Issue/Uitgawe 73

Datums

6 tot 7 Augustus –	BLWK Bewaringslandbou konferensie
21 Augustus –	SSK Wintergraandag Riversdal
21 Augustus –	SKOG
20 September –	Hopefield Wisselbouproef dag

blwk - cawc

APRIL 2019

BLWK-nuusbrief CAWC newsletter

Inhoud / Contents

Planttyd het begin of dit nou in droë grond of lekker klam is. In die suidkaap is daar al heelwat hawer wat die lig gesien het en selfs n dekgewas hier en daar. Ons bid dat die planttyd goed sal verloop en dat die gewasse sommer spoggerig sal lyk vanjaar. Ons sal binnekort ook die BLWK konferensie in Augustus vir julle deurgee. Geniet die nuwe nuusbrief.

Redakteur

Sowing time has started all over. Either dry or wet. In the southern Cape one can already see some oat fields that have emerged, as well as a cover crop or two. We pray that the sowing time will be smooth and that all the crops will be a joy to behold this season. The programme for the CAWC conference in August will also be made available soon. Enjoy the new newsletter.

Editor

Multi-crop rotation offers benefits for livestock and crops

Shauna Kopren, Freelance Contributor

March 23, 2019
https://www.tsln.com/news/multi-crop-rotation-offers-benefits-for-livestock-and-crops/

Steers grazing pea-barley at the beginning of grazing. Photo courtesy of NDSU Dickinson Research Extension Center.

At the North Dakota State University Dickinson Research Extension Center, one focus is improving crop and beef cattle production efficiency. Douglas Landblom, a beef cattle specialist, has found that multi-crop rotations with beef cattle can increase efficiency while decreasing inputs.

Landblom's research consists of studying the comparison of spring wheat grown continuously on the same land compared to spring wheat grown in a multi-crop rotation consisting of spring wheat, dual cover crop, silage corn, field pea-barley mix and sunflowers. Yearling steers grazed three of the rotation crops and the deposited manure and urine contributed to soil organic matter, providing a food source for soil microorganisms.

According to Landblom, the principles of regenerative agriculture are based in the context of improving soil health. Systems like expanded crop rotations allow soil biota, microorganisms, and fungi the opportunity to function at a higher level of efficiency. "Managing crops in a way that gives soil organisms the food necessary to perform is extremely beneficial," says Landblom.

During the first few years of the multi-crop rotation study, both spring wheat yields were 40 and 41 bushels per acre. However, Landblom found that by discontinuing fertilizer application on the spring wheat rotation reduced the cost for fertilizer and, when combined with an increase in soil-derived nitrogen, resulted in a $15 per acre greater net return for spring wheat grown in the crop rotation that included livestock grazing.

"Increasing soil health results in greater biodiversity, while grazing reduces carbon dioxide emission, improves water cycles, and increases plant-available nitrogen," says Landblom. The research conducted by Larry Cihacek, Songul Senturklu, and Landblom found that for every one percent increase in field soil organic matter content there is potentially 16 pounds of nitrogen mineralized by soil microbes and available for plant growth.

"Replacing fertilizer with nitrogen produced by soil microbial processes is water-dependent," Landblom says. "Integrating crop and livestock systems increases soil organic matter and aggregation, which subsequently contribute to a soil's water-holding capacity and offers an opportunity to support better yields during moderate drought in semi-arid regions."

Winter crops like triticale, hairy vetch and winter rye seeded in the fall make excellent grazing crops the next spring for yearling steers, feeder heifers, cows and calves, or cull cows. Designing a grazing system that incorporates native range, when annual forages need time to grow, and a sequence of annual forages for grazing throughout the summer provides a measure of grazing flexibility.

Landblom found that yearling steers that grazed native range and multi-crop rotations gained 495 pounds after grazing 211 days. After that, the grazing steers were in the feedlot for 82 days and then slaughtered, "Feedlot average daily gain was 4.7 pounds per day and required 6.23 pounds of feed per pound of gain," Landblom says. "Compared to control steers that were finished in the feedlot, net return was greater for the extended forage grazing steers by $61 per steer."

In the past, producers have focused on the maximum yield that they can get from a field. However, Landblom explains that regenerative agricultural thinking still focuses on the need to produce, but also looks at more alternative ways to achieve maximum economic yield while also relying less on purchased inputs, like fuel, fertilizer, chemical, and labor, plus reducing environmental impact.

The multi-crop rotation was originally designed for grazing yearling steers, however, it can be manipulated for producers without livestock as well. Producers can substitute the appropriate crop such as grain corn for forage corn and the pea-barley mix produces excellent hay. In addition, the pea-barley mix can be replaced with low-water use legumes such as peas, lentils, canola, and chickpeas, which are known to be financially rewarding.

For producers that are interested in implementing an integrated crop and livestock system, Landblom suggests beginning with a plan that fits the available farm labor, machinery and infrastructure, and is agreeable with other farm members with a vested interest in the farm business. Additional consultation with property owners, lenders, tax consultants and spouses is also important to keep in mind whenever changes in a farm business plan are made.

Producers also need to determine the class of livestock and the way livestock will fit into their cropping system. "Begin with a goal to produce a sequence of crops that provide for a diversity of crop types using a combination of cool- and warm-season grasses and broadleaf crops for cash grain, oilseed and forage production," Landblom says. "I cannot over-emphasize the necessity for diversity, which can have a significant impact on soil fertility, weed, and pest management."

"Multi-crop diversity is very important, and every farm may have different goals and crop sequences to achieve those goals," Landblom says. It is important for producers to seek individuals with experience when first planning a multi-crop and grazing rotation. These individuals can help design a cropping system to fit specific farm objectives and also facilitate expertise for placement of crops within the cropping sequence.

"Experience has shown that producers who begin alternative production methods begin to see greater residual nitrogen the third or fourth year after initiation and, therefore, can begin reducing the amount of nitrogen fertilizer applied and subsequently increase their efficiency of the cropping and cattle systems while lowering their inputs," Landblom says.

For more information on the research done at the NDSU Dickinson Extension Center or to learn more about improving cattle production system efficiency contact Douglas Landblom at 701-456-1109, 701-690-8245, douglas.landblom@ndsu.edu.

Links of the month

Click on the button to visit the website.

Please note you will need an Internet connection

Biochar and dung beetles with Doug Pow

Chaff dump management and 'strip and disc' systems

A Decade of Pesticides, GMOs, and Alternatives to Chemical-Intensive Farming

Plenary: Carbonomics - Keith Berns

PREDICT WHEAT WEED GROWTH TO REDUCE HERBICIDE USAGE

https://www.futurefarming.com/Smart-farmers/Articles/2019/3/Predict-wheat-weed-growth-to-reduce-herbicide-usage-408709E/

Spanish researchers performed a study that predicts the growth of this weed among wheat crops, with an aim to optimise the use of herbicides.

