CENTRE FOR HIGH CARBON CAPTURE CROPPING

# INSIGHTS

**The newsletter of the Centre for High Carbon Capture Cropping** **September 2025**


| Editorial | Research in Focus | News from the Hub | Meet the Partners | Meet the grower | Get involved |
|---|---|---|---|---|---|
| Page 2 | Page 4 | Page 9 | Page 12 | Page 13 | Page 15 |


## Stuart Knight, Niab, CHCx3 Knowledge Hub Leader

***Welcome to the fifth edition of CHCx3 Insights, the newsletter of the Centre for High Carbon Capture Cropping, or 'CHCx3' for short.***

With nearly 70 million people and a UK land area of c. 24 million hectares, ensuring that there is enough space for nature, water, and carbon capture, as well as all the infrastructure, housing, and food required by a rising population, will be an increasing challenge.

Back in January 2025 the Government launched a consultation on its vision for land use in England, and how to deliver it within a Land Use Framework. The consultation, which closed on 25 April, sought views on the types and scale of land use change that might be needed to meet environmental and climate targets, while also delivering new infrastructure and housing, and maintaining food production.

Meanwhile on 26 February the Climate Change Committee published its statutory report providing advice to the UK Government on the recommended level of the Seventh Carbon Budget (2038 to 2042). Nature-based measures such as planting new woodland and restoring peatlands, and energy crops, were identified as being integral to increasing land-based carbon sequestration, and to offsetting the residual emissions from the combined agriculture and land use sectors by 2050.

In addition to producing enough food, the need for multifunctional land use is clear. The cropping options within CHCx3 can undoubtedly help achieve this, enabling increased carbon capture, a diversified farm environment, and an enhanced supply of home-grown forage for livestock, bioenergy and biomaterials. See our articles in News from the Hub for more on these developments.

There are many ways to engage with the CHCx3 research and Partners, including free events, and information and resources on www.carboncapturecropping.com to support productive carbon capture cropping. If you are interested in getting more involved in CHCx3 or have a suggestion as to how else we can help, please do get in touch. Our contact details are provided on the last page of this newsletter.

In this edition of Insights, Lydia Smith, Niab CHCx3 Project Lead gives her viewpoint on the challenging weather for carbon capture cropping over the past year. Helen Shiels describes progress with the Value Chains research. In 'News from the Hub' we highlight new developments from CHCx3 and elsewhere. We hear from CHCx3 partners Bitrez and Rothamsted Research about their work and aspirations for carbon capture cropping, and from flax grower Andrew Stephenson.

# Editorial

**Dr Lydia Smith, Niab, Project Lead**

## *Unusual conditions in 2025 underline the need for trials*

Surely no one connected to farming needs to be told how difficult the weather has been over the last 12 months. Wet conditions over-winter followed by drought in most parts of the country after about March have been incredibly difficult for almost any crop; “challenging” doesn’t even cover it. We have, for example, seen fields that remained bare all summer in parts of Oxfordshire. Of course there was variation across the UK. In the North Cotswolds, there was 300mm of rain in the 6 months from January, but over 90% of that was before the beginning of March. A shower in mid-May was followed by very few brief showers right up until July 22nd when there was the first substantial rain. In Cambridgeshire at Niab, a less extreme story was seen; with 85mm in Jan-Feb, 7mm in March, 48mm Apr-May and so far 33mm in July.

For the fibre crops featured in CHCx3, this has resulted in a very variable outcome. Flax, which is drilled Mar-early Apr, prospered better in some regions. In Scotland it is healthy; its deep fibrous root system was able to access the lower soil horizons, but in Cambridgeshire and especially Oxfordshire and East Yorkshire where the drought started earlier and lasted longer at least one trial has been abandoned and the crop is very short elsewhere. Hemp has also suffered. The later, mid-May drill date has really impacted establishment with Oxfordshire plantings, in particular, being slow to establish. Conversely, our collaborating farm on fenland soil, with a relatively high water table is again showing its suitability for this crop; accessing water reserves via the deep tap roots.

In herbal ley trials, the outcomes across the country are both as expected and unexpected! Deep rooting perennial leys, containing both legumes and herbs alongside forage grasses would be expected to perform better than a simple grass-dominated mix during drought, and that was clearly documented in biomass assessments. The high biomass and healthy growth in the lamb finishing ley, however, was especially productive in comparison to all other leys. This simple mixture contains just legumes, chicory and ribgrass. Below ground biomass was also good.

Image: Lamb finishing mix containing chicory, red clover, white clover and plantain at Hinxton, Cambridgeshire.

