded by UKRI via the Agrifood 4 Net Zero programme administered by the Agrifood Network and was a collaboration between Centre for Agroecology Water and Resilience at Coventry University, Landworkers' Alliance, the Permaculture Association and Urban Agriculture Consortium.

Laughton, R., Longhurst, M., Goldring, A. and Tornaghi, C. (2026). Agroecology as a Tool to Cool the Planet: Early results of Farm Carbon Calculator measurements on Peri-Urban Farms. Infographic booklet. Agrifood 4 Net Zero and Landworkers' Alliance.

For further information about PAU, please visit:

https://www.agrifood4netzero.net/funding/funded-projects/funded-scoping-study-projects/agroecological-food-production-for-health-and-net-zero-exploring-implementation-pathways-for-an-agroecological-urbanism/ and https://landworkersalliance.org.uk/pau-pathways-for-an-agroecological-urbanism/

If you are a farmer or grower, and eager to get started on measuring your farm's carbon balance, please visit https://farmcarbontoolkit.org.uk/ and follow the link to the Carbon Calculator. We would love to hear about your results!

The Landworker's Alliance is seeking funding to support a larger sample of agroecological market gardens and farms to measure their carbon footprint using the Farm Carbon Calculator.
To find out more, please contact rebecca.laughton@landworkersalliance.org.uk

FUNDING: This work was funded by UKRI/EPSRC (project Agrifood4NetZero, Grant number EP/X011062/1), via the University of the West of England, through a scoping grant to Coventry University (AFN24/ No. 8512502) for the project titled "Agroecological food production for health and net-zero: exploring implementation pathways for an agroecological urbanism" (PAU).