One of the greatest enemies of certain grains such as barley, rye and wheat are wild oats. These are a kind of grass weed and they compete with these crops by taking their water, light and nutrients. Their density can double in just a year, causing production losses reaching up to 40%.

Predict growth of weeds among wheat crops

The AGR124 research group, made up of members from the Department of Graphic and Geomatics Engineering at the University of Cordoba and the Spanish National Research Council's Institute for Sustainable Agriculture, performed a study that predicts the growth of this weed among wheat crops, with an aim to optimise the use of herbicides, reports ScienceDaily.

Using precision agriculture technologies, such as sensors, drones and GPS navigators, the idea is based on observing and managing crops in order to apply only the necessary resources at the right time, thus avoiding unnecessary high costs and environmental damage.

Multispectral satellite images

The research used very high spatial resolution multispectral satellite images, able to gather data with spatial details in regions of the electromagnetic spectrum different from those in the range of visible light, meaning it can obtain information that the human eye cannot detect.

The researchers also analysed 4 different plots of wheat for 2 seasons. After verifying that there had indeed been an increase in the weeds, as pointed out by the head researcher of the study, Isabel Castillejo, they confirmed that these weeds grew in patches, which means that they are good candidates for the use of weedkillers in specific locations, instead of applying them all over the entire plot.

It was confirmed that the new wild oats that had sprouted were very nearby and relied on the ones that had grown the first year of crop. "If the new weeds are found near the old ones, we can predict what is going to happen and consider localised treatment that extends slightly beyond the place where the weeds are currently found," says researcher Isabel Castillejo.

Applying herbicide selectively

In order to effectively combat weeds, the key lies in applying herbicide selectively to portions of the plot where, even if the weed cannot be seen, there is a high likelihood that they could appear in the future due to the seed bank left by the older weeds.

These kinds of plant-protection treatments are normally used indiscriminately all over the plot, which was thought of as a continual treatment in which all the land was treated equally. Now, considering the data shown by the research, the use of weedkillers could be reduced, bringing with it environmental benefits as a result.

An image of wild oats analysed by the research group. - Photo: University of Cordoba

Increase in cost

In some of the cases studied by the group, it could be slightly more expensive to use this kind of system, since the use of adapted machinery and processing all the information currently means an increase in cost when compared to traditional systems. Nevertheless, researcher Isabel Castillejo is convinced that the progress of precision agriculture is unstoppable. "There is a lot of transfer from research to the world of agriculture and there are regulations that are fostering it, so with time this technology will be cheaper and will establish itself."

Switching to no-till? Restore degraded soil first!

By Lloyd Phillips

April 5, 2019 1:20 pm

https://www.farmersweekly.co.za/crops/field-crops/switching-to-no-till-restore-degraded-soil-first/

It is often assumed that implementing no-till production is the immediate next step towards restoring degraded soils. Not so, says Guy Thibaud, a veteran soil scientist with the KwaZulu-Natal Department of Agriculture and Rural Development.

The use of no-till conservation agriculture practices continues to grow rapidly around the world.

The Argentina Association of Direct Seeding No-Till Producers, for example, states that more than 80% of that country's crop farmers implement no-till production methods.

READ No-till: increasing soil organic content

In comparison, only about 30% of South Africa's crop production is no-till, according to Dr Hendrik Smith, Grain SA's conservation agriculture facilitator.

Veteran soil scientist Guy Thibaud says a number of South African farmers claimed to have tried implementing no-till but that it ultimately did not work for them.

"What I say, though, is that these claims of lack of success with no-till are not due to any inherent failures with the system. For one thing, if no-till created bigger problems than the ones it is meant to solve, or if it were not economically viable to implement, there would not be an estimated 120 million hectares of land – a figure that is growing – under no-till production around the world."

Thibaud believes the reason for no-till reportedly not working for some South African farmers is that these producers made mistakes or took shortcuts with their management of the system as they did not fully understand it.

He says that some farmers have complained about "the poor early performance of no-till" during and immediately after the transition from conventional tillage practices on their farms.

In response to these comments, Thibaud quotes world-renowned soil science expert Rattan Lal, who said that "severely eroded and degraded soils due to prior mismanagement do not respond to no-till unless the physical, nutritional and soil biological properties are [first] restored".

The fence row soil test: proof that it works

Thibaud says that farmers who are sceptical about no-till should take a look at the results of the simple fence row soil test devised by South African soil scientists Dr Neil Miles and Dr Alan Manson.
This visually compared the health of two soils on Cedara Agricultural Research Centre's farm. The first had been conventionally tilled and monocropped with maize for at least 38 successive years, while the second, on the adjacent grassed-over access road, had never been tilled.

"Just by looking at the soil samples from these two areas 2018it was easy to see that the levels of organic matter, biological activity and aggregate stability were significantly better in the

The fence row soil test at Cedara clearly showed that the never-tilled soil (left) was healthier than the soil (right) that had been tilled annually for 38 years.

never-tilled soil versus the long-term tilled soil," says Thibaud.

He urges farmers who still use conventional tillage to carry out this test, but acknowledges that in areas where more sandy soils are farmed, the visual differences between the two soil samples will initially not be as obvious.

However, closer inspection, including feeling the two soils, will reveal differences to prove that the never-tilled, grass-covered soil is healthier than the tilled soil.

Essential fixes before going no-till

According to Thibaud, the first important fix before transitioning from conventional tillage to no-till is to correct soil acidity. He advises no-till farmers still struggling with soil acidity to stop no-till for a season, fix the problem, and then return to no-till.

"Don't get emotional, don't live in denial, because the soil acidity problem will not disappear unless you take action. And to prevent re-acidification of no-till soils, I recommend surface-applying lime at between 1t/ha and 2t/ha every two to four years. This has proven very effective."

READ Biological wine farmer achieves twice regional average yield

A second important fix ahead of no-till implementation is to check for any soil compaction, including plough pans, subsoil compaction and surface crusting. The depth of any subsoil compaction must be determined using an appropriate soil probe tool.

A tractor-drawn ripper implement set to rip to a depth just below the compacted layer can then be used to remedy this compaction.

Thibaud points out that tillage, such as ploughing and ripping, provides only a temporary solution to soil compaction.

"If it were a permanent fix, why do farmers still plough their soil every year? As useful an invention as the mouldboard plough was considered to be when originally devised, it has since caused a lot of misery. For example, the infamous American Dust Bowl of the 1930s was directly as a result of years of annual ploughing and discing, followed by a devastating drought. As a result, there was a max exodus from affected US farms."

Nature's revenge

He adds that constant cultivation of farmland has taken its toll on beneficial soil organic matter and on the valuable topsoil itself.