## Viewpoint continued...

Image: Simple grass-dominated mix with clover herbal ley mixture at Hinxton, Cambridgeshire.

Our cover crop trials also threw up unexpected results. We tried a range of drilling dates combined with seed rates; based on the hypothesis that a slightly raised seed rate could offset the reduced biomass production following a later planting date. Unfortunately, this strategy had the opposite outcome, with interplant competition, exacerbated by herbivore predation, resulting in a lower biomass from the higher seed rates. This may have been impacted by the very cold wet soil conditions encountered in the late winter- early spring 2025.

Next issue we will consider value chains and fibre processing in more detail, but we're delighted to announce that IndiNature, who manufacture various biobased (especially hemp-fibre) C-neutral insulation and construction industry components won the prestigious 'Manufacturer of the Year' at the 2025 UK Green Business Awards; up against very stiff competition. IndiNature, also recently won BBA accreditation for their products.

## CHCx3 Research in Focus

***Research delivered through the Biorenewables Development Centre, University of York and Lucid Insight***

**Helen Shiels**

***Business Partnerships Manager, at the BDC***

**Professor Peter Ball**

***Chair of Operations Management at the University of York's School of Business and Society***

**Lukie Tolhurst**

***Director at Lucid Insight and BDC associate***

Developing value chain models for low-carbon crops to products requires evaluating the activities and processes that transform sustainably cultivated, low-carbon crops into industrial and consumer products, that ideally lock up the carbon during use and end-of- life. In developing these models, we can help processors and product developers identify where they can improve on their environmental sustainability measures and adopt lower carbon innovations for climate-smart product development. The focus of our CHCx3 value chain modelling is from farm gate to end-of-life for a range of cropping systems - cover crops, herbal leys and perennial crops, fibre crops and perennial biomass crops.

Crop to product value chains can be broken down into six key stages, with each segment representing value addition from raw materials to final product. Our team's focus is not so much the cultivation and harvesting - this is covered by other project partners, who are developing the Envirocrops calculator tool - but the activities beyond the farm gate, from - primary and secondary processing, manufacturing and product development, packaging and distribution and circular end of life journey.

There are common themes that cut across these value chain segments, which are also being addressed through our project partners -

- Research and development to advance yields and climate adapted varieties
- Policy and regulation to support the uptake of lower carbon crops
- Technology advancements to improve the pre-treatment and processing of biomass and fibres
- Training and knowledge sharing between growers and processors
- Quality standards for a range of end uses, including fire and water resistance and certification for life cycle analysis.

