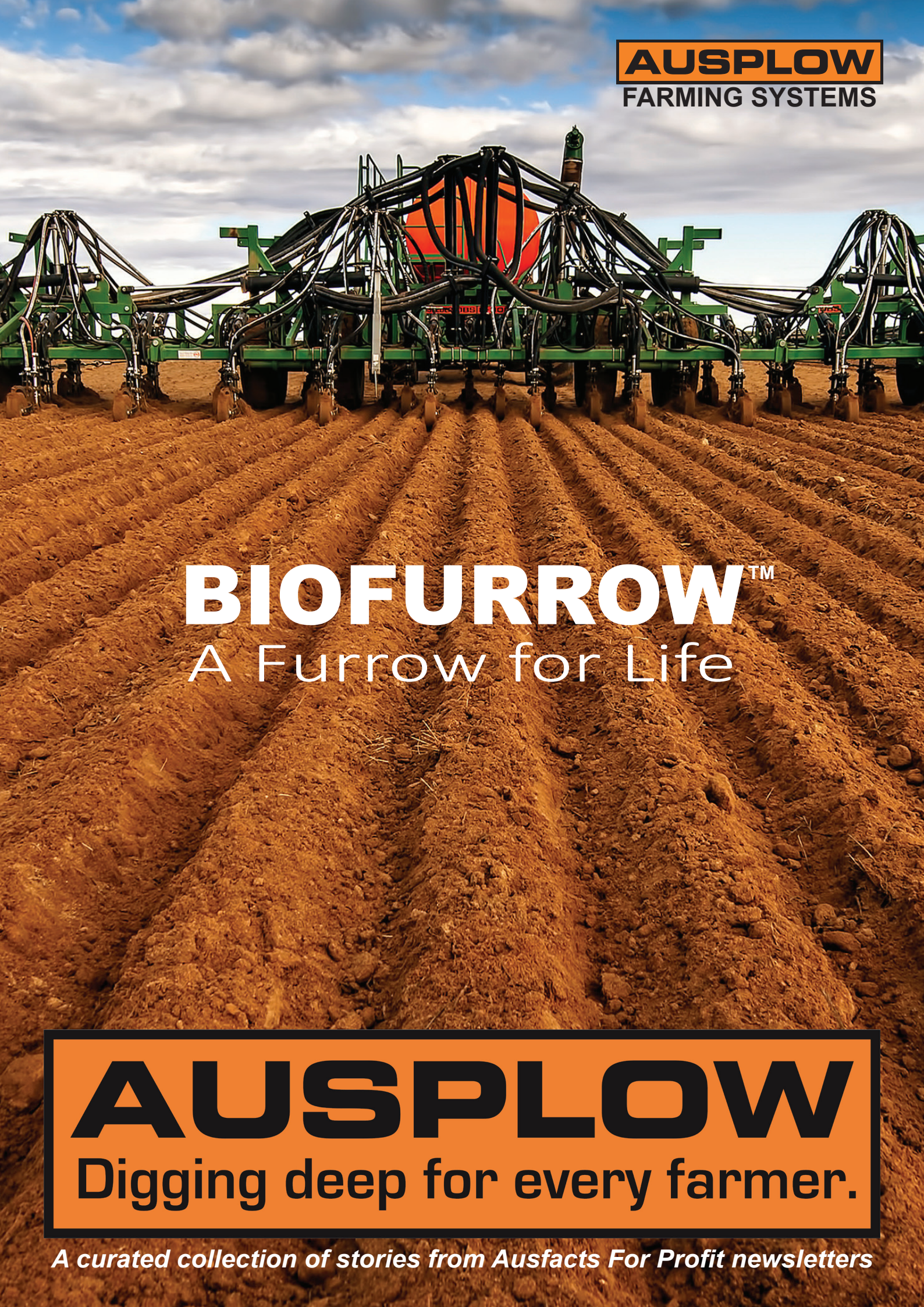

AUSPLOW
FARMING SYSTEMS
BIOFURROW™
A Furrow for Life
AUSPLOW
Digging deep for every farmer.
A curated collection of stories from Ausfacts For Profit newsletters

In the BioFuyrrow™ hypothesis growing plants provide a constant source of readily available food for microbes around the roots. In return microbes supply nutrients to plants, providing all the benefits claimed by commercial inoculants.

This example of near-row sowing forms the hypothesis of the BioFurrow™ crop establishment system.

