CENTRE FOR HIGH CARBON CAPTURE CROPPING

INSIGHTS

The newsletter of the Centre of High Carbon Capture Cropping **July 2024**

Editorial: Grasping the nettle

Stuart Knight, NIAB, CHCx3 Knowledge Hub Leader

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

If anyone needs convincing of the threat posed by climate change, look no further than its impact on farming. According to Met Office figures, from October 2022 to March 2024, nearly 1,700mm of rain fell across England, making it the wettest 18-month period since records began in 1836. April and May 2024 similarly saw unusually high rainfall. According to the Agriculture and Horticulture Development Board (AHDB) Planting and Variety Survey, areas of wheat, winter barley (UK) and oilseed rape (GB) are down by 9,12 and 21% respectively on the year, although the area of spring barley (UK) is up 18%. With the poor conditions expected to reduce yields in many crops, this is a threat to our food security. The wet weather has also affected livestock health and feed availability.

Directly and indirectly, the crops we plant, and how we grow them, have a key role to play in targeting net zero greenhouse gas emissions, not just from agriculture but also industries that could use more of its outputs, such as construction. Meanwhile increasing farmland and cropping system resilience to extreme weather is an equal imperative. Whilst there is no silver bullet, deep rooted crops and increased soil organic matter can both contribute to improving soil structure and water infiltration. The cropping options that form part of the CHCx3 research can help to achieve this, as well as capturing more carbon and enhancing rotations.

In this edition of Insights, CHCx3 Project Lead Lydia Smith gives her viewpoint on the opportunities and challenges for annual fibre crops. In an interview, Jason Kam of Terravesta tells us how biomass crops could increase soil organic carbon and growing system resilience. From the University of York, Ian Graham explains the hemp crop genetic improvement research he is leading. In 'News from the Hub' we highlight new developments in carbon capture cropping from CHCx3 and elsewhere. We hear from CHCx3 partners Farm Carbon Toolkit and Natural Building Systems on the work they do and their aspirations for carbon capture cropping, and from Lincolnshire Miscanthus grower Colin Chappell.

Throughout 2024 there will be more opportunities to engage with the CHCx3 research and our Partners, and to participate in free events, with information and resources available on crop choice, management, and utilisation. If you are interested in getting more involved in CHCx3 or have a suggestion as to how else we can support carbon capture cropping, please do get in touch. Our contact details are provided on the last page of this newsletter.

Viewpoint

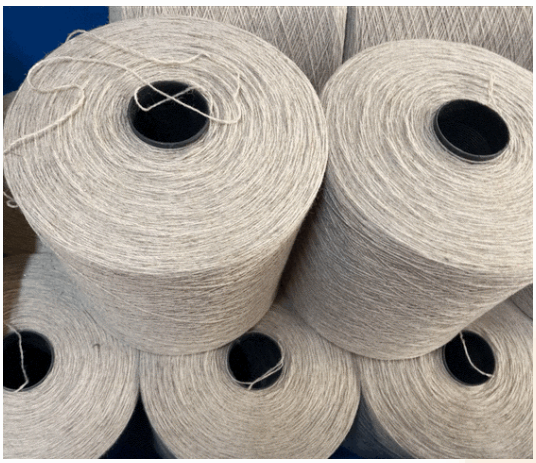
Dr Lydia Smith, Project Lead

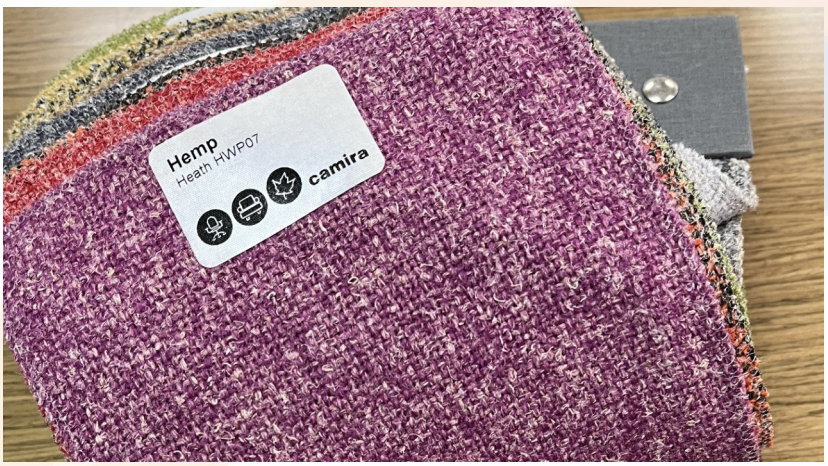
Opportunities and challenges for fibre crops

Recently, there has been a great deal of activity within our CHCx3 project in the annual fibre crop space. Nearly all of this is good news and impacts our partners and farmers, not just those working directly with the two main fibre crops – hemp and flax.

