February 2017

Issue/Uitgawe 52

blwk - cawc

Newsletter

BLWK/CAWC: Your monthly guide

Content

Upcoming farmers' days and events:

- Overberg Agri Voorsaaidag – 12 March 2017
- SKOG Voorsaaidag – 15 March 2017
- Langgewens Walk & Talk – 13 July 2017
- CAWC Lecture day – 1 August 2017
- CAWC Practical day – 3 August 2017

Hi Everybody

The 2017 production season for the Western Cape is approaching fast and we hope that it brings normal to above normal rain for our producers following the very dry summer.
We are looking forward to all the events we have planned for the CAWC (BLWK) and we have already attended our first Brown tour on the 9th of March. In the next newsletter we will give some feedback on the talks.

We have also confirmed our international speakers for the 2017 conference in August. We will be joined by Dr Wendy Taheri (US) and Dr Ken Flower (Australia). Hope you enjoy this month's newsletter.

Regards
The editor

Western Cape Government
Agriculture
BETTER TOGETHER.

LANDCARE
SOUTH AFRICA

What is Regenerative Agriculture?

December 21, 2016

"Regenerative Agriculture" describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity – resulting in both carbon drawdown and improving the water cycle.

Specifically, **Regenerative Agriculture** is a holistic land management practice that leverages the power of photosynthesis in plants to close the carbon cycle, and build soil health, crop resilience and nutrient density. Regenerative agriculture improves soil health, primarily through the practices that increase soil organic matter. This not only aids in increasing soil biota diversity and health, but increases biodiversity both above and below the soil surface, while increasing both water holding capacity and sequestering carbon at greater depths, thus drawing down climate-damaging levels of atmospheric CO2, and improving soil structure to reverse civilization-threatening human-caused soil loss. Research continues to reveal the damaging effects to soil from tillage, applications of agricultural chemicals and salt based fertilizers, and carbon mining. Regenerative Agriculture reverses this paradigm to build for the future.

Regenerative Agricultural Practices are:

Practices that (i) contribute to generating/building soils and soil fertility and health; (ii) increase water percolation, water retention, and clean and safe water runoff; (iii) increase biodiversity and ecosystem health and resiliency; and (iv) invert the carbon emissions of conventional agriculture to one of remarkably significant carbon sequestration thereby cleansing the atmosphere of legacy levels of CO2.

Practices include:

1. No-till/minimum tillage. Tillage breaks up (pulverizes) soil aggregation and fungal communities while adding excess O2 to the soil for increased respiration and CO2 emission. It can be one of the most degrading agricultural practices, greatly increasing soil erosion and carbon loss. A secondary effect is soil capping and slaking that can plug soil spaces for percolation creating much more water runoff and soil loss. Conversely, no-till/minimum tillage, in conjunction with other regenerative practices, enhances soil aggregation, water infiltration and retention, and carbon sequestration. However, some soils benefit from interim ripping to break apart hardpans, which can increase root zones and yields and have the capacity to increase soil health and carbon sequestration. Certain low level chiseling may have similar positive effects.
2. Soil fertility is increased in regenerative systems biologically through application of cover crops, crop rotations, compost, and animal manures, which restore the plant/soil microbiome to promote liberation, transfer, and cycling of essential soil nutrients. Artificial and synthetic fertilizers have created imbalances in the structure and function of microbial communities in soils, bypassing the natural biological acquisition of nutrients for the plants, creating a dependent agroecosystem and weaker, less resilient plants. Research has observed that application of synthetic and artificial fertilizers contribute to climate change through (i) the energy costs of production and transportation of the fertilizers, (ii) chemical breakdown and migration into water resources and the atmosphere; (iii) the distortion of soil microbial communities including

the diminution of soil methanothrops, and (iv) the accelerated decomposition of soil organic matter.

3. Building biological ecosystem diversity begins with inoculation of soils with composts or compost extracts to restore soil microbial community population, structure and functionality restoring soil system energy (C-compounds as exudates) through full-time planting of multiple crop inter-crop plantings, multispecies cover crops, and borders planted for bee habitat and other beneficial insects. This can include the highly successful push-pull systems. It is critical to eliminate synthetic nutrient dependent monocultures, low-biodiversity and soil degrading practices.
4. Well-managed grazing practices stimulate improved plant growth, increased soil carbon deposits, and overall pasture and grazing land productivity while greatly increasing soil fertility, insect and plant biodiversity, and soil carbon sequestration. These practices not only improve ecological health, but also the health of the animal and human consumer through improved micro-nutrients availability and better dietary omega balances. Feed lots and confined animal feeding systems contribute dramatically to (i) unhealthy monoculture production systems, (ii) low nutrient density forage (iii) increased water pollution, (iv) antibiotic usage and resistance, and (v) CO2 and methane emissions, all of which together yield broken and ecosystem-degrading food-production systems.

Co-Authors:

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http://www.csuchico.edu/sustainablefuture/aginitiative/
The Carbon Underground
https://thecarbonunderground.org/

This definition will continue to evolve as research and practice inform what builds the health of soils, sequesters carbon, and grows more topsoil for future generations.

Links of the month

Click on the button to visit the website.

Please note you will need an internet connection

VIEW PAGE Click to view website

Banking on Soil Health for Long-Term Profits

VIEW PAGE Click to view website

7 sustainable agricultural innovations

VIEW PAGE Click to view website

Three growers look for alternatives to world's top herbicide

VIEW PAGE Click to view website

More soil organic matter makes more rain

VIEW PAGE Click to view website

Soil Fungi Serve as Bacterial Highways and Dating Services

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Planting Green

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Ollila says there's more to No-till than buying equipment

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Build Soils with Good Forage

VIEW PAGE Click to view website

New 'super yield' GM wheat trial gets go-ahead

VIEW PAGE Click to view website

What I've Learned From No-Tilling: No-Till, Cover Crops and Wheat Pull Farm Out of a Yield Rut - See more at: https://

QUICK IMAGE

TREAT

No-Till and Cover Crops from a Farmer's Point of View

Jamie Scott participated in a roundtable on climate change and agriculture with USDA Secretary Vilsack in East Lansing, Michigan on April 23rd, 2015. Mr. Scott is the Chairman of the Kosciusko County Soil and Water Conservation District and currently serves as the Vice-President of the Indiana Association of Soil and Water Conservation Districts.