The Evolution of a cropping Revolution

By JOHN RYAN AM - Ausplow Managing Director

THE EVOLUTION OF A REVOLUTION IN AUSTRALIAN BROADACRE CROP ESTABLISHMENT IS NOW MORE THAN 50 YEARS OLD.

And it's continuing with more questions than answers.

But before we get to the questions, it is helpful to review the context in which we are asking questions.

Briefly the so-called agricultural revolution mentioned above started in Australia in the 1970s with an English chemical manufacturer called Imperial Chemical Industries (ICI) introducing a concept into Australia called direct drilling.

This called for the use of a knockdown chemical called Spray Seed to eliminate the need for any pre-cultivation, deemed necessary to kill weeds before sowing a crop – hence, spray, then seed.

In the 1990s the system was further refined by the introduction of no-till, again with the intent of eliminating wind erosion but with a few more goodies thrown in such as increasing moisture retention and lowering fuel costs.

Interestingly in a 2008-2009 GRDC study revealed the most commonly stated reason for no-till users increasing their extent of no-till use, was reduced fuel and labour costs at seeding (cost of seeding), followed by soil conservation and soil moisture management.

The perceived benefits of soil conservation related mostly to eliminating soil erosion by retaining stubble.

The understanding of soil moisture management related to preserving moisture in the soil profile because of the benefits of less soil disturbance and stubble cover, which provided stored moisture for plant roots.

And that is essentially where the story ends because the so-called no-till practice of broadacre crop establishment is now well established throughout Australia.

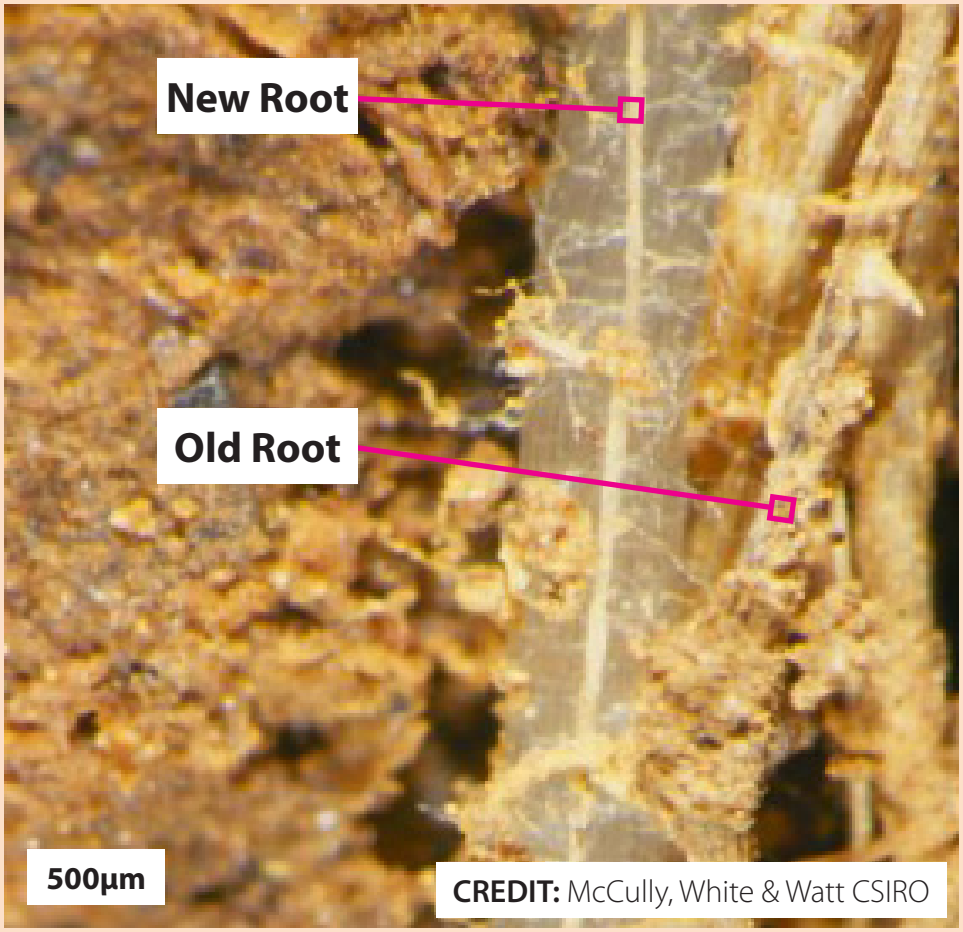
But nowhere in the 'evolution' story is there mention of the ripple effects of no-till on the soil, including the use of inorganic fertilisers and chemicals.