"If you pillage, plunder and rape the soil for long enough, the forces of nature will expropriate your land, and it will be without compensation."

He points out that in their 1953 paper, 'The regeneration of soil humus under a grass ley', University of Pretoria researchers JJ Theron and DG Haylett discussed the issue of declining crop yields in South Africa.

The pair warned farmers that this decline was caused by, in turn, loss of soil organic matter through repeated tillage, rapid impoverishment of the ploughed soil, soil structure deterioration, and loss of topsoil due to erosion.

Despite this warning, generations of farmers have continued to till their soil conventionally and repeatedly.

As a result, and in combination with arguably the country's most severe drought of the past century, regions of South Africa experienced conditions during the 2015/2016 summer crop production season worryingly similar to those of the American Dust Bowl of the 1930s.

"While farmers in the Free State's Hoopstad area were planting that season, there was a massive dust storm," explains Thibaud.

"This dust was lifted from the local highly degraded and therefore highly erodible soils.

"If the Hoopstad farmers, and perhaps tillage farmers in other areas too, now want to transition to no-till, they'll first have to recognise and fully accept that crop residues, soil carbon and organic matter are all key factors for no-till to work effectively. If they can't accept this, they won't even get out of the starting blocks."

Beyond not ploughing

Thibaud warns farmers to avoid becoming so preoccupied with not ploughing soils that they forget to address the other important aspects of sustainable soil management and crop production.

READ Ploughing: things to know before you plunge

No-till cannot work without the simultaneous use of organic soil covers, such as crop residues and cover crops.

He quotes Lal, who says that crops which do not leave a significant amount of residue on the soil surface cannot be grown continually in a no-tillage system without seriously deteriorating the soil's physical properties.

Smooth the bumps with cover crops

The transition from conventional tillage to no-till sometimes comes with short- to medium-term challenges. Thibaud cites US soil scientist James Hoorman, who said in 2009 that no-till maize production had struggled to be successful in the Midwestern US.

"[Successful] no-till farmers [there] say that it takes seven to nine years to transition from conventional farming to long-term no-till. Yields are typically reduced by 10% to 20% during those transition years."

Hoorman says this transition period can be dramatically shortened to two to four years if cover crops are also grown.

This is supported by another US soil scientist, Dr Jill Clapperton, who, when speaking in South Africa in 2014, said unstructured soils with low organic matter content take between three and five years to build the soil biological properties necessary to improve soil structure.

Clapperton's recommendation at that time was that it was better to start the transition to a conservation tillage system after a perennial crop or pasture phase of two to five years.

Thibaud says that with much of South Africa being classed as arid and semi-arid, consideration should be given to the water usage for cover crops that do not directly contribute to a farmer's income.

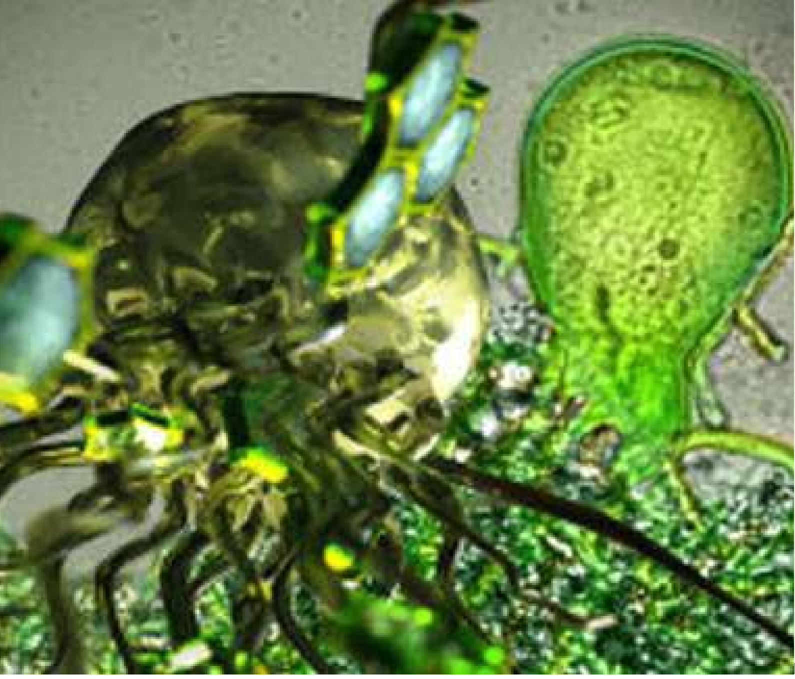
In areas where rainfall and water resources are particularly scarce or under pressure, he suggests planting one or more ley crops in winter as an alternative to conventional cover crops.

"By first addressing soil acidity and soil compaction, and by first improving soil structure and general health through the use of living and dead soil cover, the transition from conventional tillage to no-till will get a valuable jumpstart," he says.

"This will not only reduce the length of the transitional period but minimise any potential yield losses commonly associated with this transition."

This presentation was given at the 2018 No-Till Conference. Visit notillclub.com.

Contact Guy Thibaud on 033 355 9447 or at guy.thibaud@kzndard.gov.za.



How fungi make nutrients available to the world

February 1, 2018 , US Department of Energy
https://m.phys.org/news/2018-02-fungi-nutrients-world

Anaerobic gut fungi colonize plant matter and release enzymes that break cell walls into simple sugars.

Like most of us, trees don't want to be eaten alive.

To prevent this gruesome fate, they developed extremely tough cell walls around 400 million years ago. For millions of years, nothing could break down lignin, the strongest substance in those cell walls. When a tree died, it just sank into the swamp where it grew. When the fossil record started showing trees breaking down around 300 million years ago, most scientists assumed it was because the ubiquitous swamps of the time were drying up.

But biologist David Hibbett at Clark University suspected that wasn't the whole story. An alternative theory from researcher Jennifer Robinson intrigued him. She theorized that instead of ecosystem change alone, something else played a major role – something evolving the ability to break down lignin. Through evolutionary biology research supported by the Department of Energy's (DOE) Office of Science, Hibbett and his team confirmed her theory. They found that, just as she predicted, a group of fungi known as "white rot fungi" evolved the ability to break down lignin approximately the same time that coal formation drastically decreased. His research illustrated just how essential white rot fungi were to Earth's evolution.

Fungi are still indispensable. The short-order cooks of the natural world, they have an unheralded job making nutrients accessible to the rest of us. Just like cooking spinach makes it easier to digest, some fungi can break down plant cell walls, including lignin. That makes it easier for other organisms to use the carbon that is in those cell walls.

"We all live in the digestive tract of fungi," said Scott Baker, a biologist at DOE's Pacific Northwest National Laboratory. If we weren't surrounded by fungi that decay dead plant material, it would be much harder for plants to obtain the nutrients they need.