In addition to the existing partners, we have now extended our consortium to include others that are working in this space: Bitrez Ltd, based in Wigan. This innovative company works alongside sister companies in developing new uses for their resins and in the development of new resins/polymers and mixtures, which are made from biobased feedstocks. These materials are vital components of vehicle internal parts; such as dashboard and door panels, which they will develop, working with our existing colleagues at SHD Ltd based in Lincolnshire. SHD have identified many new potential applications, some are now at an advanced stage of development others in early piloting. They include the use of bast fibres, especially flax, embedded within a bard resin matrix, for use in automotive, aerospace and motorsport. components.

Our third collaborator is Camira Limited, based in Huddersfield, Yorkshire. Camira have become interested in the replacement of synthetic textile fibres with bast fibres from both hemp and flax. They are already now producing high quality fabrics composed of between 30-40% flax or hemp and other fibres (usually wool or wool+ a little nylon). This group will work together using materials sourced from our farmer group, which are growing several varieties of both hemp and flax at different locations. Camira will spin the bast fibres to produce thread that can then be used in the various applications above and in more traditional material used in the upholstery of furniture.





In the field, a new study identifying the potential for low levels of inputs in hemp is being undertaken at three farmer sites by NIAB regional agronomist Syed Shah. One slightly less welcome issue was the scarcity of flax seed this year; this was partly due to conditions last year and to growing interest in the crop. This underlines the vital importance of developing stores of good quality foundation seed for UK farmers to use.

CHCx3 Research in Focus

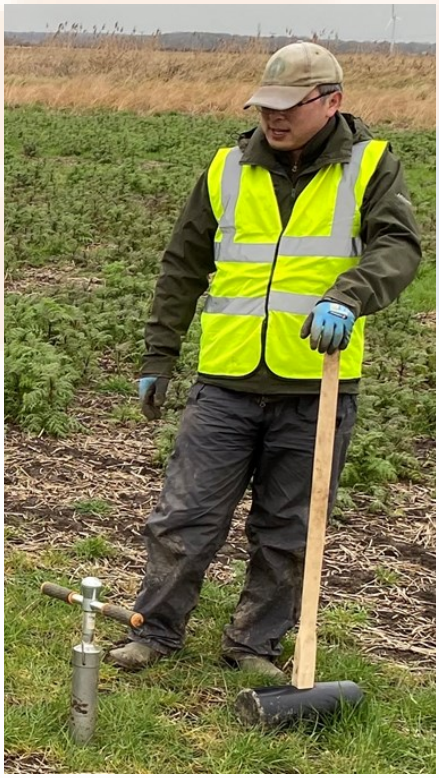
Dr Jason Kam, Scientist at Terravesta

Unlocking the carbon storage potential of Miscanthus and willow

Biomass crops like Miscanthus and willow are perennial, with a long life cycle, and can accumulate carbon underground each year. They are planted on less productive UK land, meaning farmers can leave them to grow and concentrate on their productive fields to produce food. Planting Miscanthus and willow is a good way to let land rest, recover, stabilise and store carbon over time, and it's profitable. In the case of Miscanthus, crop specialist - Terravesta, has an established supply chain, to supply renewable energy power stations with locally grown crops.

Understanding underground carbon storage potential

To quantify the carbon storage potential of Miscanthus and willow, Dr Jason Kam and Alex McCash from Terravesta's R&D department as well as a team led by David Marsh from Energy Crops Consultancy have begun taking soil samples this year. "We are looking to answer two key questions with the sampling," explains Jason. "Do these crops improve soil health? And how much carbon are they depositing in the soil?" To do this, large-scale data collection, with soil sampling from commercial Miscanthus and willow crops has commenced this spring. "Nine fields of Miscanthus and four of willow are being sampled. Some of these are newly planted and some are mature crops," says Jason. Samples taken are from the soil at particular depths. "We are testing for a 'Visual Estimate of Soil Structure' (VESS) of the top 30 cm; chemical analyses on 0-30 cm as well as 30-60 cm; and bulk density testing at 0-5 cm as well as 30-35 cm depth. "So far, the top 30 cm of soil seems to be more favourable for plant growth than the deeper layer, with a lower pH, higher potassium content, and a higher microbe score. Essentially, reflecting the presence of the root/rhizome structure benefits," he says. "Miscanthus has a deep root network that can go down to a metre, so it will be interesting to see if the lower 30-60cm structure also improves with time," says Jason.



