> *"It's important to understand which cover crops are most appropriate to use when making a transition to no-till."*

Cover crop establishment

Research insights

Could a series of research projects looking at the impact of tillage approaches and climate change on cover crop establishment help Scottish farmers to make more of the valuable rotational tool? *CPM* speaks to the James Hutton Institute to learn more.

By Janine Adamson

Climate change projections suggest Scotland's weather patterns are changing. As well as an increase in temperature across all seasons, it's likely growers will face warmer, drier summers and milder, wetter winters.

At the same time, management challenges experienced in the North such as later harvests mean despite best intentions from growers, cover crops haven't always been a roaring success.

But now, researchers hope to improve the accessibility of the tool by understanding how factors such as tillage techniques and extreme weather conditions impact the success rate of cover crop establishment in Scotland.

Dr Tracy Valentine, research leader for plant:soils interactions at the James Hutton Institute, is involved in two Scottish government-funded projects – 'Healthy soils for a green recovery (Healthy soils)' and 'Crop improvement for sustainable production in a changing environment (Abiotic stress)'. Once collated, she believes the project findings will help growers to make more informed decisions about which cover crop species to use and in which scenarios.

Healthy soils project

The Grieves House tillage trial was first established in 2017 and is currently funded as part of the wider healthy soils project. "This is primarily a tillage trial comparing full inversion with no-till techniques across two cropping approaches, but we began to investigate cover crops within the trial around three years ago," explains Tracy.

"One half of the trial is a spring-based rotation featuring spring barley, oats and beans, whereas the other is a winter rotation where soils are covered at all times. It's the winter rotation where we're able to assess the cover crops," she continues.

"Research has shown some species are better suited to non-inversion approaches, so our aim is to understand the varietal differences in crops and cover crops across the two tillage systems and what's driving that."

Currently, the project is measuring how different cover crops respond to the two methods by assessing plant biomass. "In year one, we observed that cover crop biomass (radish and rye) was significantly reduced in the no-till treatment compared with the full inversion plough.

"To investigate this further, in year two we planted oats and radish – although the radish biomass was again reduced in the no-till, the oats did much better. What this means is it's important to understand which cover crops are most appropriate to use when making a transition to no-till," suggests Tracy.

As well as measuring the biomass of the cover crops, the trial also involves quantifying the biomass of the subsequent weed burden. "We know there can be a trade off when implementing a no-till approach, so understanding the relative competitiveness of the cover crops will be valuable insight to add to our findings."

And although biomass is only an indicator of a plant's establishment success, reduced effectiveness of certain cover crop species used in these systems is important information. This is because cover crops can be integrated in no-till systems as an approach to climate change mitigation through carbon sequestration and reduced fuel use, explains Tracy.

The next stage of the project will involve assessing a more diverse range of cover crop species, selected based on their rooting-ability.

Crop improvement for sustainable production in a changing environment

According to Tracy, this project explores the impact of abiotic stress and climate change on multiple Scottish crops including cover crops. The cover crop research began three years ago with lab-based experiments.

"We wanted to assess a cover crop seed's

Researchers such as Tracy Valentine hope to improve the accessibility of cover crops in Scotland by understanding the impact of tillage techniques and extreme weather conditions.

Lab-based experiments have been taking place to assess a cover crop seed's response to water.

response to water – either drought or water-logging – at the initial germination phase. We did this by looking at seed coat mucilage which researchers believe influences germination through its relationship with seed hydration. We also looked at effects of temperature on germination.

"To ensure a robust sample, we sourced seed for around 30 different species of cover crop from a range of suppliers, some of whom provided the seed in kind," says Tracy.

The aim of the work is to understand which species – ranging from clovers and radishes to black oats and phacelia – establish best in different environmental conditions. Alongside the lab studies, field work is taking place to evaluate the success of these cover crops live in-situ.

"The trial is untreated, so it very much depends on the weather as it happens each season and comparing year-on-year. Plots were ploughed in the first year but will be direct drilled from the second year onwards.