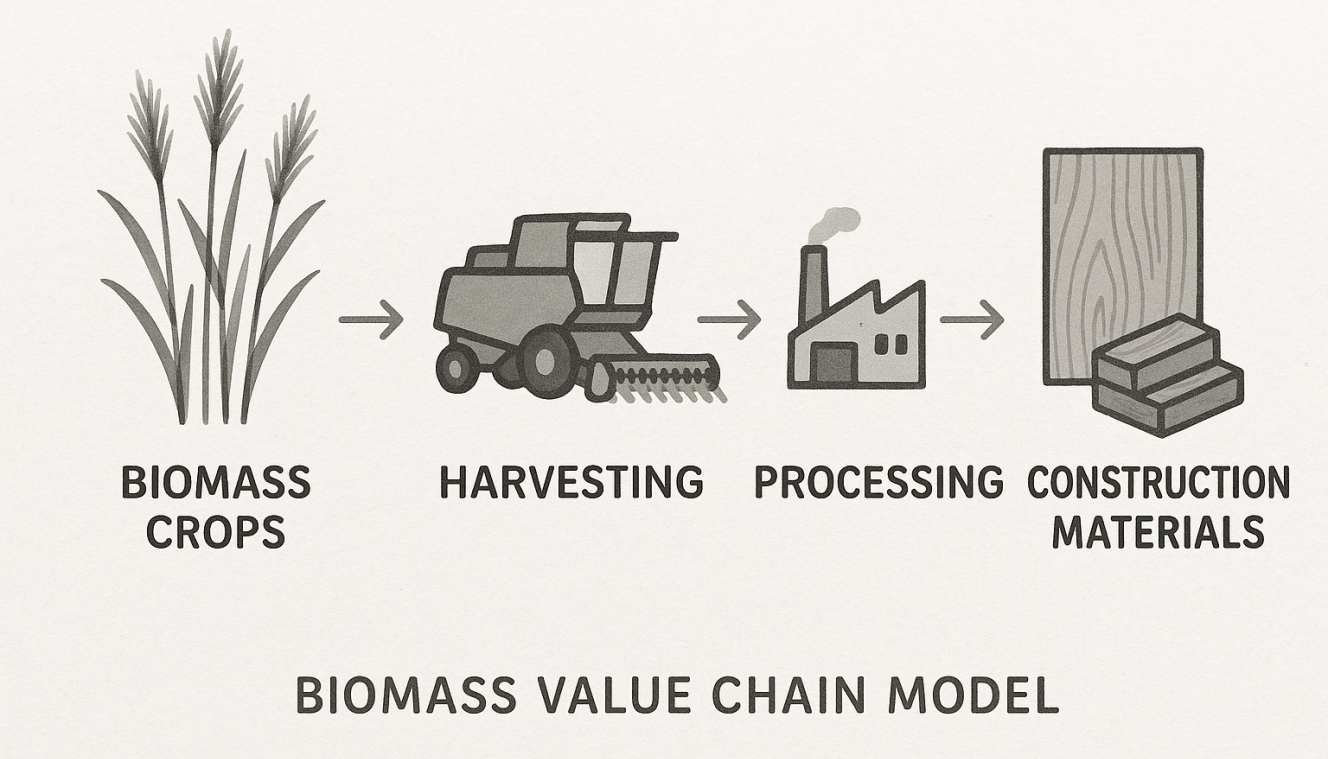



Image: A basic biomass value chain model

Our team's work also includes the development of an Environmental Performance Decision and Guidance Tool that will help guide product manufacturers to the best available environmental and carbon analytical tools for their product and consumer needs. The intention is to publish this tool alongside the Envirocrops calculator tool, to provide an easy to access and seamless set of decision and guidance tools for the farmer and product manufacturer.

We welcome your enquiries and suggestions to help us develop the most useful set of models and tools - please get in touch through our CHCx3 project website www.carboncapturecropping.com or directly through Biorenewables@york.ac.uk.

# How much value do you place on soil organic amendments?

*Ian Shield, Rothamsted Research*

In 2017 Rothamsted Research began a pair of parallel experimental field platforms for research around Regenerative Agriculture. One on the sandy loam soil at Broom's Barn in Suffolk and one on the silty clay loam at Harpenden in Hertfordshire. The sites include all combinations of crop rotation (3, 5 & 7 year), cultivation (inversion and direct drill), crop management (conventional and "novel") and soil amendments.

Image: The Harpenden site in spring

The CHCx3 project is focusing on the soil amendment aspect of the platform. The design is using a systems approach, the effect of growing an over-winter cover crop cannot be separated from that of an accompanying compost application. The 3 year rotation is all autumn sown cropping so does not include cover crops. Compost is applied once every 3 years. In the 5 and 7 year rotations overwinter cover crops are grown before sowing spring crops in two years. Compost is applied in combination with cover crops in one year in the 5 year rotation and in both years in the 7 year rotation.

The compost is derived from household and municipal garden waste. It is applied at 30 t $ha^{-1}$ fresh weight in early autumn. Two cover crop mixes are used, a Simple mix of phacelia and black oat and a Complex mix of 3 brassicas, 2 legumes and black oat. Both mixes are sown at 35kg $ha^{-1}$ seed as early as possible in

the autumn. Some frost damage is usually evident before cover crop destruction with a herbicide (glyphosate) in late January. The cover crops are compared to Natural Regeneration in the in unseeded stubble.

The Complex cover crop mixture generally produces the greater above ground biomass in mid-winter. Both cover crops exceeding what grew from the Natural Regeneration from stubble. It should be noted that the Complex cover crop most probably benefits from some nutrition in the compost in all years sown, whereas the Simple cover crop only benefits in half of years sown and the Natural Regeneration not at all.