You might quickly counter that your soils have improved under no-till.

And right now most Australian farmers will confidently tell you the basics of how to grow a crop.

But they might feel put back a bit by retired North Dakota agronomist, lecturer and soil scientist Jon Stika.

John has written a book called A Soil Owners Manual



The hypothesis of the BioFurrow™ is that new plant roots associate with old roots in established root pathways in an environment which is nutrient-rich (N and P) with microbial interactions (Calcium-rich).

in which he describes the world's agricultural regions as "mostly dysfunctional soils".

He says symptoms of dysfunctional soil include cultivation, chemicals, soil erosion, water runoff (and non -wetting), nutrient deficiencies, imbalance of fertiliser inputs, soil pH imbalance, compaction, soil crusting, weeds, insect pests, plant diseases and water pollution.

From his observations and research, he believes no-till is only half the story, because it hasn't improved the soil to the extent of it being fully functioning with active bacteria.

According to Jon Stika, nobody is apportioning blame to what is basically now a system of agriculture growing crops in (a majority of) dysfunctional soils.

Nutrient trial data throughout the world has basically been collected from crops growing in dysfunctional soils, 'proving' the need for more N,P, K and other nutrients.

This enables dysfunctional soil to work.

But Jon says it's a cycle that does little to enhance an active bacterial population in the soil.

Active bacteria are capable of providing the necessary nutrients (N, P, K) plants require as well as guarding plant roots against pathogens and sequestering carbon to build soil structure.

And Jon adds that inorganic fertilisers are almost unnecessary in a functional soil, outlining trial results that show a marginal yield decline in crops grown with no fertiliser, compared against 'çonventional' crops grown with recommended fertiliser inputs.

Jon says, inadvertently, generations of farmers have become 'hooked' on inorganic fertilisers and chemicals to produce their crops using the best available information at the time which largely was based on dysfunctional soils.

Farmers have maintained a strong ethos to leave the land in a better condition to what they found it but the problem has been not factoring in the effect of commercial inputs on "dysfunctional soil".

Scientists have long despaired that our 'conventional' agricultural methods and inputs are killing our soils (active bacteria) hence changing them from functional to dysfunctional.

In the process, functional soils don't get much chance to show their wares in terms of producing healthy plants and crops.

When they do they conclusively prove what scientists have been saying for decades. That is, functional soils are the key to plant health and profitable farming.

And I have seen practical proof through the efforts of several DBS owners, notable among them, Greg Chappell, who farms at Glen Innes in New South Wales.

Two years ago, I questioned whether there was a better way, as I assessed future designs for the Ausplow DBS precision seeder and the liquid-ready Ausplow Multistream air seeder.

In discussions with DBS owners and Ausplow consultants Dr Margaret Roper (a former CSIRO microbiologist) and fertiliser and soil chemist Dave Seagreen, I formulated a BioFurrow™ hypothesis, which you will read about in the following pages which have appeared in our Ausfacts for Profit newsletters over the past two years.

Looking back over 50 years of crop establishment evolution, the BioFurrow™, arguably, is the first attempt to introduce a system of crop establishment that encourages soil biology to become the dominant factor for plant health and growth.

In other words, turning dysfunctional soil into functional soil, alive with soil bacteria.

The BioFurrow™ is not a replacement for current methods of crop establishment employing no-till.

Rather it is a refinement on a system of near-row sowing that has gained a growing following over the past two decades.

‘BioFurrow’™ a furrow for life

Is this the next step in crop establishment techniques?

By JOHN RYAN AM

IT IS NEARING NEARLY THREE DECADES SINCE I STARTED THE CONCEPT OF DEEP BLADE SOWING (DBS).

And apart from the usual improvements that come with any new system, the basic principles have remained the same.

But now I want to introduce an hypothesis which I believe could help DBS owners move forward on a new pathway.

I call it the BioFurrow™ system of crop establishment ... a furrow for life.

Basically, it a system that enhances what my uncle Percival Yeomans achieved with the Keyline Plan and the Yeoman’s plough.

What Percival couldn’t achieve then, we can now, thanks to technological advances.

I’m talking about in-furrow liquid nutrient management and it’s the focus of our trial work at our Quairading Research and Development Centre.

You are very aware of my pot plant analogy of how the DBS works and I regard the BioFurrow™ as the ultimate broadacre pot plant and ideally suited to in-furrow liquid management.