The hope is to test more Miscanthus and Willow crops. "This year we have been hampered by the weather, which meant we had a limited window to conduct soil tests in. "We are looking to update the protocol and do more sampling of new and existing crops," says Jason. The soil sampling results are shared with NIAB for deeper analysis, and at this stage, Jason and Alex are collecting as much data as possible. "Miscanthus is perennial, so it can store a lot of carbon over time and because of the deep root network, the plants have time to develop complex microbial communities and draw down carbon further into the soil, for potentially 20 years or more in the case of Miscanthus. We see this as important work, because we need to be able to quantify the benefits of Miscanthus and willow crops," adds Jason.

Interview by Sophie Robinson, Terravesta

Professor Ian A. Graham, Centre for Novel Agricultural Products, University of York

Developing hemp as a multipurpose crop for UK agriculture

Hemp is recognised as being about twice as effective as trees at sequestering carbon with the resulting biomass having multiple uses that can replace fossil derived products. Its use in crop rotation is also very attractive given the low input requirement and benefit to soil composition. CHCx3 is providing much needed support to better understand the benefits and help realise the potential of this underutilised crop.

Two main types of hemp can be grown in the UK. Fibre hemp is planted in April or May, mown in August and left to ret for two to six weeks prior to being processed. Multipurpose hemp is grown for both seed and fibre. It is also sown in April or May, flowers early and is grown for longer to allow seeds to mature and be combine harvested in September/October. Despite the huge potential and efforts to develop new products and increase market pull, we still only grow around 800 Ha each year in the UK. In contrast, in Canada in 2022 the total hemp crop area was 31,120 Ha, with the majority of this being multipurpose hemp, grown in response to demand from the food and nutrition sector.

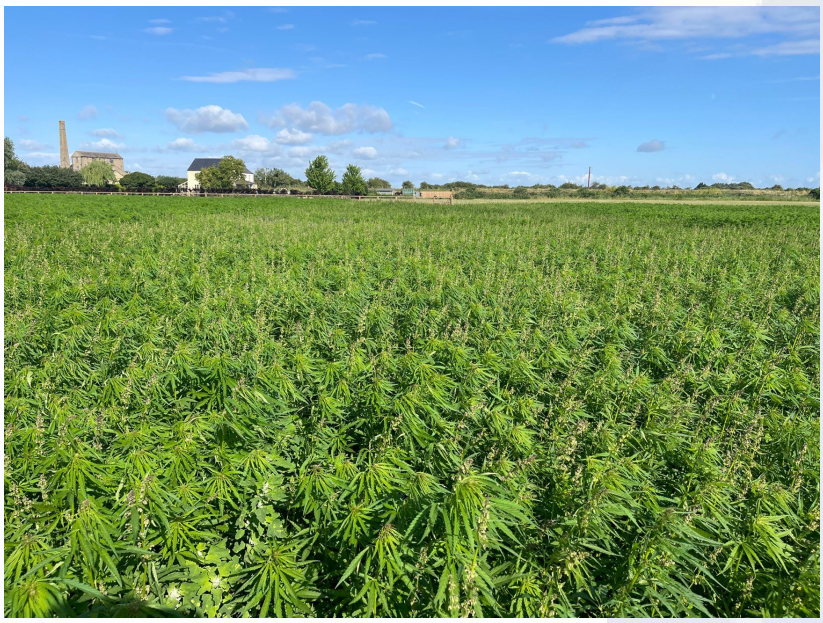
In the Centre for Novel Agricultural Products at the University of York our focus has been on developing new varieties of multipurpose hemp targeted primarily at the food and nutrition sector. We have already used fast track molecular breeding to develop CNAP1HOH, with almost 80 per cent oleic acid, compared with typical values of less than 10 per cent in the standard multipurpose hemp. This high mono-unsaturated/low poly-unsaturated fatty acid profile increases the oil's thermal stability and oil from the new variety was shown to have around five times the stability of standard hemp oil. This not only makes the oil more valuable as a cooking oil but also increases its usefulness for high temperature industrial processes.

As part of CHCx3 we are now focussing on other targets for improvement, such as decreasing amounts of cannabinoids and increasing the size and yield of seeds. By growing the market for hemp seed our aim is to provide farmers with a financially sustainable break crop which can also serve as a stepping stone for developing confidence in the supply chain for hemp fibre derived products and realising the full potential of this remarkable crop.