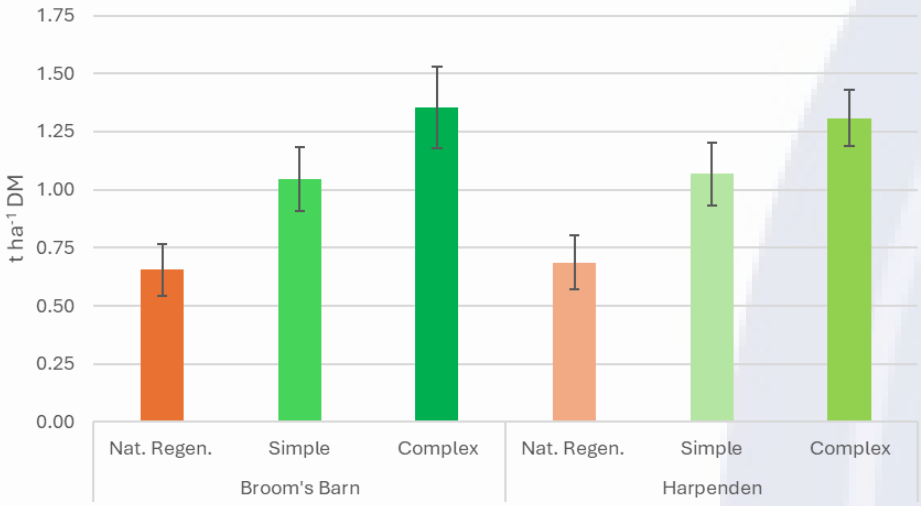
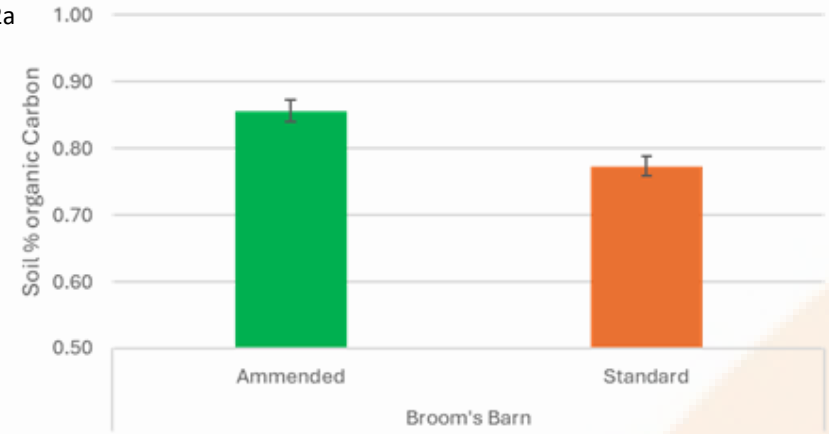



Figure 1: The cover crop biomass and green material results from mid-winter in tonnes per hectare. On the left, the results from Broom's Barn and on the right, Harpenden.

2a

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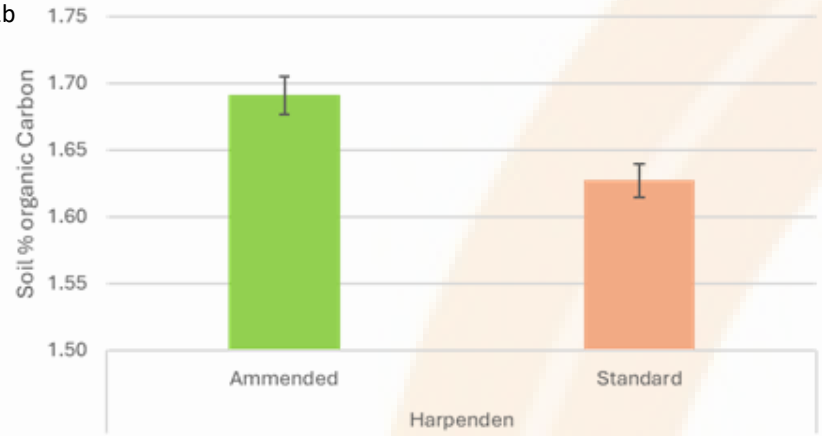


The effect of the soil amendment has been to raise the soil organic carbon, notably after only 3 years at Harpenden. The sandy loam soil at Broom's Barn is unable to accumulate and retain as much carbon as the silty clay at Harpenden. There were no effects of the soil amendment below

Figure 2a: Organic carbon (%) in the top 0-23cm of soil at Broom's Barn. Error bars are shown.

Figure 2b: Organic carbon (%) in the top 0-23cm of soil at Harpenden. Error bars are shown.

*Note different scale on Y axis. Broom's Barn data from year 6, Harpenden data from year 3 (year 6 being processed now). Soil organic matter = organic carbon x 1.724*