To understand fungi's role in the ecosystem and support biofuels research, scientists supported by DOE's Office of Science are studying how fungi have evolved to decompose wood and other plants.

The Special Skills of Fungi

Fungi face a tough task. Trees' cell walls contain lignin, which holds up trees and helps them resist rotting. Without lignin, California redwoods and Amazonian kapoks wouldn't be able to soar hundreds of feet into the air. Trees' cell walls also include cellulose, a similar compound that is more easily digested but still difficult to break down into simple sugars.

By co-evolving with trees, fungi managed to get around those defenses. Fungi are the only major organism that can break down or significantly modify lignin. They're also much better at breaking down cellulose than most other organisms.

In fact, fungi are even better at it than people and the machines we've developed. The bioenergy industry can't yet efficiently and affordably break down lignin, which is needed to transform non-food plants such as poplar trees into biofuels. Most current industrial processes burn the lignin or treat it with expensive and inefficient chemicals. Learning how fungi break down lignin and cellulose could make these processes more affordable and sustainable.

Tracing the Fungal Family Tree

While fungi live almost everywhere on Earth, advances in genetic and protein analysis now allow us to see how these short-order cooks work in their kitchen. Scientists can sample a fungus in the wild and analyze its genetic makeup in the laboratory.

By comparing genes in different types of fungi and how those fungi are evolutionarily related to each other, scientists can trace which genes fungi have gained or lost over time. They can also examine which genes an individual fungus has turned "on" or "off" at any one time.

By identifying a fungus's genes and the proteins it produces, scientists can match up which genes code for which proteins. A number of projects seeking to do this tap the resources of the Joint Genome Institute (JGI) and the Environmental Molecular Sciences Laboratory (EMSL), both Office of Science user facilities.

Understanding the Rot

Just as different chefs use different techniques, fungi have a variety of ways to break down lignin, cellulose, and other parts of wood's cell walls.

White Rot

Although fungi appeared millions of years earlier, the group of fungi known as white rot was the first type to break down lignin. That group is still a major player, leaving wood flaky and bleached-looking in the forest.

"White rot is amazing," said Hibbett.

To break down lignin, white rot fungi use strong enzymes, proteins that speed up chemical reactions. These enzymes split many of lignin's chemical bonds, turning it into simple sugars and releasing carbon dioxide into the air. White rot is still better at rending lignin than any other type of fungus.

Brown Rot

Compared to white rot's powerful effects, the scientific community long thought the group known as brown rot fungi was weak. That's because brown rot fungi can't fully break down lignin.

Recalling his college classes in the 1980s, Barry Goodell, a professor at the University of Massachusetts Amherst said, "Teachers at the time considered them these poor little things that were primitive."

Never underestimate a fungus. Even though brown rot fungi make up only 6 percent of the species that break down wood, they decompose 80 percent of the world's pine and other conifers. As scientists working with JGI in 2009 discovered, brown rot wasn't primitive compared to white rot. In fact, brown rot actually evolved from early white rot fungi. As the brown rot species evolved, they actually lost genes that code for lignin-destroying enzymes.

Like good cooks adjusting to a new kitchen, evolution led brown rot fungi to find a better way. Instead of unleashing the brute force of energy-intensive enzymes alone, they supplemented that enzyme action with the more efficient "chelator-mediated Fenton reaction" (CMF) process. This process breaks down wood cell walls by producing hydrogen peroxide and other chemicals. These chemicals react with iron naturally in the environment to break down the wood. Instead of fully breaking down the lignin, this process modifies it just enough for the fungus to reach the other chemicals in the cell wall.

There was just one problem with this discovery. In theory, the CMF chemical reaction is so strong it should break down both the fungus and the enzymes it relies on. "It would end up obliterating itself," said Jonathan Schilling, an associate professor at the University of Minnesota.

Scientists' main theory was that the fungus created a physical barrier between the reaction and the enzymes. To test that idea, Schilling and his team grew a brown rot fungus on very thin pieces of wood. As they watched the fungus work its way through the wood, they saw that the fungus was breaking up the process not in space, but in time. First, it expressed genes to produce the corrosive reaction. Two days later, it expressed genes to create enzymes. Considering fungi can take years or even decades to break down a log, 48 hours is a blip in time.

Scientists are still trying to figure out how much of a role the CMF process plays. Schilling and like-minded researchers think enzymes are still a major part of the process, while Goodell's research suggests that CMF reactions do most of the work. Goodell's team reported that CMF reactions could liquefy as much as 75 percent of a piece of pine wood.

Either way, the CMF process offers a great deal of potential for biorefineries. Using brown rot fungi's pretreatment could allow industry to use fewer expensive, energy-intensive enzymes.

Not all fungi stand alone. Many types live in symbiosis with animals, as the fungus and animal rely on each other for essential services.

Partnerships with Rumens

Cows and other animals that eat grass depend on gut fungi and other microorganisms to help break down lignin, cellulose, and other materials in wood's cell walls. While fungi only make up 8 percent of the gut microbes, they break down 50 percent of the biomass.

To figure out which enzymes the gut fungi produce, Michelle O'Malley and her team at the University of California, Santa Barbara grew several species of gut fungi on lignocellulose. They then fed them simple sugars. As the fungi "ate" the simple sugars, they stopped the hard work of breaking down the cell walls, like opting for take-out rather than cooking at home.

Depending on the food source, fungi "turned off" certain genes and shifted which enzymes they were producing. Scientists found that these fungi produced hundreds more enzymes than fungi used in industry can. They also discovered that the enzymes worked together to be even more effective than industrial processes currently are.

"That was a huge diversity in enzymes that we had never seen," said O'Malley.

O'Malley's recent research shows that industry may be able to produce biofuels even more effectively by connecting groups of enzymes like those produced by gut fungi.

Termites as Fungus Farmers

Some fungi work outside the guts of animals, like those that partner with termites. Tropical termites are far more effective at breaking down wood than animals that eat grass or leaves, both of which are far easier to digest. Young termites first mix fungal spores with the wood in their own stomachs, then poop it out in a protected chamber. After 45 days of fungal decomposition, older termites eat this mix. By the end, the wood is almost completely digested.

"The cultivation of fungus for food [by termites] is one of the most remarkable forms of symbiosis on the planet," said Cameron Currie, a professor at the University of Wisconsin, Madison and researcher with the DOE's Great Lakes Bioenergy Research Center.

Scientists assumed that the majority of the decomposition occurred outside of the gut, discounting the work of the younger termites. But Hongji Li, a biologist at the University of Wisconsin, Madison, wondered if younger insects deserved more credit. He found that young workers' guts break down much of the lignin. In addition, the fungi involved don't use any of the typical enzymes white or brown rot fungi produce. Because the fungi and gut microbiota associated with termites have evolved more recently, this discovery may open the door to new innovations.