"We have a weather station in close proximity meaning we can map the results accordingly," explains Tracy. "And as we progress through the project, we'll select certain cover crop species to take further through their life cycles beyond just the germination phase."

Integrated research

The information gathered from these projects will be combined with plant temperature and light growth data in models that link to climate change projections for different regions in Scotland.

"While projections suggest central-eastern areas of Scotland will become warmer, they also propose it to be much drier in the August-September cover crop sowing window, potentially affecting germination rates.

"Further north, projections become much more uncertain, but the issue of quickly fading light for plant growth will still remain whatever the weather brings," she adds.

Also, because previous James Hutton Institute research has investigated the rooting behaviour of different types of cover crops, this can also be layered onto findings. "The two projects certainly inter-link while being relevant to previous research we've undertaken at JHI.

"It's about helping to improve the access to cover crops in Scotland and the North, so growers can reap the widely publicised benefits that they offer," concludes Tracy. ■

Nuffield cover crop study

Nuffield scholar, Toby Simpson, first took an interest in sustainable farming when he returned to the family business and saw how Denton Lodge Farm's soils had benefitted from a reduction in tillage.

"My father adopted a min-till approach and within 15 years we were able to see considerable improvements in soil health as well as labour/fuel savings. This led to a switch to direct drilling in 2019, but it was evident we required a bigger system change than that alone which is where the cover crops came in," he explains.

The farm, which manages around 700ha, has a rotation featuring winter wheat, oats, spring barley, spring wheat, 'boats' (bi-cropped beans and oats) and stewardship schemes. Having dabbled with some catch and cover crops, Toby decided to explore the topic further with a Nuffield Scholarship.

And through his studies he was able to tour countries including Norway, Sweden, Denmark, Germany, France, Canada, North America and the UK, looking at comparable systems which could be translated back to the family farm in Cambridgeshire.

"One of my biggest learnings was that rather than soil being perceived as inert, it's a living ecosystem which we have a responsibility to look after. Having living roots in the soil, as with cover cropping, is the cornerstone of all soil functions whether that's biological, physical or chemical," he suggests.

Furthermore, Toby says roots are system enablers and ubiquitous in what farming should be aiming to achieve.

A key aspect of Toby's travels which remains front of his mind was work presented by French researcher, Thierry Tétu. "Thierry shared the importance of plant densities above and below ground – up to 300 plants/m² – which creates a dense canopy and thick rooting framework.

"With the roots this results in a rhizosphere priming effect to release nutrients from the soil and exploit its potential, whereas the canopy captures CO_2 which is transpired from the ground, creating a greenhouse effect."

Toby says the concept of planting more and truly investing in a cover crop resonated with him and is something which can be readily implemented. "I believe we can achieve this on the farm by home-saving some seed and then topping up with other bought in species."

Another inspiring part of his study tour was meeting the late David Brandt in Ohio, who utilised cover cropping within a no-till system for around 50 years before passing away in 2023. "David worked his soils so significantly that they were re-classified. His approach was very simple with no silver bullet, but he'd looked after his soils for a really long time and that year-on-year transformation accumulated," says Toby.

"It proves this doesn't have to be complex to work, and for David, he could reduce his inorganic fertiliser use by around 75% without an impact on crop output."

Having dabbled with some catch and cover crops, Toby Simpson decided to explore the topic further with a Nuffield Scholarship.

Toby now hopes to implement some of his Nuffield learnings at Denton Lodge Farm, including planting more catch crops between rotations to reduce waterlogging and slug pressure. He's also paying more attention to how cover crops are established.

"There's no right or wrong way but it all comes down to seed-to-soil contact. For us, it makes most sense to drill our cover crops rather than broadcast, as this delivers more consistent results.

"But something worth considering is drilling depth – different species have different requirements and this affects how they're planted. An example being crimson clover which prefers a shallow depth so could be dribbled on with a slug pelleter and then perhaps rolled," he concludes.

Toby's full report 'Catch and cover cropping opportunities in UK arable agriculture' can be found on the Nuffield Farming Scholarships website.