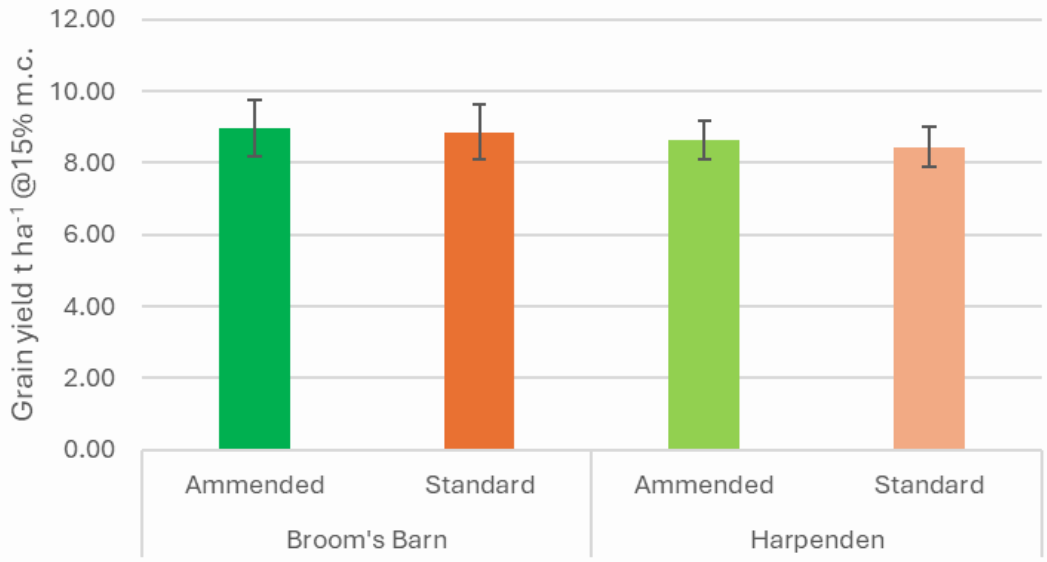


Figure 3: Winter wheat grain yield, tonnes per hectare. On the left, the results from Broom's Barn and on the right, Harpenden.

Winter wheat is the only crop common to all three crop rotations and is therefore considered the "test crop". Soil amendment is different across the rotations, however, there has been no effect on winter wheat yield. All spring barely crops follow the same soil amendment (compost and cover crop) and show a potential yield response at Broom's Barn (awaiting statistical analysis). Other crops; beans, linseed, oilseed rape and sugar beet, show no response so far. The additional yield at Broom's Barn has generally been associated with a slightly lower grain nitrogen content which has been important as all spring barley is grown for malting.

Assuming that both farms had successfully entered the Sustainable Farming Incentive (SFI) scheme they would receive £58 $ha^{-1}$ for leaving Natural Regeneration or undisturbed stubble overwinter (AHW6) and £129 $ha^{-1}$ for sowing the cover crops (SAM2). That leaves a £71 $ha^{-1}$ difference to account for seed and drilling. To achieve the additional 0.6 – 0.7 t $ha^{-1}$ of above ground dry matter indicated most probably requires the nutrition derived from the compost which costs very little, but delivery and spreading add further costs. After seven harvests the only potential financial return has been from spring barley at Broom's Barn. This platform is a long-term commitment, results may change in future years.

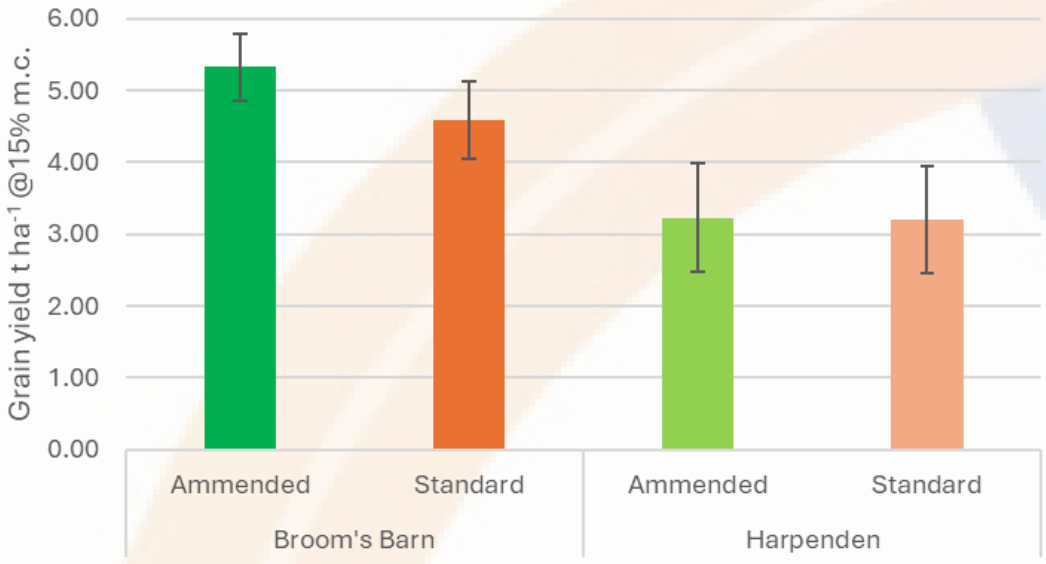


Figure 4: Spring barley grain yield, tonnes per hectare. On the left, the results from Broom's Barn and on the right, Harpenden.