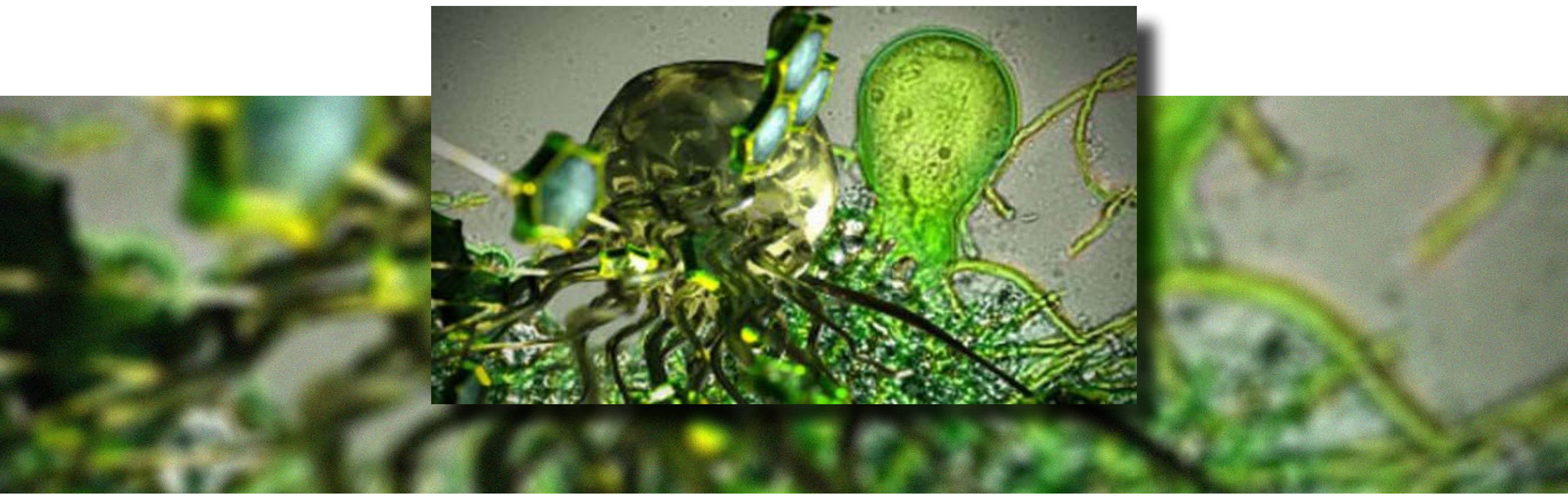
From the Lab to the Manufacturing Floor

From the forest floor to termite mounds, fungal decomposition could provide new tools for biofuels production. One route is for industry to directly produce the fungal and associated microbiota's enzymes and other chemicals. When they analyzed termite-fungi systems, scientists found hundreds of unique enzymes.

"We're trying to dig into the genes to discover some super enzyme to move into the industry level," said Li.

A more promising route may be for companies to transfer the genes that code for these enzymes into organisms they can already cultivate, like yeast or E. coli. An even more radical but potentially fruitful route is for industry to mimic natural fungal communities.

For millions of years, fungi have toiled as short-order cooks to break down wood and other plants. With a new understanding of their abilities, scientists are helping us comprehend how essential they are to Earth's past and future.



HARD-SEEDED PASTURE LEGUMES EXPAND AS MIXED-FARMING OPTION

Liz Wells, April 11, 2019

https://www.graincentral.com/cropping/hard-seeded-pasture-legumes-expand-as-mixed-farming-option/#.XK8EXr3REjw.twitter

A RIP-ROARING drought and buoyant livestock prices have bolstered interest in hard-seeded legume pastures as a worthy inclusion in mixed-farming rotations in New South Wales.

Already a favourite in some Western Australian farming systems, the Mediterranean natives and their spin-offs can last for years in paddocks which can host simultaneous cash crops, and are being considered as an alternative to subterranean (sub) clovers and medics.

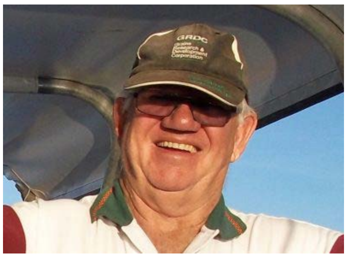
Generating interest are species including arrowleaf, bladder and gland clovers, hard-seeded French serradella and biserrula.

Natives sourced from the Centre for Legumes in Mediterranean Agriculture (CLIMA) and investigated in WA by the Murdoch University, University of Western Australia, CSIRO and WA's agriculture department introduced hard-seeded pasture legumes to Australia in the 1990s.

Part of their initial appeal was their ability to increase the amount of groundcover provided by winter-crop residue in the face of wind and rain events over the summer fallow period.

The hammering topsoil in parts of NSW has received from dust storms in the face of failed or low-yielding crops due to drought has boosted eastern-states interest in them.

Nitrogen fillip



Global Pastures director **Neil Ballard** is a long-term proponent of hard-seeded pasture legumes, and grew Santorini, the first serradella variety, when it was released in WA in 1995.

In WA, he said concerns about herbicide resistance and high expenditures on artificial nitrogen were continuing to boost interest in hard-seeded pasture legumes.

He said farmers from eastern states who wanted to maximise their earnings from livestock with a resilient and flexible pasture base have been contacting him more frequently in recent times.

"They allow you to alter your crop-to-pasture ratio, and your crop-to-livestock ratios, and you can also reduce your dependence and outlay on artificial nitrogen," Dr Ballard said.

"Now that sheep and wool and meat are providing a strong level of return, some people are thinking cropping by itself isn't doing the land any good.

"It's a high-input, high-risk and high-outlay situation."

Dr Ballard said some cropping operations, including that of users **Colin and Anna Butcher** at Brookton, 120 kilometres east of Perth, are saving tens of thousands of dollars per year by growing hard-seeded pasture legumes which have reduced their need for artificial nitrogen.

The Butchers have also been able to grow wheat crops yielding up to five tonnes per hectare, with no response to artificial nitrogen shown in barley, canola and wheat crops, in paddocks after hard-seeded pastures.

"We're not growing better crops, but we're growing similar-yielding crops with lower input costs and reduced production risk," Anna Butcher said.

Additional N	Yield	Protein
No added N	5.0t/ha	10.0pc
Urea at 50kg/ha	4.2t/ha	10.2pc
Urea at 100kg/ha	4.7t/ha	10.3pc
Urea at 150kg/ha	5.4t/ha	11.0pc
Urea at 200kg/ha	4.8t/ha	10.3pc

Table 1: Results from a DAFWA and Murdoch University trial site on Colin and Anna Butchers' Brookton, WA, property where Mace wheat was grown in 2013 following a year of serradella.

Dr Ballard said most new species are "incredible nodulators" compared with sub clover.