Alongside my father Jim, I operate JA Scott Farms. Together we grow approximately 2,000 acres of corn, soybeans and wheat in Kosciusko County, Indiana. One-hundred percent of those acres are planted using a no-till conservation cropping system that incorporates cover crops every winter.

We use this approach to take advantage of the soil health benefits of no-till and cover crops. We have higher yields, richer soil, and improved water holding capacity. I am also encouraged that these practices can remove carbon from the atmosphere and store it in the soil. We have found that these benefits outweigh the added expense of labor and cover crop seeds.

Once I realized the benefits of no-till and cover crops, I decided to try and spread the word to my fellow farmers. I host cover crop and soil health field days at my farm on a regular basis. In 2014, I spoke at the National Cover Crops and Soil Health conference in Omaha, Nebraska.

In 2012, I decided to turn my passion into a separate business by starting a turn-key cover crop service called Scott's Cover Crops. We serve over 400 farmers in Northern Indiana and Southern Michigan, providing cover crop seed for over 100,000 acres and cover crop planting on over 50,000 acres. We constantly try to expand our knowledge and understanding of the benefits and challenges of cover crops, planting a variety of different test plots to calibrate the best seeding rates and mixes.

What is right for soil health and cover crops in my part of the country is not the right prescription everywhere. I encourage producers to work with their local USDA office or soil conservation district to learn about the best way to improve soil health in their area.

MITIGATING CLIMATE CHANGE BY LOW-DISTURBANCE NO-TILLAGE

Dr C John Baker, ONZM, Feilding, New Zealand
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- At the 2015 Paris Convention on Climate Change the French Minister of Agriculture suggested increasing the carbon content of the world's soils by 0.4% per year for the dual purposes of reducing the amount of C02 in the atmosphere and increasing the world's ability to feed itself (Chambers et al, 2016).

- The single most important function that the recent practice of no-tillage (sowing agricultural seeds into soils that have not been ploughed) can perform in relation to climate change is to recapture CO2 from the atmosphere by photosynthesis and sequester it back into the world's 1.4 billion hectares of arable (cropping) soils since the vast majority of the world's food comes from annually-sown arable crops.

- Nature's way of sequestering carbon back into such soils from arable crops is largely by microbial decomposition of the straw and stubble (residues) from previous crops although root exudation during crop growth also contributes. The organic compounds are combined with clays and coated onto mineral particles in the soil to form soil structure. Earthworms and other soil fauna take both the residues and products of their decomposition into the soil with minimal mechanical disturbance of either.

- The common practice of burying the residues in the soil by mechanical cultivation (or tillage) does more harm than good by maximising soil/residue contact and causing more rapid oxidation of existing soil carbon into CO2, which is lost to the atmosphere, than is gained from the buried residues (Reicosky, 2006).

- This is why continuous cultivation of the world's cropping soils has cumulatively depleted their carbon contents, structure and biological life to unsustainably low levels. By the year 2050 with present methodologies, it is predicated that the world's arable soils will no longer be able to grow sufficient food to feed the anticipated increase in world population, which some sources estimate will be 50%.

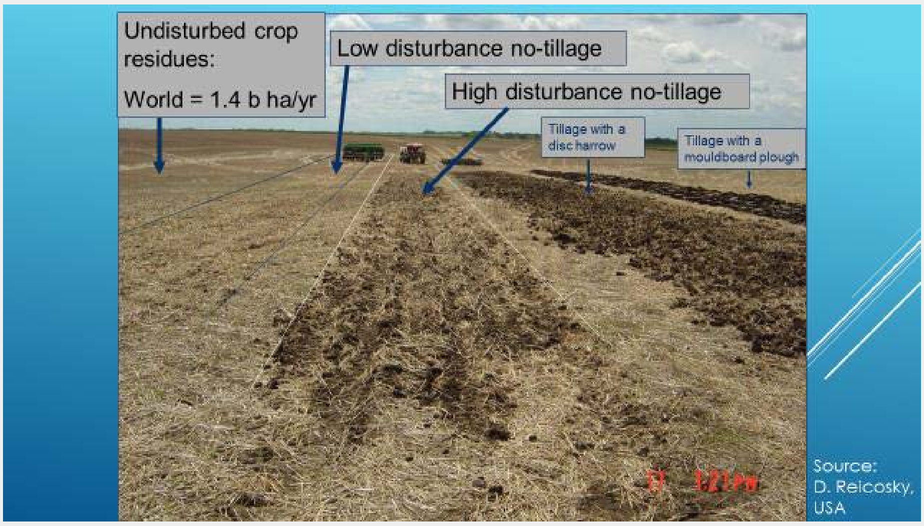
- The Paris Convention recognised that rebuilding soil carbon levels is not only a fundamental pre-requisite for the regeneration of soil health, it is also an inexpensive and effective way of removing significant amounts of existing CO2 from the atmosphere.

- Achieving these complementary outcomes requires special seed drills that can:
  a. Penetrate through the mulch of crop residues remaining on the surface of the soil after harvest of the previous food crop and sow the next crop, while simultaneously minimising mechanical soil disturbance, and
  b. Leave the mulch of crop residues in situ so that it covers as much of the soil surface as possible after seeding to reduce soil erosion. A mulch cover over the newly-formed slots created by the seed drill in the course of sowing the next crop also traps soil water vapour that virtually guarantees seed germination and crop establishment, even in dry soils.

- Very few seed drills can achieve this.

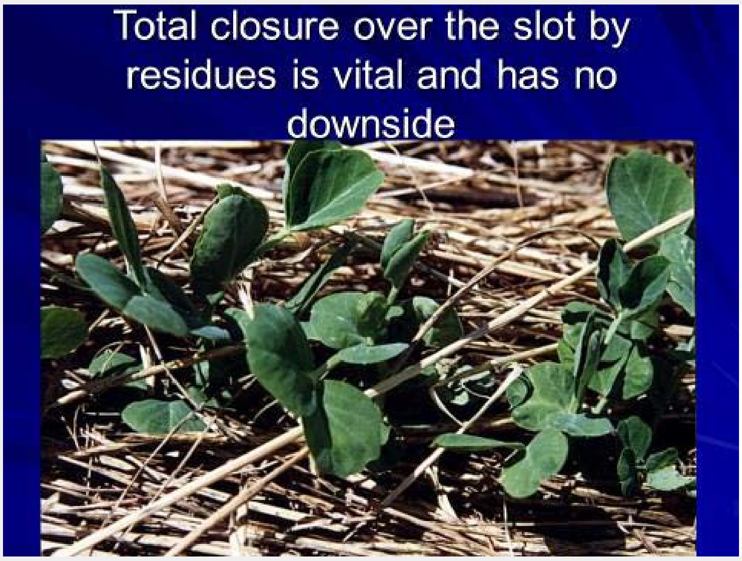
- Cross Slot® low-disturbance no-tillage seed drills, developed at New Zealand's Massey University over a period of 30 years and now marketed by Baker No-Tillage Ltd in Feilding, NZ, (Baker et al, 2006) is the most effective design that can achieve these objectives.