A new, highly stable, seed oil variety has been developed and registered in the UK.

News From the Hub

Hemp Licence update



Following interaction between government, NFU and other members of the CHCx3 consortium, we are delighted with the outcome of recent discussions to identify changes to the Home Office Industrial Hemp Licence; required by all farmers before they can cultivate industrial hemp in the UK. The changes were published recently on the Government webpages; current details are at Industrial hemp licensing - GOV.UK (www.gov.uk). In short, from January 2025, farmers will be able to grow an industrial hemp crop anywhere on a licenced farm; it will be possible to extend the current 3-year licence to 6 years; and farmers will be able to apply for a licence in advance. Specifically, they can apply in January 25 for cultivation in 2026. Other changes that we hoped to see, such as the standardisation of the UK 0.2% limit for THC (the active pharmaceutical component) to be increased to 0.3 as exists across the EU was not agreed *but*, this possibility is still in discussion. Already, the number of farmers with a licence has increased from 6 in 2013 to 136 in 2023. We anticipate this will start to drive markets that wish to use these bast fibres and the corky shiv, derived from within the main hemp stem.

Carbon Capture Cropping Opportunities within Sustainable Farming Incentive

From Summer 2024, new options should become available to farmers and land managers as part of Sustainable Farming Incentive (SFI) 2024 agreements under the Combined Environmental Land Management offer. The new 'actions' include:

- No-till farming (where no-till farming techniques are used to establish crops so soil disturbance is reduced).
- Multi-species spring, summer, or autumn cover (where there is a well-established multi-species cover crop during the spring, summer, or autumn months).

These will complement existing relevant 'actions' for SFI 2023, such as:

- Assess soil, test soil organic matter and produce a plan.
- Multi-species winter cover crops.
- Herbal leys.

Further details of the actions, along with updated scheme rules and how/when to apply, can be found at https://www.gov.uk/government/publications/sustainable-farming-incentive-scheme-expanded-offer-for-2024

Effect of cover crops on soil organic carbon pools

Recently published research (Fohrafellner et al., 2024) has reported the first meta-analysis of cover crop effects on differing soil organic carbon (SOC) pools in arable cropland relevant to European climatic conditions. The analysis included 71 studies from 61 articles published between 1990 and June 2023. Compared to no cover crop cultivation, cover crops were found to have significantly increased mineral-associated organic carbon (MAOC), particulate organic carbon (POC) and microbial biomass carbon (MBC) in the topsoil, thereby feeding into stable as well as the more labile C pools, but to different extents. The effect of cover crops on MAOC was dependent on soil clay content and initial SOC concentration, whereas POC was influenced by factors such as cover crop biomass and experiment duration. For MBC, clay content, crop rotation and tillage depth were identified as key drivers. Whilst the study highlighted knowledge gaps and long-term research needs it provides useful evidence of the potential for cover crops to promote carbon capture in the soil.

Reference: Fohrafellner, J., Keiblinger, K.M., Zechmeister-Boltenstern, S., Murugan, R., Spiegel, H., Valkama, E. (2024). Cover crops affect pool specific soil organic carbon in cropland – A meta-analysis. European Journal of Soil Science, 75(2), e13472. https://doi.org/10.1111/ejss.13472

Soil organic carbon sequestration under perennial energy crops

A global meta-analysis has provided new estimates for the rate and extent of soil organic carbon (SOC) sequestration under perennial energy crops (PECs). The study by Yini Wu et al. (2024), published recently in Soil and Tillage Research, has indicated that PEC cultivation globally achieves a mean SOC sequestration rate of 210 kg per hectare per year. Crop age and soil depth were found to be the main factors influencing the rate, with rate initially increasing with crop age but eventually declining, typically reaching its peak at 9 years. The SOC sequestration rate was higher in deeper soil layers, particularly 30-60cm, compared to topsoils (0-30cm).