# News From the Hub

## *Land use framework*

The UK Government has made a number of commitments to restore nature, support food production, improve climate resilience, reduce carbon emissions and deliver new infrastructure and housing. Collectively, these translate to growing demands upon a limited land area. England is still a predominantly rural country with 67% of its land classed as agricultural (38% arable and 29% grassland). As well as wildlife habitats, the land provides critical underpinning for the country's economy, with the associated natural capital generating an estimated annual flow of benefits, including food production, of £37bn.

To make space, land use changes are likely to be needed over the next 25 years. In early 2025, Defra carried out a consultation to seek views on the types and scale of land use changes that might be needed, as well as the actions that Government could take to support these. The responses will feed into a Land Use Framework for England that is expected to be published in summer 2025. The focus is on land use change (for example, from arable or grassland to non-agricultural uses such as energy production or supporting biodiversity) rather than how the land is managed (*e.g.*, conventional vs organic cropping), and at a national level not differences across a farm.

According to the Government's analysis, by 2050 about 9% of agricultural land will need to have changed to non-agricultural, dedicated to delivering environmental and climate benefits. 5% will need to be being farmed mainly for benefits other than food (*e.g.*, species-rich grassland habitats, responsibly managed peat, or short rotation coppice). 4% will need to be used for both food and environmental benefits, incorporating more trees alongside food production, with a further 1% of land with field margins or other small areas reserved for nature. However, the way each land use is managed, including fully agricultural land, will have a significant impact on the outcomes.

## *Willow set to replace peat in UK compost amid industry shift*

In response to the UK government's ban on retail bagged peat compost, manufacturers face the challenge of finding suitable alternatives. Research reveals that willow can replace up to 50% of peat without compromising seedling growth. Working alongside a leading compost manufacturer, ECC has tested willow wood chips as a replacement in compost blends, proving its viability in both composition and performance. The 50mm willow chip, traditionally used for biomass fuel, is adapted to meet the needs of compost production and has gained approval from national garden centres and DIY chains. While Homebase's unexpected closure in November 2024 impacted distribution, the seasonal nature of the retail compost market (April to September) offers an opportunity for willow as a sustainable peat alternative. This shift marks a significant growth opportunity for willow in the growing media sector, as demand for wood-based ingredients continues to rise.

Image: Willow wood chips

## *Miscanthus*

Miscanthus offers British farmers a growing opportunity to develop a domestic supply of sustainable biomass from agriculture, alongside and supporting profitable food production. In 2019, the National Farmers' Union of England and Wales (NFU) set out its ambition for agriculture to achieve a net zero contribution to climate change across the whole of agricultural production by 2040, focussed on three key themes or 'pillars' – recognising that the agricultural sector is almost uniquely both a source and a sink for greenhouse gas emissions, with the potential to make good use of the 75% of UK land area under farming.

Although progress on clean energy policy has slowed since the 2024 General Election, there are signs of a resurgence in demand for bioenergy. An industry-led GB Green Gas Taskforce is calling for more investment in biomethane production, and the rising 'Sustainable Aviation Fuel mandate' for low-carbon aviation fuel is likely to drive demand for biogenic $CO_2$ as a feedstock, alongside its use in geological sequestration of carbon. The emerging business framework and reporting standards for carbon capture are expected to replace historic subsidies and incentives for energy crop production, but a key NFU ask is for a stronger home-grown bioenergy supply chain to support the UK agricultural role in greenhouse gas removals.


Image: Harvesting miscanthus at Terravesta open day in February 2025

# News From the Hub

## *The HAUS project*

The HAUS project, delivered by Natural Building Systems for Installer SHOW 2025, offered a live demonstration of how biobased modular construction can achieve both exceptional performance and significantly lower environmental impact. Designed by IF_DO and built using our ADEPT® system—comprising UK-grown hemp, timber, and wood fibre—the HAUS was rapidly reassembled on-site to showcase circular construction in action.

A third-party Life Cycle Assessment (LCA) by One Click LCA validated the performance of the system. It confirmed a 24% reduction in fossil-based embodied carbon (Modules A1–A3) compared to the LETI *baseline* for UK new-build homes, despite the HAUS delivering 25–30% better thermal performance than typical new housing stock. Total cradle-to-gate emissions were calculated at 38.9 tonnes $CO_2e$, while the biobased materials used in the structure sequestered 46.5 tonnes of biogenic $CO_2$, resulting in a net carbon impact of –7.6 tonnes $CO_2e$.