- Unfortunately, most of the world's "minimum tillage", "strip tillage", "conservation tillage" and "high-disturbance no-tillage" machines do not regularly achieve net increases in soil carbon during seeding. While they might reduce the carbon emissions otherwise caused by conventional cultivation, achieving a consistent net increase in soil carbon content at seeding time requires more sophisticated designs than most farm machinery companies are currently offering (Reicosky, 2015).



Left: The visual differences between high-disturbance and low-disturbance no-tillage seed drills plus two forms of conventional tillage, are illustrated

Close-up views of low-disturbance no-tillage are shown ***below***



What the numbers mean

- The world's total carbon emissions in 2015 were approximately 11 billion tonnes (11 GT) (Rattan Lal pers.com. 2015).
- New Zealand's total carbon emissions in 2014 were approximately 22 million tonnes (22 MT), of which approximately 25% was from agriculture.
- (Ministry for the Environment on-line data, 2016).
- The French target at the 2015 Paris convention was 0.4% increase in global soil carbon per year.
- Such a goal is probably unachievable because most of the world's soils are not accessible to direct manipulation by mankind because of topographical or climatological limitations or alternative uses such as urbanisation or nomadic livestock farming (Rattan Lal pers.com. 2015).
- But the world's 1.4 billion hectares of highly-accessible arable land is (by definition) accessible to mankind on an annual basis and comprises approximately 25% of all agricultural land (Wikipedia, 2011).

- Cross Slot® no-tillage has been shown to be capable of adding a minimum net* 500 kg carbon/hectare/year (Ghatohra, 2012) to the soil when used to grow arable cereal crops followed by either forage or cover crops, whereas conventional tillage loses up to net 2,000 kg carbon/hectare/year growing the same rotation.

- Total gains in carbon from decomposition of the residues of the previous crop, minus the measured field emissions of carbon from all sources (including respiration by decomposition microbes, oxidation from soil disturbance, burning or removal of residues prior to conventional tillage, and tractor exhaust gases) during the same period (see Attachment A).

- Applied to New Zealand's 1 million hectares of annual seeding of all soils (involving arable crops, forage crops and new pastures, Baker unpublished data 2002) Cross Slot low-disturbance no-tillage alone could offset 0.5 million tonnes (or 10%) of New Zealand's total annual carbon emissions from agriculture of 4.8 million tonnes, or 2.5% of the 22 million tonnes of carbon emitted from all sources in NZ.

- Applied to all of the world's 1.4 billion hectares of arable soil, Cross Slot low-disturbance no-tillage could offset 700 million tonnes (or 6%) of the world's total annual carbon emissions of 11 billion tonnes from all sources.

Attachment A: The basis of estimates of carbon gains and losses

Estimates and measurements of gains and losses of soil carbon ("carbon-in" versus "carbon-out") are as follows:

<u>For the spring-establishment of a barley crop in NZ after a pasture:</u>

By low-disturbance no-tillage:
"Carbon-in" from low-disturbance no-tillage results from decomposition of 1,000 kg Dry Matter (DM) of residual pasture with a measured carbon content of 45%, which is killed by glyphosate application in spring and allowed to decompose in situ on the ground surface. All of the carbon present is assumed to be added to the soil and any respiratory losses are accounted for by measurements of "carbon-out" below.

Estimated "carbon-in" at establishment of the barley crop is <u>450 kg C/ha.</u>

"Carbon-out" from low-disturbance no tillage has been measured (Ghatohra, 2012) as above-ground emissions of carbon dioxide from all sources during and after the seeding process by a Cross Slot no-tillage seed drill. The barley seeds were drilled through the decomposing pasture residues in a one-pass seeding operation that caused minimum disturbance to the soil and residues.

Measured "carbon-out" is <u>2,215 kg C/ha</u> for establishment and harvest of the barley crop.

By conventional tillage:

"Carbon-in" from conventional tillage results from physical incorporation of 1,000 kg DM of residual pasture with a measured carbon content of 45%, which is killed by glyphosate application in spring. Soil incorporation occurs with a plough or powered rotary cultivator.

Estimated "carbon-in" at establishment of the barley crop is <u>450 kg C/ha.</u>

"Carbon-out" from conventional tillage has been measured (Ghatohra, 2012) as above-ground emissions of carbon dioxide from all sources during and after the tillage process and drilling by a Cross Slot seed drill operating in the tilled soil.

Measured "carbon-out" is <u>2,580 kg C/ha</u> for establishment and harvest of the barley crop.

<u>For the autumn-harvest of the barley crop and autumn-establishment of a subsequent cover crop, forage crop or pasture:</u>

By low-disturbance no-tillage:
"Carbon-in" from low-disturbance no-tillage results from decomposition of an assumed 8 tonne/ha* DM of barley residues after harvest, containing 40% carbon (Smil, 1999).

> *In NZ, the weight of harvested seed from small grained cereals crops is approximately equal to the weight of straw, stubble, roots and chaff remaining as crop residues after harvest. Up to 11 tonne/ha of barley grain has been harvested in this district from Cross Slot low-disturbance no-tillage, but in this example 8t/ha is used as an achievable yield. The 8t/ha of crop residues is comprised of 3.2 t/ha (40%) roots and 4.8 t/ha (60%) aerial residues)

Estimated "carbon-in" is 3,200 kg/C/ha.