Reference: Yini Wu, Huarong Huang, Feng Chen, Tiansu Tan, Yi Xu. Soil organic carbon sequestration rate and spatiotemporal dynamics under perennial energy crops cultivation: a global meta-analysis. Soil and Tillage Research, Vol 240, 2024, 106064, ISSN 0167-1987, https://doi.org/10.1016/j.still.2024.106064

Bioenergy Crop Statistics for England and the UK

Crops for bioenergy were grown on 133,000 ha of agricultural land in the UK in 2023, according to a new compendium Bioenergy Crops in England and the UK: 2008-2023 issued by Defra (Official Statistics) on 27 June 2024. However, the majority of this was wheat and sugar beet used for biofuels (45,000 and 2,600 ha, respectively), or maize used for anaerobic digestion (73,000 ha). Miscanthus and short rotation coppice (SRC) for biomass occupied 8,800 and 3,800 ha, respectively. The Defra June survey of Agriculture and Horticulture highlights that, over the 6 years from 2018 to 2023, the area of miscanthus grown in England has averaged just over 8,000 ha, and the area of SRC (willow or poplar) about 3,000 ha. Including straw and other sources as well as miscanthus and SRC, 6.7M tonnes oil equivalent of plant biomass were used to produce electricity and heat in the UK in 2022, an 11% decrease on the previous year, but still substantially higher than the 1.5-2M tonnes oil equivalent used in 2010-12.

Meet the CHCx3 Partners

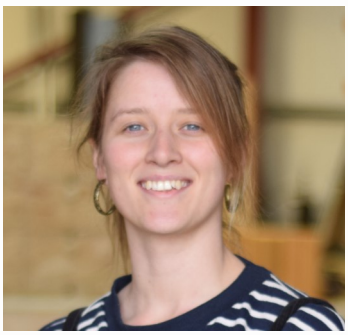
Liz Bowles, Farm Carbon Toolkit

Lead partner for the CHCx3 Soil Carbon Workstream

Farm Carbon Toolkit (FCT) has recently joined the team working within the Centre for High Carbon Capture Cropping. The photo shows most of our staff at a recent team day. FCT was set up by farmers back in 2009 to support the UK farming sector to better understand greenhouse gas emission sources on farms and encourage the transition towards more sustainable and climate friendly farming systems.

Today we are a fast growing organisation with an expert team of carbon and soil advisors alongside data and software experts who work directly with farmers, growers and supply chains and are responsible for one of the leading Carbon Calculators used in the UK and across the globe. We currently have over 8,000 regular users of our Calculator, with usage growing fast. In 2023, we launched our Carbon Calculator API which is enabling us to support many more businesses and organisations to share carbon data across a range of data platforms. Of itself this reduces the need for repeat data entry and supports greater consistency. At the Farm Carbon Toolkit, we're developing our software so that our users can securely share their data with other organisations and the software services they use, while retaining clear ownership and control.

Our role in the Centre for High Carbon Capture Cropping is to lead on all aspects of greenhouse gas fluxes associated with soils, crops and farm businesses arising from the production of high carbon capture crops. Specifically we will be developing tools to enable farmers and growers to more accurately estimate changes in farmland carbon stocks (facilitating access to the Voluntary Carbon Markets) within our existing Farm Carbon Calculator, use project research to update the Calculator with improved emission factors and methods of product accounting for high carbon capture crops such as hemp, flax, miscanthus and willow, which require different assumptions to annual cropping systems We are really excited to be joining this project and working to support the UK Farming sector to play an effective role in meeting the challenges of climate change. Making sure farmers have access to good quality data to underpin decision-making is key to our work and this project seeks to provide that for crops which have been, to date, challenging to include in farm carbon footprints