Image: The HAUS under construction

This net-negative result highlights the untapped potential of construction crops and short-cycle biomass to actively reverse the environmental burden of buildings. By locking carbon into the fabric of the building using renewable, regenerative materials, and designing for disassembly and reuse, the ADEPT® system offers a scalable route to climate-positive construction.

The HAUS also reinforced the importance of product-specific Environmental Product Declarations (EPDs) and transparent digital traceability. Natural Building Systems is committed to growing the ecosystem of low-carbon, high-performance solutions needed to transform the built environment—starting not just with better buildings, but with better materials.


Image: The HAUS demonstration

# Meet the CHCx3 Partners

## Bitrez

### *Paul Jones and Wendy Howarth*

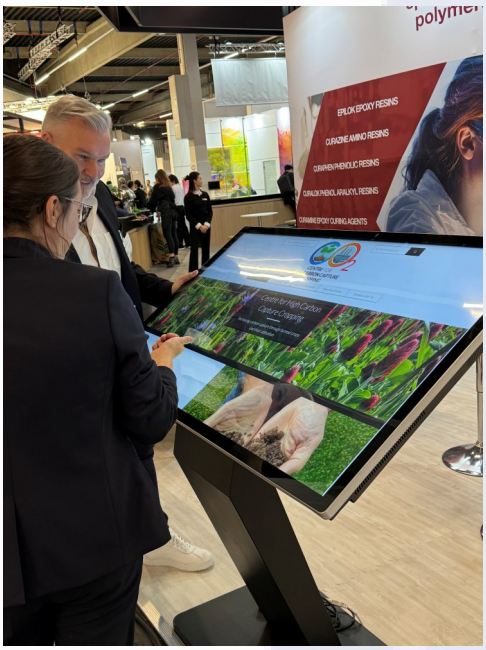


Image: Paul Jones and Wendy Howarth at The European Coating Show in Nuremberg, Germany, March 2025.

Bitrez is one of the UK's leading manufacturers of specialist polymers and chemicals. Established in 1982, we work with world class companies in over 25 countries and collaborate with research institutes and universities both in the UK and overseas. Our products are used in a broad range of markets including packaging, aerospace, automotive, rail, defence, nuclear, energy, heavy electrical, composites and general industries.

There is no question that the chemical sector recognises the importance of transitioning away from petrochemical raw material sources to sustainable feedstocks. This is just a part of the process and to be truly successful there needs to be a holistic approach taking into consideration numerous elements of extraction, recovery, usage, and ultimately the longevity of the resultant part or system that needs to be fit for purpose.

The composite sector has started to adopt some matrix systems derived from sustainable sources and they tend to have biogenic carbon contents between 25-50%. The origin of the feedstocks can sometimes be questioned when they may have an adverse impact on the environment in other respects. In addition, the industry has been looking at natural reinforcements as a replacement or partial replacement to conventional glass or carbon.

Bitrez see the CHCx3 project as being an almost perfect opportunity to address anthropogenic damage, with hemp offering an excellent agricultural option for carbon sequestration, a sustainable reinforcement, and potential source for natural feedstock to be employed as the basis of the matrix system.

This concept is not without challenge. Partners are working collectively to determine and provide evidence of the suitability of growing and harvesting hemp as part of the UK's agricultural framework. At Bitrez, we have initiated a series of research programs to look at the oil extracted from hemp. The fatty acid composition has been analysed with a view to undertake subsequent reactions to produce amido-amines and polyamides for use as an epoxy curative, although whilst yielding a polymer, the resultant products were deemed unsuitable. We have since initiated work to establish the level of unsaturation in the fatty acid chain and functionalise further to provide scope for improved cross-link density. The oils present are aliphatic and for composite parts it is more typical to have systems based on aromatic materials that offer greater structural integrity. Whilst wanting to use the feedstock for all the merit it provides in soil health, sequestering carbon and providing a natural reinforcement, we still need a polymer that cures to offer support to the composite part, and work continues.

# In the Field

## Reflections on Re-establishing Flax Production in Scotland

*Andrew Stevenson*

Location of the farm. East Scotland.

Farmer, Andrew Stevenson of Bonerbo Farm, and Mike Munro, Managing Director of ESG Natural Fibres Ltd (East of Scotland Growers) have been in the forefront of the redevelopment of Scotland Flax industry and are key members of the CHCX3 project, trialling a range of Flax Varieties in association with Elsoms Seeds Ltd. ESG was formed in 1986 and produces 3,000 Ha of Brassicas Alliums and Root Crops from its members land bank of 15,000Ha.