Essentially it is near-row sowing which encourages plant roots to seek out moisture and nutrients, in the presence of air, by following old root pathways in the same furrow.

A healthy sample of plant roots growing in one of the trial sites at the Ausplow Research and Development Centre at Quairading.

Employing guidance technology, it is possible to establish a left-side, right-side alternating sowing pattern each year.

In effect, each crop row can become a ‘furrow for life’ as it takes on similar characteristics you would find in market gardens, where moisture and air and bacteria combine to build fertile soils.

I am convinced the BioFurrow™ system can have application in market gardens too.

We see the benefits as:

1. Re-building and aerating soils, increasing organic carbon levels and elevating moisture-holding capacity, while moderating topsoil pH.
2. Greatly reducing, and in some soil types, eliminating the symptoms of non-wetting.
3. Greatly reducing wet-dry sowing scenarios which lead to staggered plant germinations.
4. Defacto soil amelioration through in-furrow nutrient inputs, eliminating costly conventional amelioration practices such as deep ripping, mould boarding and spading.
5. Enhanced moisture penetration in structure-building furrows, through greater mycorrhizal fungi growth.
6. Retention of beneficial bacteria not destroyed by cultivation.
7. Resultant presence of beneficial bacteria in the ‘pot plant’ rows may mitigate plant root diseases.
8. Less cost through tailored liquid nutrients (no fertiliser or other product spreading necessary) and less fuel due to less horsepower requirements in pulling the DBS seeding rig.
9. Side-to-side near-row sowing will also provide sufficient sub-soil shattering via DBS blades to act as a ‘furrow renovation’ each year, preventing soil-settling that can cause hardpans.
10. Establishing a defacto Keyline system that allows moisture to stay where it falls.
11. Possible frost mitigation through increased Brix readings in healthier plants.
12. Potential for lower seeding rates.
13. Greater competition against weeds
14. A more sustainable crop establishment system.

As with any new system, the initial object is to start with trials to make your own assessments.

Ausplow general Manager, Chris Farmer (left) with Ausplow trials co-ordinator Dr. Margaret Roper and Ausplow asssociate and chemist Dave Seagreen discussing BioFurrow™ trials

Examining the potential of near-row sowing

THE POT PLANT ANALOGY OF HOW THE DBS WORKS HAS ALWAYS BEEN A FAVOURITE WAY FOR AUSPLOW MANAGING DIRECTOR JOHN RYAN AM TO EXPLAIN HIS INVENTION.

It is well understood because most of us at some stage have poked our finger into soil to create a hole to pace the seed then pat the soil or 'tamp' it before watering it.

And one of our first observations is that the water 'sinks' into the hole we created.

There also is an expectation that the seed will germinate and produce a plant, based on the fact that it is in a 'healthy' environment.

We take on the advice of horticulturists who tell us what potting mix to buy or how we can create our own potting mix to ensure the pot becomes the best environment possible to grow the plant or plants we have 'sown'.

In a nutshell, that became the driving force behind John's desire to create the proverbial right-tool-for-the-job.

His vision was that the DBS would become a pot plant maker with hundreds of 'pots' established in rows in broadacre cropping.

To a large extent that has been achieved and is the reason why the DBS has become so popular throughout the Australian grainbelt.

Now, John believes he is on the cusp of another crop establishment revolution, based on his pot plant analogy.

With former CSIRO microbiologist Dr Margaret Roper now part of the Ausplow research and development team, John is assessing the potential of near-row sowing – a method of crop establishment where seed is placed in close proximity to the previous year's crop row, enabling new plant roots to grow into old root pathways.

He has named the method, the BioFurrow™.

It involves RTK guidance and a hydraulic hitch arrangement connected to the seeding bar to prevent the bar from 'crabbing' and bulldozing stubble into the old rows.

Recently John and Margaret visited Cranbrook farmers Twynam and Elizabeth Cunningham and their son Theo, who is an advocate of near-row sowing following a suggestion from his father that it was the "way to go", after seeing the ProTrakker hydraulic hitch in the United States.

The Cunninghams also own a 46 foot (13.9 metres) DBS equipped with a ProTrakker, which Theo has been using for the past two years.

He regards near-furrow sowing as an ideal way to maintain the "pot plants", inching sideways each year with new establishment that still allows new plant roots to grow into old root pathways.

Dr Roper said research had shown re-using the 'pot plants' had significant benefits, including alleviating non-wetting issues, enhancing water harvesting and residual nutrient benefits and, most importantly, establishing an environment where moisture was held.