Natural Building Systems

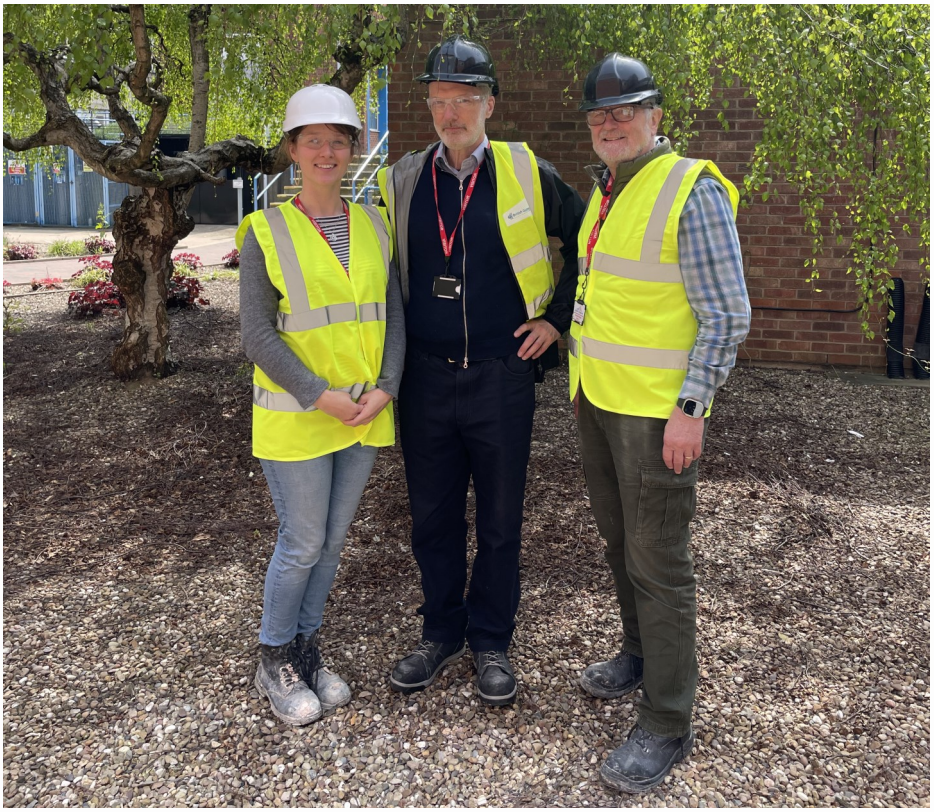
Partner in the fibre crop workstream

Natural Building Systems started life in 2019 inspired by an idea from the Managing Director, Chloe Donovan.

Chloe was inspired by the potential of industrial hemp to address both the housing shortage and biodiversity loss by promoting its use as a construction material. Her goal is to stimulate demand that will create new revenue streams for UK farmers while enhancing the performance and sustainability of future buildings in response to the growing climate crisis. As a Trustee of the Food Ethics Council and a Fellow of the Royal Society of Arts, Commerce, and Manufacturing, Chloe founded Natural Building Systems because of her passion for holistic and systemised solutions to complex challenges. She is also committed to maximising the adoption of innovation and technology in construction, advocating for a manufacturing -led, modular kit-of-parts approach to revolutionise and rapidly decarbonise the industry.

Chloe approached David, who has a background in facilities management and construction, about her ideas, and this struck an immediate chord. David has always been passionate about sustainability in construction, appalled by the amount of waste and inefficiency he came across every time he wanted to do improvements or make changes to a property in his portfolio. They got their heads together and came up with the concept of a low environmental impact modular construction system that was made from exclusively climate neutral materials, comprising a breathable, high performance thermal envelope, floor and roof elements and internal walls. All parts of the system are individually demountable, allowing adaptation during use, end of life disassembly and reuse. This is now manufactured under the trade name ADEPT®.

Miscanthus board (left) and the modular natural fibre systems created by NBS at the Future Build Expo.



Founders of NBS, Chloe Donovan, David Nicholson, Dr Mike Lawrence

After a period of intensive research, using hemp-lime as the core ingredient, it became apparent that hemp-lime was problematic when used in a pre-fabricated construction system, due to the amount of water required in the initial mixing. Hemp-lime was considered to be a vital element within the system, not just for its environmental credentials but also due to its exceptional moisture and thermal buffering characteristics, so they approached Dr Mike Lawrence, a world renowned expert in hemp-lime, whose name they kept hearing about in their research.

Mike had recently retired from the University of Bath, where he had been Director of their Building Research Park. In the following 12 months, Mike came up with a novel binder for a hemp bio-composite which used significantly less water and offered improved moisture buffering and thermal performance whilst also being compatible with high volume factory manufacture systems. The material is known as HempSil®, and is patent pending.

Mike joined Chloe and David on the board of Natural Building Systems, and together they continue to explore the development of more novel low environmental impact construction materials. The Natural Building Systems team has since grown to include a range of designers, engineers, researchers and construction professionals and they are currently focused on the testing and certification of their modular system alongside scaling their manufacturing capacity.

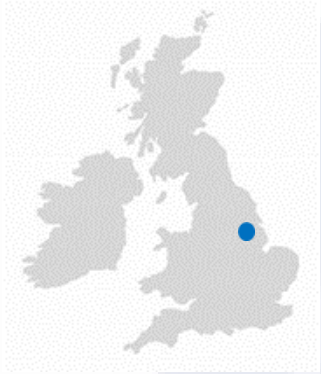
Under the CHCx3 project we are developing a construction board product made from bio-based materials using the feedstock from the crop trials as part of the project together with a range of innovative binders, including the HempSil® binder. We expect to have a number of materials ready for use in construction by the end of the project and are keen to collaborate with other material manufacturers or sustainability focused developers and construction professionals.