In 2021, with grower's margins coming under increasing pressure they looked at alternative crops which would perform well with their growers and where they could add value and hence improve the income of their members. In 2022, a small trial of hemp was carried out on two farms but it was a struggle to get the crop to ret sufficiently and the income generated was less than established cereal crops, so this did not seem like a viable new opportunity. In 2023, ESG took the opportunity to trial fibre flax growing 34Ha with 5 growers. The crop performed excellently in terms of growth and retting with end users in Holland, Belgium and France being impressed by the yields and quality of fibre produced. In 2024, the area was expanded with 14 growers drilling 350Ha split across 35 different fields. Locations ranged from the Coast at sea level to 700ft up to 50km inland on soil types varying from light sand/silt through to heavy clays.


Image: Andrew and Lydia at the farm in July 2025.

Harvesting the Flax for fibre is carried out by specialist machinery of which there was none in the UK. In the first year the group purchased a 42 year old puller, 2 x 30-year-old turners and a 10 year old baler to harvest the crop and get it safely in the shed. They then invested in more second hand and some new machinery for 2024 to enable them to support their growers in the larger area grown. There is/was no Govt financial support for doing this. Looking back on the last couple of years Mike and Andrew make the following comments on lessons learned so far from growing the crop.

**Seed Bed:** Ideally plough based to reduce compaction and to reduce weed pressure as there is little if any chemistry available to control weeds. Flax has a small seed so you need to produce a fine seed bed and must wait for soil temp and moisture to be sufficient (end March/early April) to enable the crop to get away rapidly.

**Rotation:** ESG have been using Flax as break crop after wheat and in advance of first wheats with the following crop benefitting from improvements in soil structure as with Linseed (which is "oil flax"). In 2025, following a flax crop, Andrew had a yield of 13.1 tonnes WW/ha as compared to 11.6 in a second wheat at the same farm (verified on the farm weigh-bridge).

**Soil Type:** The crop has struggled on heavier soils, and this can present a particular problem at harvest time when "pulling" the crop out of heavy soil to ensure good fibre yield and quality can be problematic.

**Retting:** You need moisture for the crop to ret and ESG have found that it can take anywhere from 2 weeks to 2 months for this to be completed. Obviously, the overall climate will have an impact but so will the aspect and location of the field. The impact of surrounding woodland should be considered because changes in light levels, temp and moisture can impact on consistency and timing of retting.

**Pigeons:** As with OSR and other crops, pigeons can be a real problem, and growers need to have a plan for reducing the risk and managing the problem.

**Gross Margin**: At the end of the day, you have to sell the crop. Currently, ESG and several other growers are exporting the relatively small amounts produced to processors in Holland, France and Belgium. For the crop to become a viable option for a wider range of growers, UK fibre processing facilities (scutching plants) with contracts with end markets must be created, which will require very significant investment.

Image: Retted, baled flax in the farm barn

# Get Involved

Contact us at **chcx3@niab.com**

Visit our web pages **carboncapturecropping.com**

Find out more from one of the CHCx3 Partners:

Niab, Biorenewables Development Centre, Bitrez, British Hemp Alliance, Cotswold Seeds, Crops for Energy, Elsoms Seeds, Energy Crops Consultancy, Farm Carbon Toolkit, FarmED, F C Palmer & Sons, National Farmers Union of England & Wales (NFU), Natural Building Systems, Northern Ireland Hemp Association, Rothamsted Research, Terravesta, UK Hempcrete, University of York, Unyte Hemp

## Forthcoming Events

| Date | Event | Location |
|---|---|---|
| 24 October 2025, 09:00—14:30 | **Agri-TechE Week** **How can agriculture help decarbonise supply chains?** | Sophi Taylor Building, Niab, Park Farm, Histon, Cambridge, CB24 9NZ |
| Autumn 2025 | **From fibre crop to building** | FarmED, Station Rd, Shipton-under-Wychwood, Chipping Norton OX7 6BJ |
| Autumn 2025 | **Cover crop farm walk** | Trial site location coming soon! |
| November 2025 | **Fibre crop breeding and trials** | Webinar |
| November 2025 | **Soil Carbon** | Webinar |
| Winter 2025 | **Cover crop trials and soil microbiology** | Webinar |
| Winter 2025 / Spring 2026 | **Willow in the field** | Coming soon! |


## Acknowledgements

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