"Where there's moisture there's bacteria and we have shown in CSIRO trials greater populations of microbial communities," she said. "There are 10 times more microbes in moist soil than in the dry inter-row and the majority are what we called actinobacteria and they are major contributors to biological buffering of soils, but we have not looked at these communities overall. "And we have evidence that actinobacteria suppresses soil-borne diseases."

According to Theo, the adoption of the ProTrakker in combination with the DBS, has enhanced the ability to establish crops every year during the optimum growing window while minimising the risk of establishment.

"Our average crops yields are slowly creeping up but the best thing is that we are now more confident in

our expectations of reliably achieving 1.8 tonnes (a hectare) with canola, three tonnes with wheat and 3.5t/ha with barley.
"These have become realistic figures for our annual budgets."
The year 2018 provided compelling reasons for the Cunninghams to use the ProTrakker-DBS combination.
"Our canola went in on rain on April 15 and germinated a week later," he said.
"We didn't get any more rain until late May but we put our DBS in at seven inches (175 millimetres) and we got a wick-effect by tapping into subsoil moisture.
"We got really even germination which was better than with the spring tine bar we used previously.
"The canola that went in on April 15 turned out to be our best crop."
Theo credits the combination of the Pro Trakker, DBS and use of liquid nutrient injection for the farm's above average crops.

A tell-tale sign of healthy soil … earthworms abound in the topsoil.

The critical role of plant roots

Editorial By JOHN RYAN AM

A LOT OF FOCUS ON PRECISION SEEDING IS NATURALLY ASSOCIATED WITH THE SEED BED.

Primarily the idea is to place plump seed on a firm, but not compacted, soil 'bed' which is permeated with moisture, air and nutrients.
But as we develop our hypothesis on the BioFurrow™, I would like to focus on the 'root bed' – or root zone - which is arguably where crop plants are 'fuelled up' or turbo-charged.
It is widely accepted that maximum potential yields - profits - are set in the first few weeks of germination associated with a range of factors such as optimum soil temperature, moisture, oxygen and nutrients.
Wheat plants, for example, can produce a greater number of tillers from an optimum germination, which includes unimpeded primary and secondary root growth. This provides the plant with potentially higher grain yield.
The primary 'mission' of the DBS is to set up such a soil environment for this yield potential to occur.
I describe it as the DBS three-slot system that involves deep under-seed cultivation, a shallow bed for the seed and a defined 'slot' trench for water harvesting along with a protective environment for germinating seeds.
Essentially the DBS creates the BioFurrow™ which can best be understood as a pot plant where seed is sown.
The hallmarks of a pot plant are loosely aggregated soil, fine soil particles in contact with the seed and PLENTY of space, in between the soil aggregates, for roots to develop in an environment of moisture and air.
Roots then essentially become the umbilical cord to the emerging seedling , taking up oxygen, moisture and nutrients from the soil and delivering them to the new plant.
This process continues throughout the life of the plant.
The roots deliver minerals and water to the rest of the plant. In return the leaves take up carbon dioxide from the air through photosynthesis producing carbohydrates which provide energy for plant growth. Some of this carbohydrate is exuded through the roots into the soil and feeds soil microorganisms.
In January's Ausfacts edition, former CSIRO scientist and microbiologist Dr Margaret Roper explained the complex plant-microbe relationship in which soil bacteria and fungi provide nutrients to plant roots while accessing food in the form of exudates from the roots.
She explained that a classic visual of this process was the 'dreadlock' roots you find on healthy plants, with soil and microbes adhering to roots.
This interaction between microorganisms and roots is the forming ground of organic carbon.
It is interesting that scientists and governments are now increasingly vocal about the critical importance of growing our understanding and control of plant root processes as they apply to carbon sequestration.
As I said in the earlier story, perhaps they should visit Australia and talk with DBS owners.

Soil pH is the big issue

ELEVATING SOIL PH IS ONE OF THE MAIN GOALS IN WA'S WHEATBELT.

But there's a salient message for Australian wheatbelt farmers dealing with the jigsaw puzzle of growing crops and pastures.

According to long-time Ausplow associate and soil chemist Dave Seagreen, there's part of the jigsaw puzzle missing that relates to balanced soil pH (percentile hydrogen), and that's calcium.

It is not just any calcium it has to be calcium carbonate

"Until very recently, growing crops and pastures has been mainly a N,P,K story with the common trace elements such as copper, zinc, molybdenum, manganese, etc.," Dave said.