The UKGBC has found that the industry's annual embodied carbon footprint has reduced by 4% since 2018 compared to the 17% reduction needed, read more at: https://ukgbc.org/wp-content/uploads/2023/12/Progress-Report-Roadmap-December.pdf

In the Field

Colin Chappell

Miscanthus grower



The Chappell family has been farming on the banks of the River Ancholme in the Lincolnshire flatlands for four generations. Today, Colin Chappell continues this legacy by managing the 645-hectare family farm, producing a diverse array of crops and embracing innovative farming practices. After studying agriculture at Harper Adams University, Colin worked in Australia before returning home to take over the family farm. His tenure as an AHDB monitor farmer from 2017 to 2020 allowed him to broaden his perspective through knowledge exchange with other farmers. Colin is passionate about soil health, encouraging young people to pursue careers in agriculture, and educating school children about the origins of their food. His efforts earned him the inaugural Rawcliffe Bridge Sustainable Farmer of the Year award in 2022.

A challenging year

Despite the challenging year, Colin has expanded his farming operations. This year, he has planted an additional 4.7 hectares of Terravesta Athena™ Miscanthus next to his current 26-hectare crop. He notes that farming has become increasingly difficult due to changing weather patterns. "Normal cropping might be a thing of the past," he says, reflecting on the severe flooding that left 85% of his fields unplanted by mid-April this year. In response to these challenges, Colin emphasises the benefits of growing Miscanthus on less productive land. "We grow food on the better land and farm Miscanthus on the less productive land," he explains. Colin says that he expects the floods to have significantly impacted his yields. “Winter wheat, which typically yields 12 tonnes per hectare, will likely produce only about 6 tonnes per hectare this year as a spring sown crop. Similarly, the spring barley, planted late April, may yield at best around 7.5 tonnes per hectare,” he says. With only 5.5 fields of winter crops surviving out of an initial nine, Colin has turned to spring crops, with their associated high costs due to seed crop failures.

Where Miscanthus fits in

"British farmers are in unknown territory,” he says. “Miscanthus offers numerous advantages, including long-term financial security, robust markets, and environmental benefits. With Miscanthus, you have to take a long-term view and look at the guaranteed returns from an upfront investment," says Colin. “It provides an income each year, with next to no inputs post-establishment,” he says.

“The Miscanthus fields teem with wildlife, including reed buntings, reed warblers, redshank, curlew, linnet, deer, and many underground species that thrive due to minimal soil disturbance, and the crop is a valuable carbon sink.”