"Carbon-out" from low-disturbance no tillage (Ghatohra, 2012). Carbon is removed by (a) harvest of the grain from the crop for food purposes, and (b) as measured above-ground emissions of carbon dioxide from all sources during and after the harvest of barley together with seeding of the next crop by a Cross Slot no-tillage seed drill. The (in this case) following pasture crop seeds were drilled through the decomposing barley residues with minimum disturbance to the soil or residues.

Measured "carbon-out" is 2,877 kg C/ha for re-establishment of a following pasture crop.

By conventional tillage:

"Carbon-in from conventional tillage is mainly the carbon contained in the roots of the previous crop (40%) because it is common for the aerial residues of a harvested barley crop to be removed (by baling, burning or burial) to permit passage of the tillage implements. The roots component of the crop residues are also partly destroyed by any tillage process and their carbon is oxidised and captured in the measured above-ground emissions listed below.

Estimated "carbon-in" is 1,280 kg C/ha

"Carbon-out" from conventional tillage (Ghatohra, 2012). In addition to the harvested grain, has been measured as above-ground emissions of carbon dioxide from all sources during and after the tillage process and drilling by a Cross Slot seed drill operating in the tilled soil.

Measured "carbon-out" is 3,330 kg C/ha for re-establishment of the following pasture or cover crop.

For the growth and winter-harvest of the following pasture or cover crop

In NZ, because animal agriculture is commonly integrated with arable farming, it is assumed that both Low-disturbance no-tillage and Conventional tillage will experience the same net gain of soil carbon after establishment of a 5,000 kg DM/ha forage crop with 40% carbon content. In both cases it is assumed that the forage crop is consumed by animals in situ and the carbon content of the animal excrement is returned to the soil.

By contrast, in most pure arable rotations, sowing cover crops by conventionally cultivation is impractical. In the absence of animal-consumption and recycling, the cover crops residues have to be removed in bulk before tilling the seedbed for the next arable crop. Low-disturbance no-tillage, on the other hand, adds the carbon content of the cover crop to the soil at the start of the next cropping cycle, which is one of its main carbon-recapture mechanisms.
Estimated "carbon-in" for both treatments arising from a winter forage crop in NZ = 2,000 kg C/ha but in any case is assumed to be similar for both low-disturbance no-tillage and conventional tillage.

SUMMARY

Net carbon balances for the year in NZ (kg/ha/year):

By low-disturbance no-tillage: (450 + 3,200 + 2,000) – (2,215 +2,877)
= positive 558 kg C/ha/year
(say, an annual increase of approximately 500 kg soil C/ha/year).

By conventional tillage: (450 + 1,280 + 2,000) – (2,580 + 3,330)
= negative 2,180 kg C/ha/year
(say, an annual decrease of approximately 2,000 kg soil C/ha/year).

The main difference between the two options (tillage and low-disturbance no-tillage) occurs at step 2 when the carbon in the straw and residues of the barley crop is either returned to the soil (with low disturbance no-tillage and minimum soil/residue contact) or largely lost within a year (because of oxidation and maximum soil/residue contact from conventional tillage).

In arable situations with no animals, there is likely to be a further "carbon-in" opportunity for low-disturbance no-tillage from the ability to retain and drill through the cover crop residues. By contrast, cover crops are largely impractical with conventional tillage because of the need to dispose of the aerial residues before tillage can take place without machine blockages.

There are also differences in carbon emissions ("carbon-out") between the two methods of crop or pasture establishment. But these differences are smaller than the net gains to be made in carbon sequestration ("carbon-in") from retention of crop residues made uniquely-possible by low-disturbance no-tillage.

Conclusions:

The above figures firstly explain why the soil organic matter and soil carbon levels of most of the world's 1.4 billion hectares of arable soils have steadily declined over centuries due to intensive tillage with all of the negative environmental consequences (including soil erosion, sedimentation of waterways and declining – or at least the levelling off – of crop yields) that the world is now experiencing.

These soil effects are mirrored by excessive carbon in the atmosphere with its consequent negative effects on climate change.

The data also demonstrate that both processes can be reversed by the widespread application of low-disturbance no-tillage practices, the planting of cover crops and the retention of crop residues between successive crops.

Indeed, unless the figures are reversed or some other (as yet unrecognised) factor is able to increase crop yields from the world's degenerating arable soils, the world will simply not be able to feed all of its inhabitants by 2050.

The most important point is that the technologies and knowledge to implement low-disturbance no-tillage practices in the world's arable soils already exist and can be implemented almost immediately. Farmers simply need to change their methodology, which they can do at the same time as increasing profitability.
It's a classic win-win for agriculture and New Zealand's Cross Slot® is leading the way!

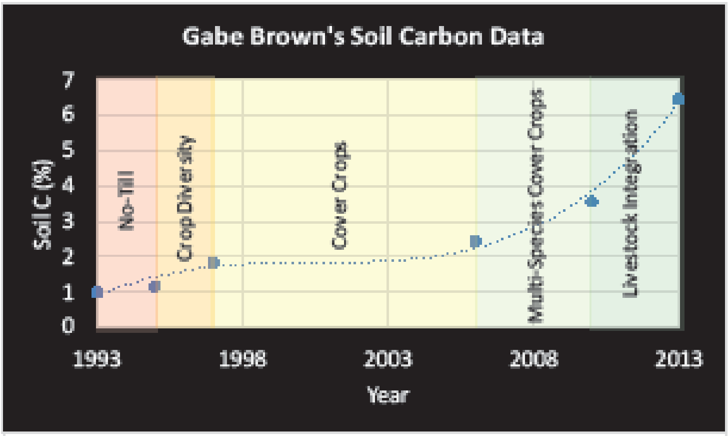
HOW YOU CAN HELP?