"This compares with a grain legume, where you cart 30 per cent of your nitrogen out in the truck."

"The general message is that you need a legume in the rotation to get your own organic nitrogen."

"Long-term croppers are finding more and more paddocks are becoming uneconomical to farm because artificial nitrogen isn't the answer."

A further agronomic benefit of hard-seeded pasture legumes is their ability to promote rhizobia populations, which help crops absorb nutrients in the soil.

Alternative to sub clovers, medics

Less reliable rainfall patterns have contributed to mixed farmers looking for an alternative to sub clovers and medics for their pasture phase.

"Sub clovers and medics have shallow root systems, and the seedbank can be depleted through false breaks in late summer and early autumn where seedlings die dry springs, because they can't access deep moisture and set seed," NSW Department of Primary Industries soil unit researcher Belinda Hackney said.

Management has also played a part in the loss of popularity in sub clovers and medics in some districts.

"Because of how much livestock weren't worth through the 90s and into the Millennium Drought, farmers weren't always following through with their fertiliser inputs, and seed banks fell away."

Dr Hackney is involved with a number of trial sites, including one at Ungarie, northwest of West Wyalong, which got 90 millimetres of growing season rain in last year's unusually dry growing season.

Sub clover set no seed, medic set less than 10kg/ha, and biserrula set 170kg/ha, which exceeds the benchmark rate of seed set of 100-150kg/ha.

"Serradella, arrowleaf and biserrula can go down to 1.5 or 2 metres for moisture, so they are quite well protected from dry spring conditions."

Beckom experience

South of West Wyalong at Beckom, farmer Mike O'Hare was introduced to hard-seeded pasture legumes through his hosting of a hard-seeded pasture legume trial conducted by Dr Hackney in 2009, when dry seasons had depleted sub clover seed banks.

"We saw the benefits of it in the first couple of years, and we just kept going to where we are now, with 90pc of our farm sown with biserrula."

"We're still learning, but we feel it's handling our system easily, and it's regenerating after three years without seeding."

The O'Hare farm covers 2200 hectares, and is 50/50 split between sheep and cropping in a 475-millimetre annual average rainfall area.

Mr O'Hare grows biserrula on its own, and has some area planted to a mixture of arrowleaf, bladder and gland clover, and additional area with barrel medic.

"The hard-seeded clovers are not as reliable, and they didn't perform so well in the wet year in 2016, which didn't worry the biserrula, but they all have their place."

Beckom farmer Mike O'Hare in a paddock of biserrula. Photo: Ted Wolfe

Performer on acid soils

Esperance-district farmer Scott Welke, Cascade, first experimented with serradella in the early 2000s as a means of dealing with red- clover syndrome.

"Red-clover syndrome makes subs underperform and become Bonsai, particularly with an early break," Mr Welke said.

"Our sub clover base was diminishing, and we couldn't carry as many sheep as we used to, so I got into Santorini serradella as an annual to put in with subtropical perennials.

"It's worked well on acid white sands.

"It's bolted away on our sand hills, and turned some really ordinary country into productive country."

Mr Welke said the farm's area was split half and half between cropping and sheep, but the improved productivity in their pastures since serradella was introduced has allowed them to run the same amount of sheep on 30pc of their country, and crop the other 70pc.

"For us, serradella is an autumn-break plant, and seems to have a stronger resistance to disease and insect pressure from pests like red-legged earth mite."

"It's a deep-rooted plant, and can hang on into December if get a late rain in spring.

Mr Welke harvests his serradella every year, and inoculates the seed.

"We use lifters to harvest, as if you were harvesting peas or lentils.
Cheaper to plant, harvest

Now that the sun has set on suction-harvester manufacturing, hard-seeded pasture legumes are making mechanical as well as agronomic sense.

Suction machines are essential for harvesting sub clovers, and handy for harvesting medics, but have become difficult to purchase second-hand, and problematic to fix due to the shortage of genuine parts.

"The practical thing about these hard-seeded pastures is you can grow and harvest your own seed with a conventional header," Dr Hackney said.

Seed harvested on farm has very high hard-seed content, and new methods of establishment — summer and twin sowing —have been developed to allow cheaper and timelier methods of pasture establishment.

With summer sowing, hard seed, or pod segments in the case of serradella, are sown in summer.

High summer temperatures break down the hard seed, and plants germinate on opening autumn rain.

Summer sowing also allows pasture sowing to be completed before winter-cropping program begins so labour can be used more efficiently.

Not all hard-seeded species and varieties are suitable for summer sowing.

The hard-seeded French serradella varieties Margurita and Erica developed by Dr Brad Nutt of Murdoch University and bladder clover work well for summer sowing in WA and NSW while, arrowleaf clover and biserrula have also been successful in NSW.

Twin sowing involves sowing hard seed or pod segments with the last crop in the cropping phase.

The hard seed breaks down during the final year in the cropping phase, and emerges on the following autumn rain.

Hard-seeded French serradella and bladder clover have performed well in twin sowing trials and commercially in WA and NSW.

Both summer and twin sowing require use of 20-30kg/ha of serradella pod or 10-15kg/ha of unscarified seed.

The new legumes can also be sown conventionally in late autumn using purchased scarified seed sown at 5-10 kg/ha, a similar rate to sub clover.

A first-year stand of bladder clover at McDougall Bros farm at Tincurrin east of Narrogin in WA. Photo: Global Pastures

Seed-bank management

Hard-seeded pasture legumes will germinate when their outer seed case breaks down due to rain, time or temperature variation.

“The idea is to get as big a seed bank in the ground as you can” Dr Hackney said.

Mr Ballard said planning ahead was needed to get seed into the ground before the break and maximise germination response on the next rain.

He has recommended the following management to establish hard-seeded legume pastures:

- Sow into a paddock where the weed seedbank has been controlled effectively
- Pasture in year one;
- Graze into the start of flowering;
- Lock up pasture to maximise seed set, and harvest if desired;
- Graze over summer, so a high percentage of seed passes through animals;
- Crop in year two and return to a pasture phase in year three.

“Follow this three-year discipline, and you will be set up for life,” Dr Ballard said.

Once a seed bank is established, hard-seeded legumes are very persistent.

It is generally a good idea to manage the species to allow for good seed set at least every two to three years following initial establishment to keep seed bank numbers high and ensure robust pasture regeneration.

In their native Mediterranean habitat, hard-seeded pasture legumes withstand very heavy grazing.

“These plants have survived uncontrolled grazing by sheep and goats in the Mediterranean for hundreds of years,” Mr Ballard said.

Mr Ballard said new species leave a good body of dry feed in the paddock which does not deteriorate with the amount of summer rain which would normally ruin sub clover.

"They allow you to establish pastures in a different way.

"Cropping can win out over pasture because you can pick and choose your hard-seed breakdown pattern."