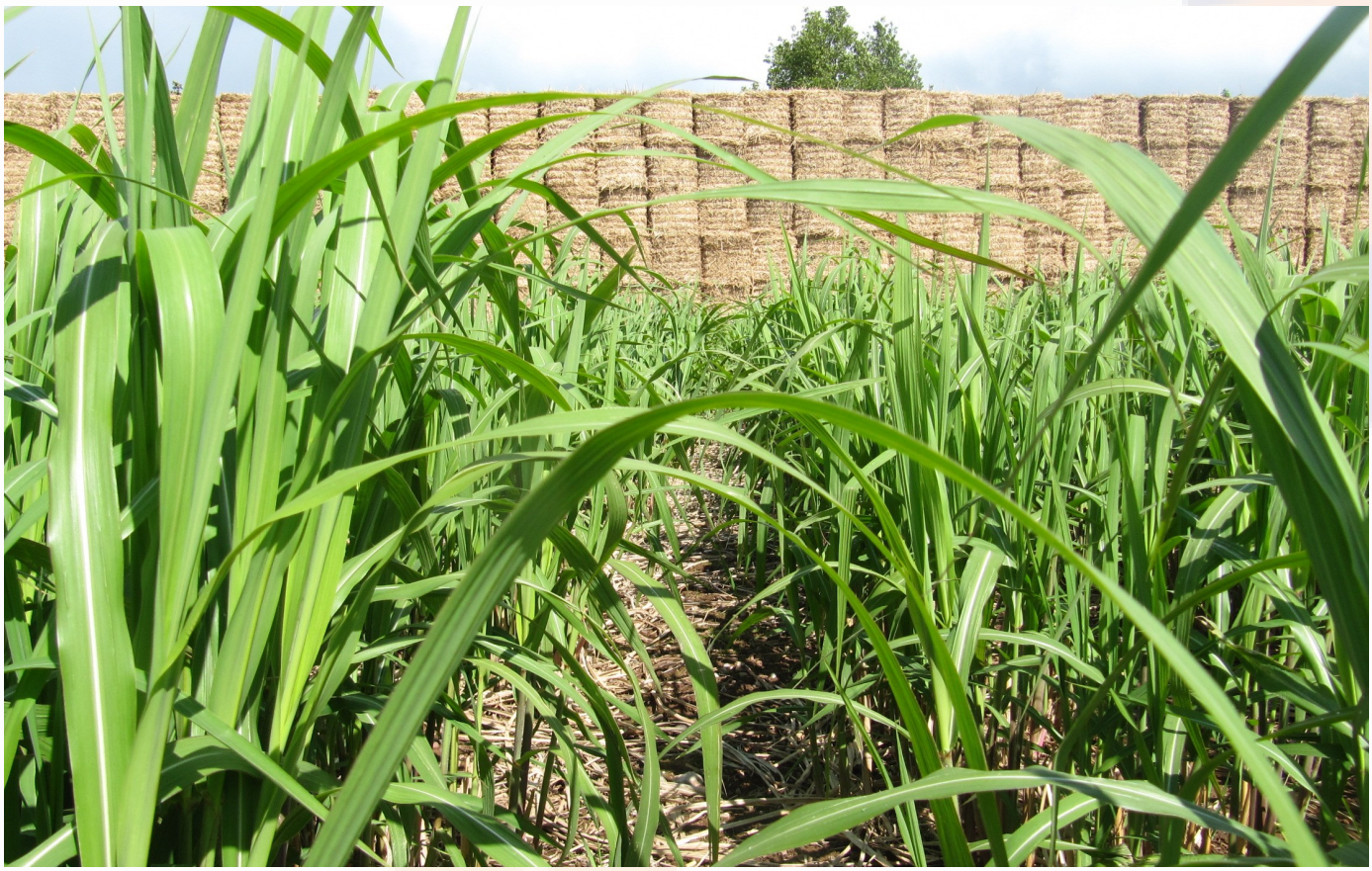
Colin supplies Miscanthus to Miscanthus specialist, Terravesta, which then supplies the Brigg Renewable Energy Plant with whole bales located less than a mile from his farm. This arrangement is supported by a 14-year contract with the power station, which benefits from long-term government support. According to Terravesta, Lincolnshire farmers are fuelling local homes. Based on 12t/ha average at 4000kwh/tonne and power station efficiency at 40%, 10ha of Miscanthus generates enough electricity to supply 55 average homes for a year at 3,400kwh average annual consumption. A grower with 25ha is probably supplying enough electricity for their entire village.

"SFI schemes are all well and good, but they're a short-term fix. Miscanthus is supplying sustainable, carbon negative energy to local homes and it's a long-term solution that's unaffected by price and weather volatility," says Colin. Colin remains optimistic about the future of Miscanthus. "It ticks lots of boxes, environmentally it's fantastic for the farm, it's supplying a local market, and it provides a long-term, reliable income, and I don't worry about black-grass because the high canopy completely outcompetes it."

Colin reports yields of 13 tonnes per hectare on poor-grade land from a Miscanthus giganteus crop planted in 2006. Thanks to improved rhizome quality and planting techniques, new crops now achieve a 90% establishment rate and are likely to yield at least 15 tonnes per hectare. "I'll be replacing some of the old Miscanthus giganteus crop, which, after 20 years is still yielding, but yields are starting to wane," he adds. "I'm hoping to plant more Terravesta Athena™ next year".

Colin admits that this year's Miscanthus harvest has been affected by the flooding. "The conditions have been less than ideal for the second year in a row, and the moisture content of the bales was more than I would have liked, but we've still harvested a viable crop in a flood-prone field and it's likely that it will be one of the more profitable crops on the farm this year," adds Colin.

Interview by Sophie Robinson, Terravesta



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 and Time	Event	Location
11/09/24 13.00—14.00	Harmonisation of Carbon Accounting Tools for Agriculture	Zoom Webinar
01/10/24—03/10/24	Biomass and Energy Crops VI	Aberystwyth University
08/11/24 10.30—13.45	Agri-TechE CHCx3 Event	Sophi Taylor Building, NIAB, Impington,

Click here to sign up for one of our free CHCx3 events or email us at chcx3@niab.com

Catch up on our previous Cover Crop webinar, Fibre Crops webinar and the Biomass Crops Webinar. Events you can catch up on are the Crops to Products and Cover Crop Open Day.

Acknowledgements

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