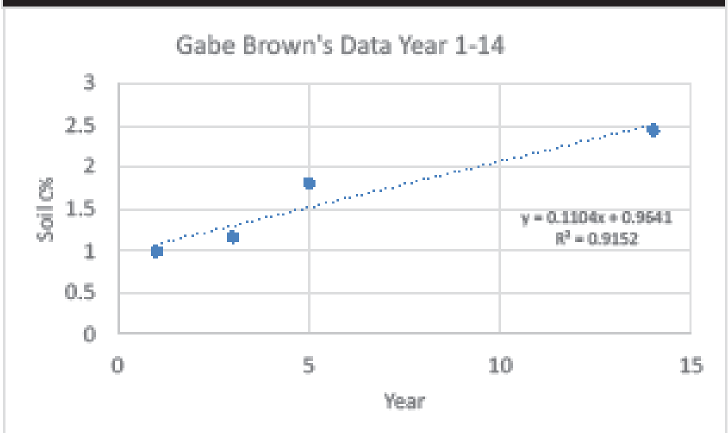
- Recognise that soil is a living biological system that requires carbon as its main source of energy to maintain food security for the survival of mankind.
- Recognise that carbon in the atmosphere and carbon in the soil are connected via the carbon cycle and the process of photosynthesis undertaken by green plants.
- Recognise that approximately 1/3 of the carbon captured from the atmosphere by photosynthesis goes into our food supply and 2/3 into maintaining the soil biological processes (D C Reicosky, pers. com. 2016)
- Recognise that no amount of reduction in atmospheric carbon will help the world feed itself unless that carbon finds its way back into the soil.
- Recognise that the photosynthesis undertaken by the world's 1.4 billion hectares of food-producing arable crops is both an effective way of re-capturing carbon from the atmosphere and can be influenced positively or negatively by mankind.
- Recognise that all soil disturbance and removal of crop residues when growing arable crops works against carbon finding its way back into the soil.
- Recognise that the carbon cycle that Cross Slot® low-disturbance no-tillage enables, can be repeated endlessly, sustainably and indefinitely in virtually any arable soil.
- Help proliferate New Zealand's unique Cross Slot® low-disturbance no-tillage technology, which works with nature to enable the transfer of re-captured atmospheric carbon back into the soil.

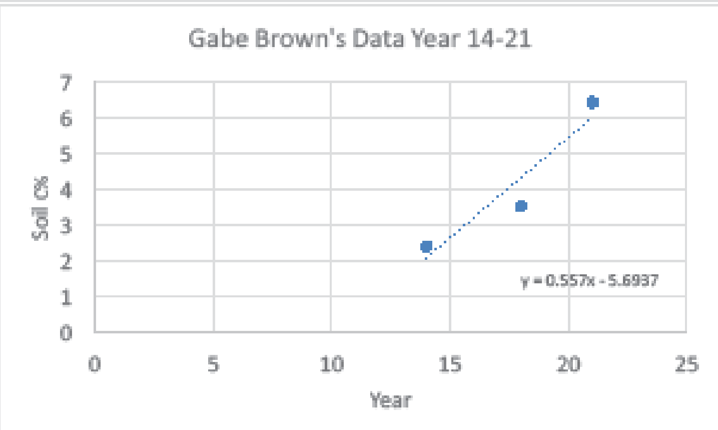
Global Carbon Capture

The best rates of field-observed soil C increases in soil restoration scenarios range between 0.24 to 0.557 tons soil C% increase/year. This translates to ~ 10.7 to 25.5 tons C/hectare/year stored in soil structures, based on the assumptions on the second page. I will give you some current observations on others as well as my research, to establish the premise that soil C% can be increased at rates considerably above observations of other research. Niggli, West and Lal have expressed soil C% increases of from 0.1 to 0.7 tons C/hectare/year. (References on request)

Gabe Browns data: The soil C% increase for the first 14 years of crop management yielded an average of 0.11% soil C% increase (slope = 0.1104) [see graph below]. The last seven years, where multispecies cover crops and livestock integration was adopted the soil C% increase was 0.56% (slope = 0.557) [see graphs and data table for Gabe's soil carbon below].







		SOM	C%
1	1993	1.7	0.988372
2	1994		
3	1995	2	1.162791
4	1996		
5	1997	3.1	1.802326
6	1998		
7	1999		
8	2000		
9	2001		
10	2002		
11	2003		
12	2004		
13	2005		
14	2006	4.2	2.44186
15	2007		
16	2008		
17	2009		
18	2010	6.1	3.546512
19	2011		
20	2012		
21	2013	11.1	6.453488

In my research I have observed 0.24 soil C% increase in my transitional soils (10.72 tons C increase/hectare/ year), approximately twice the transitional soil C% increase observed by Gabe Brown. In my improved soils a "point in time increase" in soil C% derived from aboveground biomass yielded 0.51% soil C increase . I have observed higher rates but that was using specialty crops and conditions to determine maximum photosynthetic production capacity. I feel comfortable based on Gabe's and my data that soils with improved soil microbial community population, structure and biological functionality can produce the 0.557% soil C increases implemented here.

Assumptions:
Total arable land area: 1,500,000,000 hectares (FAO)

Soil Bulk Density: 1.5 grams/cm3 soil density in this field (bulk density will change [reduce bulk density] with increase
in carbon over time)

Soil depth: based on 12" deep (30 cm, or 0.30 m) plants have been observed to increase soil carbon to depths of 6' or
deeper but sampling for these fields was only done at 12" (30 cm).

GHG emissions: 8,397,787,143 (average of 6 different estimates from various sources)

160831	1000000	ml/m3		
	1.5	g/ml		
	1500000	g/m3 soil		
	0.000001			
	1.5	mT/m3	8.40E+09	tons C emissions
Depth of Soil	0.3048	meters		
Mass Soil hectare	0.4572	m tons/m2 12 " deep	1,500,000,000	hectares Arable Land
metric T/hectare	4572	m tons/ha		
% C Increase	0.5570	percent	3.30E+08	Number of hectres required to capture all Anthropogenic C emissions
	25.46604	mt C/Ha captured	21.98%	% of Arable Land

Best case scenario on the data above indicates it would take 21.98% of total arable land area to capture all anthropogenic C emissions. Satellite data has observed approximately 22% or arable land area is fallow at any time. The previous estimate of 17% was calculated in 2007/2008 when emissions were lower, and using preliminary data gathered on a shorter timeframe. The new estimate now has more data collection and improved accuracy and similarity to other researchers conclusions.

There is a maximum soil C% that can be achieved, and that will probably top out at 7-8% soil C. The C component that has no maximum is the creation of new soil from the carbon captured and that will produce deeper soil profiles. This soil C has the potential to increase year to year for most likely many centuries to millennia. There are no other C capture technologies that can match the rate at which C can be captured or match the performance or the capacity for safe storage of C that soils possess nor have multiple co-benefits for soil fertility improvement that this has.

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September 1, 2016

My client has purchased a disc seeder – what does this mean for my advice?