"They are different to manage than sub clover, not harder."

Breaking nematode cycle

Dr Ballard said serradella and biserrula are also beneficial in breaking the cycle of nematode population build-ups for both Pratylenchus neglectus and Pratylenchus thorneii.

"Many growers are including them in their rotation mainly for that reason.

"Sulla, which isn't grown much in WA, serradella and biserrula are the three best options for breaking nematode-breeding cycles.

"One year of these reduces the populations enormously, and results in higher yields in following crops."

Multi-industry investment

While some aspects of mixed farming (think triticale) have trouble attracting funding dollars, research into hard-seeded pasture legumes has drawn broad and recurring investment.

Programs are currently supported by the Federal Government's Rural R&D for Profit program, the Grains Research and Development Corporation, Meat and Livestock Australia (MLA) and Australian Wool Innovation (AWI).

Research partners include grower groups, Charles Sturt University, NSW Department of Primary Industries, CSIRO, Murdoch University, the South Australian Research and Development Institute, and WA Department of Primary Industries and Regional Development.

Dairy Australia and the Rural Industries Research and Development Corporation have also contributed in the past.

Researchers are now evaluating and developing species and varieties to cope with challenging environments such as high-boron and high-aluminium soils, and earlier-flowering varieties for low-rainfall areas.

CONCERNS OVER GLYPHOSATE PASS FROM HUMAN HEALTH TO THE SOIL

Experts say the weedkiller's impact on soil health represents a serious threat to Europe's long-term food security.

By Simon Marks - 4/3/19, 6:30 PM CET

https://www.politico.eu/article/glyphosate-concerns-pass-from-human-health-to-soil/

When François Peaucellier talks about soil, he sounds like a sommelier. "It's full of little leaves," says the French farmer, holding up a clod from his field. "The earth is supple and beautiful. There is a surface life that is superb."

Peaucellier, who grows cereals and vegetables on a 200-hectare farm in the Hauts-de-France region north of Paris, is part of small but growing movement of farmers who are cutting back on pesticides not so much out of concerns for human health — but because they worry about what it does to the soil.

Public attention on the risk of pesticides has focused on what chemicals like glyphosate do to human health. A U.S. federal jury last week ordered Germany's Bayer to pay more than $80 million to a man who claimed his cancer was caused by exposure to the weedkiller.

But farmers like Peaucellier say the weedkiller's impact on soil health has been overlooked, and represents a serious threat to Europe's long-term food security. Soil experts, academics and scientific studies are also establishing clear links between the use of substances such as glyphosate with drops in soil fertility and the collapse of microbe ecosystems essential to healthy soil.

With more than a third of the world's land already degraded by erosion, compaction and chemical pollution, according to the U.N.'s Food and Agricultural Organization, thousands of farmers in countries like France are starting to embrace new methods.

Peaucellier, 30, no longer measures success just by the bounty of his crops, he says, but by the number of worms he finds living in the soil beneath them. "Look at the rapeseed plants. Normally the plants should be twice as high as that," he says, gazing at his neighbor's fields.

He pierces his own land with a yellow spade. The soil is marbled with healthy decomposing roots, crawling lice and squirming earthworms. "These animals do so much more work than any fertilizer will do," he says. "But you need one, two, three years to bring back the life."

Disappearing earthworms

The European Union currently has no legal limit for the amount of glyphosate permitted in European soil, according to Vera Silva, a researcher for the soil physics and land management group at Wageningen University in the Netherlands.

Silva has carried out extensive research into the prevalence of pesticide residues found in European soils. Though glyphosate can kill specific fungi and bacteria that plants need to suck up nutrients, "the effects of such a change are not completely understood yet," she says.

Silva and other researchers at Wageningen University raised concerns about pesticide residues in a 2015 study, which looked at more than 300 samples of agricultural topsoil from across the EU.

They found that four out of five samples contained at least one residue, and nearly three in five contained mixtures of chemicals. Little is known about the effects of mixtures. "The combined effects of residue mixtures need to be assessed," the study recommended.

Another study from 2015 carried out by researchers from the University of Natural Resources and Life Sciences in Vienna also showed that casting activity of earthworms had nearly disappeared from the surface of farmland within three weeks of glyphosate application.

Earthworms redistribute organic material in soil and are essential for soil fertility.

The animals' reproductive activity fell by more than half, according to the same study. "These sizeable herbicide-induced impacts on agroecosystems are particularly worrisome because these herbicides have been globally used for decades," the study found.

Beyond worms, the chemical appears to damage microbes that aid in plant decay, mineralization, and soil's vital carbon and nitrogen cycles. "Glyphosate can be present in some soil organisims," says Silva. "As soon as these organisms are affected, soil functions might be impaired."

Weighing the benefits, risks

Nearly 500 active substances are approved for use in pesticides in the EU, and European farms buy 374,000 tons of pesticides annually, according to Eurostat, the EU's statistical agency. Globally, 3 million tons of pesticides are used each year, generating about $40 billion in revenue.

Bayer, the world's largest producer of glyphosate, says that "precise application of glyphosate-based herbicides can allow farmers to leave the soil intact," reducing tilling practices that release greenhouse gases and contribute to erosion.

Pesticides companies also point out that users of pesticides should follow rules in the EU's Sustainable Use Directive, which requires farmers to be trained in their use. The directive also mandates that all chemical equipment be inspected, prohibits aerial spraying and limits pesticide use in sensitive areas.

"Soil, like any resource, must be respected and protected," says Graeme Taylor, director of public affairs for the European Crop Protection Association, a lobby representing the pesticide industry. "The strong implementation of the Sustainable Use Directive is crucial in this respect."

Taylor added that EU pesticide laws insist that pesticides undergo a soil risk assessment in which an acceptable concentration is defined.

Even glyphosate-skeptics like Peaucellier acknowledge that farming without pesticides is difficult. Peaucellier still uses small amounts of glyphosate on his fields. To reduce his use further, he is experimenting with new strategies like conservation agriculture, a system that promotes permanent soil cover, no tillage and regular crop rotation as a way of improving biodiversity.

Peaucellier's new farming practices go like this. Rather than leaving land fallow after a harvest, he immediately reseeds with a "cover crop" that's left to wilt. He crushes the cover plants with a roller, so they lie against the ground, helping prevent weeds. Soon they decompose and replenish the soil with nutrients.

Last year Peaucellier began field tests comparing different cover crops and glyphosate doses on 30 strips of his own farmland. At the end of May he'll review the test plots with experts from the French National Institute for Agricultural Research, and evaluate the results.