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Keywords: zero-till farming systems, disc seeders, management practices

Take Home Messages

- It is important to first identify what the grower aims to achieve by moving to a zero-till system with a disc seeder.
- With a wide range of configurations available, disc openers are not a direct substitute for tyne openers.
- When using a disc seeder, the furrow should be kept free of plant residue to achieve optimum seed to soil contact and uniform seed depth.
- Disc seeding requires different agronomic practices, particularly in relation to pre-emergent herbicide use and plant residue management.
- Disc systems also require a higher level of management in relation to crop rotation and grass weed control. Growers and their advisers need to understand the complexity involved to fully capture the benefits that are promoted.

Introduction

Many growers have now converted to no-till farming systems in both high and low rainfall production areas of Australia. Originally this meant a switch from seeders that achieved full seedbed disturbance to a system involving a knife point and press wheel with less soil disturbance. However growers are increasingly moving towards a zero-till system using a disc seeder, which is changing some aspects of the farming system and the recommendations advisers provide to their clients.

Zero-till systems impose far less soil disturbance than no-till systems with knife points, aiding moisture retention at sowing and throughout the growing season. Disc seeders also allow higher levels of stubble to be retained, particularly at narrow row spacings, which has been a key driver of their adoption. Disc seeders can also travel at higher sowing speeds than tyne openers and generally have lower draft requirements. Although improvements in soil structure and water holding capacity are proven outcomes of the zero-till system, these benefits take time and growers need to be aware of limitations during the transition stage.

Following are some of the practical experiences and key research outcomes to help advisers and growers get the most out of a disc seeder in a zero-till farming system.

1) The most important thing to do as an adviser is to understand the mechanics and engineering principles of the disc seeder being used.

Each disc seeder has gone through a rigorous engineering process in order to achieve what the manufacturer believes to be the best machine they can produce. EVERY DISC SEEDER IS DIFFERENT and knowledge of its strengths and weaknesses in various paddock scenarios is a must in order to give good agronomic advice. What one person regards as an advantage, another may see as a disadvantage. Understanding this is the key to achieving good crops and robust farming systems.

Some things to look for and understand in each seeder include:

- level of soil disturbance
- evenness of soil disturbance and ability to keep the inter-row free of soil from neighbouring furrows
- ability to penetrate compacted soil, especially wheel tracks
- ability to penetrate through layers of stubble
- ability to get through wet, sticky clay soils and close the seed slot
- stubble clearance and mechanics that may affect poor residue flow under certain conditions
- shape of furrow achieved
- depth of furrow/maximum seeding depth
- seed placement in furrow, ie bottom or side
- press wheel shape and mechanics
- ideal sowing speed
- effect of depth gauge wheel on stubble during sowing

2) Management for disc seeders starts before harvest.

There are several aspects to consider during harvest in order to achieve good establishment at sowing:

- Minimise compaction from the header, chaser bins, seeder and boom spray. Disc openers are not as effective at penetrating compacted soils, with the lack of soil disturbance potentially limiting plant growth, uniformity and consequently yield. Disc seeders suit controlled traffic farming (CTF) systems, where wheel traffic is restricted to permanent, three metre traffic lanes. Consider removal of compacted layers with a tyne system or non-inversion tillage before moving to disc seeders and CTF.
- Spreading residue from the header becomes even more important with a disc seeder as stubble or residue lying on the ground causes hair-pinning with most types of disc seeders. Fitting appropriate spreaders or choppers, or even using stripper fronts, is very important to ensure that the ground surface is in a condition to allow a disc opener to roll over and penetrate. Consider the width of your comb front if wanting to sow into stubble using a disc – straw spreaders are currently only able to spread residue evenly in all conditions across the width of 9 or 10.5m (30-35ft) fronts. Residue is unable to be spread evenly across wider fronts such as 12 or 13.5m (40-45ft).
- Residue managers such as the Aricks wheel have proven effective at clearing stubble ahead of the disc unit and significantly improving stubble handling capacity and seed to soil contact. These units are essential for improving crop establishment in the presence of heavy stubble loads, especially for some single disc openers such as the John Deere or Excel machines. Aricks wheels have also been successfully added to large diameter discs such as the Daybreak.
- Residue management can be complemented in a zero-till system by using 2cm Real Time Kinetic (RTK) guidance, allowing repeatability across seasons or operations and the ability to inter-row sow between standing stubble.

- In higher rainfall areas or under irrigation, stubble height becomes critical. If conditions are likely to be wet at sowing, harvesting the stubble low allows some drying of soil from sunlight. This is particularly important on clay soils.

3) Understanding early crop vigour, disease and crop nutrition strategies.

Reduced early vigour is a common feature of the disc seeding system, with limited soil disturbance creating less mineralisation of nutrients in the immediate seed zone. This is usually not yield limiting as the plant tends to catch up quite quickly, particularly in lower yielding environments. However it does mean that sowing time becomes more critical, especially in medium to high rainfall areas where declining soil temperatures limit root development. Commercial experience suggests the sowing window can be pushed five to seven days earlier than recommended when using disc seeders. However this practice has not been verified in trials and is subject to managing frost risk with flowering, especially in cereals and pulses.

Rhizoctonia has been prevalent in cereals where disc seeders are used, particularly during the early years of transition from a tyne seeder. Tactics such as sowing early in the window using longer season varieties, avoiding root pruning herbicides (eg sulfonylureas), seed dressing with zinc and applying liquid nitrogen in the furrow at sowing help to improve early crop growth. Whilst the impact of rhizoctonia may be worse with a disc seeder, low disturbance tynes and fully conventional systems are still not immune to crop damage.

Fertiliser applied with the seed needs to be carefully managed in a disc system, with the concentration of fertiliser granules increasing in the confined seed bed. Seed bed utilisation (SBU) of common knife point and press wheel seeders is 10%, but this figure is commonly less than 5% with disc seeders. This is further compounded as row spacing is increased greater than 250mm. Crops sensitive to fertiliser toxicity such as lupins and canola should not have high levels of fertiliser with the seed. Most other crops will also show signs of toxicity, even at rates commonly used with tyne seeders. It is therefore important to plan your fertiliser strategy carefully, in many cases separating fertiliser from seed, or top dressing a portion of it in a separate operation.