A farmer sprays glyphosate herbicide produced by U.S. agrochemical giant Monsanto on May 11, 2018, on a field of no-till corn in Piace, France | Francois Monier/AFP via Getty Images

Peaucellier is one of 5,000 farmers in France to have adopted conservation agriculture techniques, he said. On Thursday he is scheduled to travel to the National Assembly in Paris, to argue for conservation agriculture to be specifically subsidized as part of the EU's €59-billion-per-year Common Agricultural Policy. The national farming plan predominantly focuses on conventional farming methods.

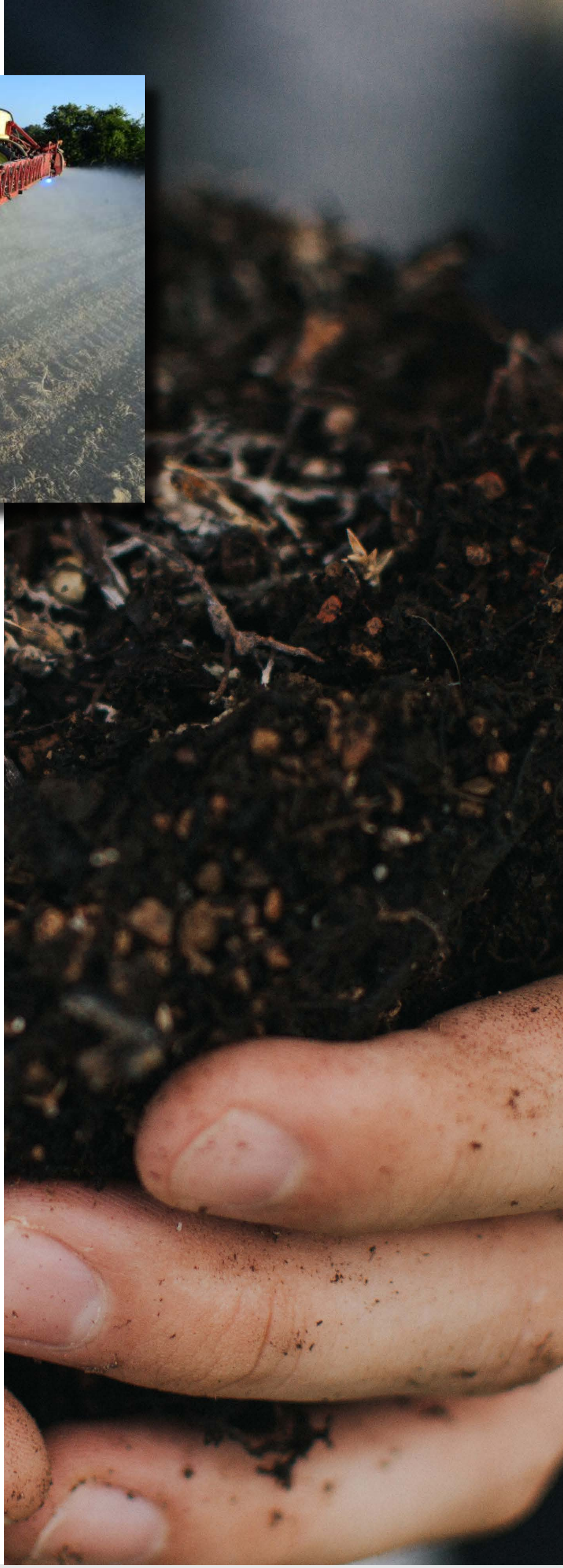
"The idea is to say to politicians 'help us to finance our cover crops rather than buying enormous machines that are useless,'" he says. "They don't understand that planting a seed can be useful to cover the soil, nourish the soil and avoid that carbon is released into the atmosphere."

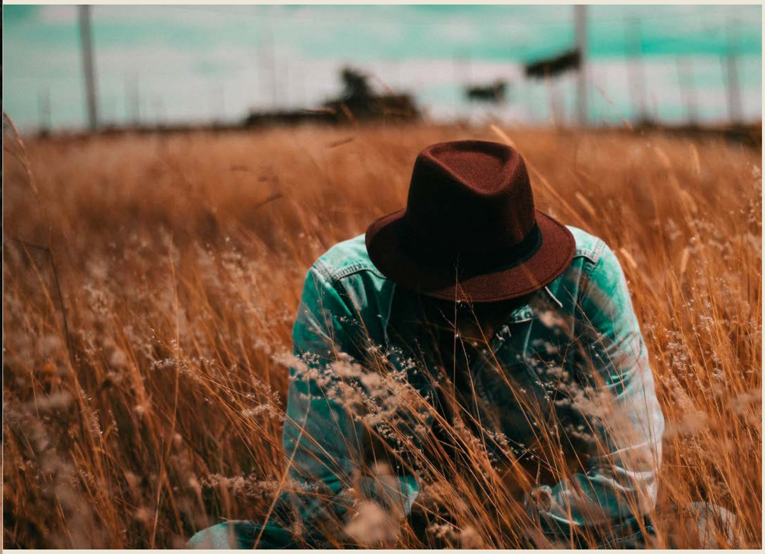
To illustrate his point, Peaucellier crosses the road to his neighbor's field and drives his shovel into the ground. The earth is hard, compact and resists his attempt to break it up. Underneath, the ground is hard, with no evidence of underground life.

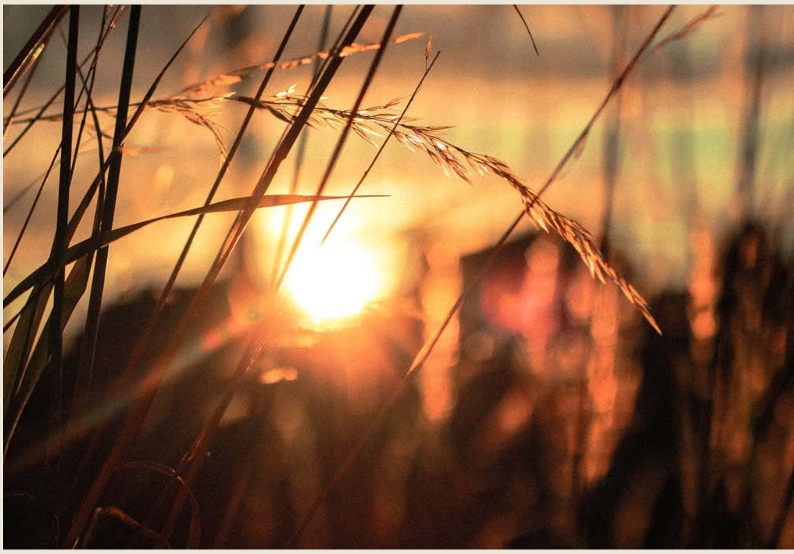
He points to a large crack — evidence of erosion. Pesticide residues had run off and contaminated a stream further down the valley, he says. "When it's sprayed on ... the degradation of the earth is much quicker," he says.

"There's a real problem when we say we have to put in more to have more," he says.

This article is part of a special report on soil degradation in Europe.







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