Lime incorporation is not recommended with disc seeding units, particularly in medium and high rainfall areas where soil acidity is a major limitation to crop yields. Incorporation of lime using full disturbance tyne implements or offset discs is preferred, especially where soil pH_{Ca}, Aluminium % and cation exchange capacity (CEC) are required for sensitive crops. Where pH_{Ca} values are not critical and top-up lime applications are being applied, standard no-till tyne implements (knife points) are satisfactory, although it may take one to three years before the lime is fully effective.

4) Using pre-emergent herbicides in disc seeding systems.

This is an area which has attracted a lot of research in recent years. There are some key outcomes that need to be understood to be able to give good advice in this area. Importantly, discs are not supported by many herbicide labels at this point in time, so the decision to use a pre-emergent herbicide carries with it a certain level of risk.

a) <u>Every disc seeder is different!</u> This is so important - from trials in SW NSW we have found disc seeders that are nearly as safe as a well set up tyne machine, while others have resulted in over 50% crop losses with some herbicides. Damage tends to be greater where the seed slot is not closed properly.

- In general you want to achieve:
  - a plant row free of herbicide
  - an inter-row with at least 2cm of fresh soil cover to limit herbicide washing back into the furrow
  - at least 2cm of herbicide free soil covering the seed in a fully closed furrow

b) Every herbicide is different! Understanding herbicide chemistry is equally as important as understanding the mechanics of your disc seeder. In particular:

- *Herbicide water solubility*, which impacts the way the herbicide may wash into (or out of) the seed furrow. This can also affect the way the herbicide may wash into the furrow even though it may be covered by soil on the inter-row.
- *Crop safety margins.* From the trials conducted, large differences in crop safety have been measured between herbicide products and rates of herbicides (refer point 'c' below). Understanding how a plant metabolises any herbicide that it comes in contact with is essential in selecting the most appropriate product and rate for the situation.

Table 1. Pre-emergent herbicide use with disc seeders – measurements and observations from trials across southern NSW over three years. *(Source: B. Haskins)*

Crop	Herbicide	Water solubility	Need for incorporation	Crop safety margin in adverse conditions
wheat, barley	Trifluralin	low	high	Very low. High rates worse.
wheat, barley	Stomp	low	med/high	Med. High rates worse.
wheat, barley	Boxer Gold	med	low/med*	Med. High rates worse.
wheat,	Sakura	med	low/med*	Med/High
wheat, barley	Avadex Xtra	low	med/high	Low. High rates worse.
wheat,	Logran B	high	low*	High. Little damage most trials.
wheat**, barley** chickpeas fieldpeas	Diuron	high	low*	High. Little damage most trials.
wheat**, barley** chickpeas fieldpeas	Metribuzin	high	low*	Low. High rates worse.
chickpeas	Simazine	high	low*	Med.
chickpeas fieldpeas	Terbyne	med	low*	Low/med.
chickpeas	Balance	high	low*	Low. High rates worse.
fieldpeas	Spinnaker	high	low*	Low. High rates worse.

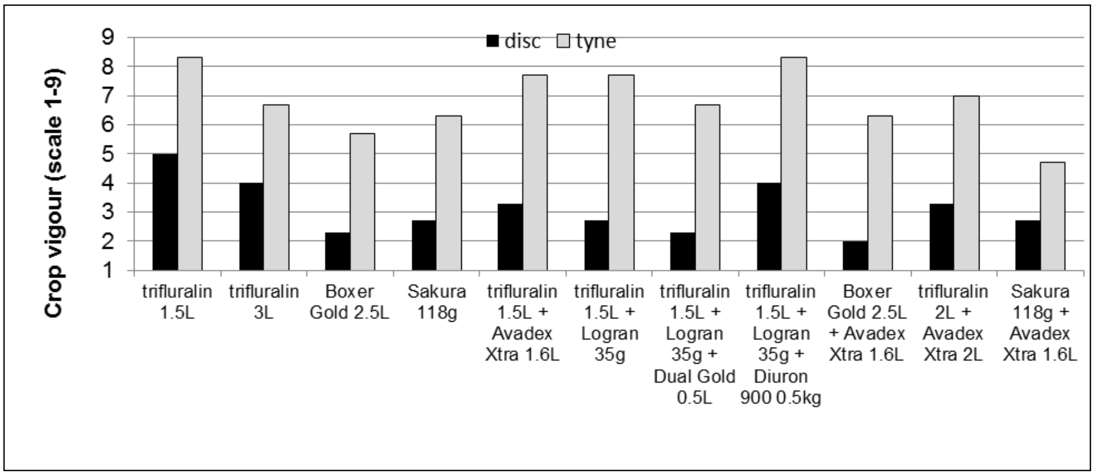
** Rainfall is required to activate and/or incorporate the herbicide. Labels may recommend physical incorporation.*

c) Be aware of crop safety.

- Many disc seeders (especially double discs) do not achieve any soil throw, so the choice of herbicides suitable for this type of seeder are limited to those that are non-volatile and will wash into the soil with moisture. Unfortunately in this scenario, the herbicide can run to the point of least resistance which is the plant row, where crop damage is likely.

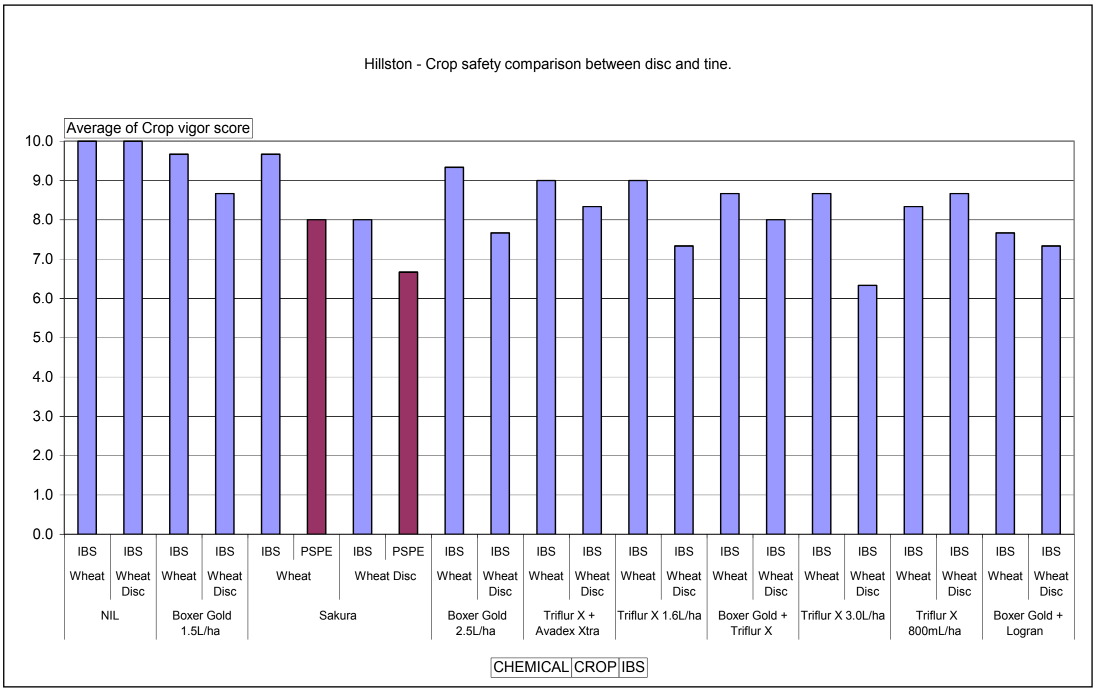
- Seeders that do achieve controlled soil throw (eg NDF Swing arm and Serafin Ultisow) allow much safer conditions when using pre-emergent herbicides, however the increased soil disturbance also encourages greater weed germination. Residue managers such as the Aricks wheel have improved crop safety with disc units where pre-emergent herbicides are used, but more research is needed.
- Wet soils can also pose a higher risk when using pre-emergent herbicides with disc seeders in cereals. A trial conducted at Grenfell in 2010 highlighted the extreme differences in crop safety that can occur between disc and tyne seeders when sowing into heavy stubbles and a wet soil profile (Figure 1). Slow emergence in the disc treatments was exacerbated by waterlogged conditions, which consequently placed the crop under greater pressure from pre-emergent herbicides compared with the tyne treatments. Prolonged wet conditions (1015mm rainfall was recorded for the year, 650mm of which fell between September and December) meant some disc treatments were unable to recover. Although the adverse conditions meant some damage was also evident in several of the tyne treatments, symptoms were only temporary.

Figure 1. Crop safety in disc and tyne systems at Grenfell, August 2010 (Daybreak disc on 375mm and Horwood Bagshaw with press harrows on 350mm); ***Adverse conditions for pre-emergent herbicides.*** *(source: Grassroots Agronomy)* **LSD (0.05) = 2.2.**



- Observations across 15 trials over various seasons and soil types have shown that in most situations, crop safety is improved when a herbicide is applied and incorporated by sowing (IBS) rather than post sowing pre-emergent (PSPE), eg. Figure 2. While the improved safety margin is usually better than 10% with IBS, this figure can be as great as 50% with some water soluble herbicides. Weed control was usually similar between the two application methods.

Figure 2. Crop safety in disc and tyne systems at Hillston, 2010 (NDF Swingarm disc seeder on 330mm and Morris Contour drill tyne seeder on 250mm). ***Conditions not adverse for pre-emergent herbicides.*** *(source B. Haskins)*



5) Disc seeders in mixed farming systems.

Disc seeders are predominantly used by dedicated cropping operators. However in southern NSW, there are a number of growers who have successfully integrated disc seeding and stubble retention into a mixed farming system without negative impacts on crop yields. Access to a tyne seeder is still recommended for certain operations to ensure crop and pasture establishment is not compromised.

Grazing cereals can be established very efficiently with disc seeders in autumn on marginal moisture, allowing early growth for greater dry matter. Sowing the following crop, however, may be compromised by surface compaction from grazing. The lack of tilth with a disc opener can restrict establishment, particularly when sowing sensitive crops (eg. canola) into dry soils. Growers should consider using a tyne seeder after grazing crops to break up surface compaction and improve tilth for establishment. If grazing crops make up a large percentage of the rotation for a mixed farmer, it would be advisable to avoid a disc seeder altogether.

Disc seeders, however, have a key advantage over tyne seeders in their ability to sow through grazed stubbles, although the stubble still needs to be carefully managed. Limiting grazing pressure of heavy stubbles and the use of residue managers such as Aricks wheels will help avoid hairpinning and reduce residue within the furrow that restricts seed to soil contact required for optimum crop establishment.

Undersowing lucerne and clover with disc seeders has proven effective, but requires attention to detail to ensure small pasture seeds are sown in a residue free environment. The stubble should be grazed heavily or burnt to reduce establishment problems and lime incorporated with a tyne implement prior to sowing pH sensitive pastures such as lucerne.

A tyne seeder with knife points is preferred when returning to the crop phase after pasture to ensure the paddock is levelled at the start of the rotation and crops emerge in loose soil. Disc seeders have proven ineffective at sowing crops into hard pasture paddocks, with limited root development and dry matter production ultimately restricting crop growth and yield.

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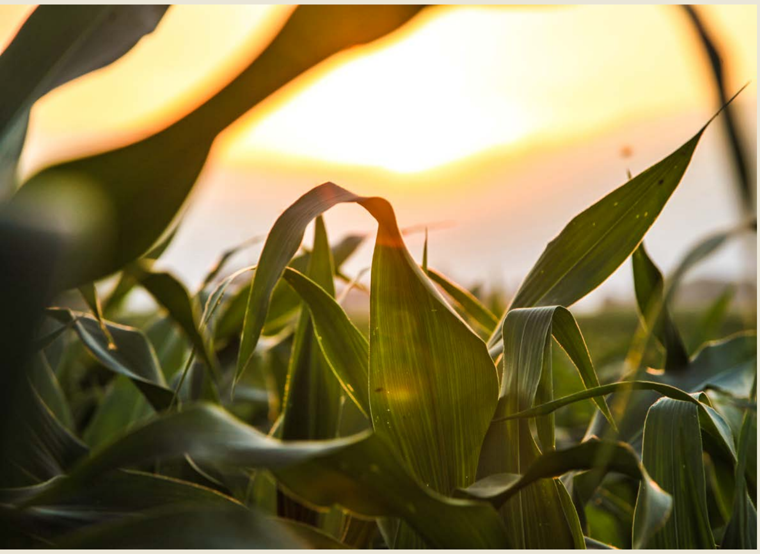

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