"But productivity is measured by the amount of calcium in the soil because it is one of the main movers of nutrients in the soil; it makes everything happen and it has been described as the prince of nutrients.

"There's a huge interplay between calcium, nutrients and microbes, which sets up a symbiotic relationship leading to building soil humus, carbon building and retention of moisture.

"Calcium is one of the main keys, although I am quick to acknowledge it's not a silver bullet.

"And that's where soil pH comes into the story because levels below 4.5pH, expressed as calcium chloride, makes it impossible to build soil humus.

"The ideal is a soil pH of 5.5 and upwards which is where we see calcium really switch on."

The problem is that calcium is not naturally occurring and is probably why it is neglected in discussions on nutrients in the soil.

According to Dave, typical sandy soils such as those in WA have calcium concentrations between 300 and 400 parts per million (ppm), with some areas as low as 150ppm.

"The Holy Grail is about 1800ppm," Dave said.

It is true that lime can increase calcium levels but until recent years the issue was that lime quality was "not great" and it was spread on the soil surface, effectively of no use to subsoil.

"It has to be incorporated to depths between 300 and 400 millimetres," Dave said. "And that's a very costly operation which a lot of farmers simply cannot afford to do.

"With a lot of our lime, which is dispensed in a bigger micron form, soil pH changes are minimal particularly if the lime particles are too coarse and can remain unreactive for years. Surface area is key to lime reactivity.

"This in turn means calcium may remain unreactive for years in a low pH environment, hence there has been no resulting in little reaction with the microbial community, thus inhibiting soil humus growth."

One of the issues with lime, which Dave says is now coming into focus, is lab testing.

Farmers send in a soil sample for soil pH testing, with coarse lime particles present.

"Generally, the soil particles are ground down to a smaller form for testing and suddenly the lime becomes available in lab tests," he said. "So, there's a potential error between land and lab that can create a false positive.

"Fortunately, things are changing and some labs are now altering changing their testing protocols because of this issue.

"However, unless the correct lab protocols are used, when acting upon lab results there is a danger that farmers may think they have sufficient lime when in fact they don't.

"So there needs to be a lot more focus on soil pH but while keeping in mind that there are a few complications such as the high use of nitrogen, which decreases soil pH.

"The main reason there's a high demand for nitrogen throughout the world, is because of quick visual results.

"Getting a good calcium magnesium ratio - provided the calcium and magnesium levels are good - will increase the nitrogen performance thereby making pH management a little easier.

It has been surmised by well-known US agronomist Dr Arden Anderson, that the overuse of nitrogen is the wrong pathway.

He told Australian farmers two years ago at a conference in Queensland that agriculture should be calcium-led not nitrogen-led.

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He told Australian farmers two years ago at a conference in Queensland that agriculture should be calcium-led not nitrogen-led.

While precision seed establishment is vital for improved crop production, it goes hand-in-glove with balanced soil pH.

According to soil chemist Dave Seagreen, there's a huge interplay between calcium, nutrients and microbes, which sets up a symbiotic relationship leading to building soil humus, carbon building and retention of moisture.

The role of soil chemistry and nutrition

LOW SOIL PH REMAINS A MAJOR PROBLEM THROUGHOUT AUSTRALIA'S WHEATBELT.

In fact, CSIRO reports that 50 per cent of agricultural land has surface pH values 5.5 (below optimum for extremely acid- sensitive agricultural plants and below the optimal level to prevent subsoil acidification.

It estimates between 12 and 24 million hectares of agricultural land is extremely to highly acidic, with pH values below 4.8.

According to long-time Ausplow associate and fertiliser and soil chemist Dave Seagreen, the main reason for low soil pH is hydrogen ions.

"Basically, you need to neutralise all those ions," Dave said,

"But this can largely go unnoticed by farmers with an increased focus on nitrogen, because when calcium and magnesium soil levels are low, nitrogen becomes more inefficient and therefore more nitrogen is applied.

"It's a bit of a catch 22 at the moment," Dave said.

"There's not a lot of understanding about soil chemistry and soil nutrition and I think we need to look at doing things slightly differently.

"That's why I was attracted to Ausplow's BioFurrow™ hypothesis because there is a lot of focus on the interaction between soil chemistry and soil nutrition to improve the health of the soil and the health of plants.

"While I agree the soil ideally should be as near as possible to 5.5pH and above, achieving that through liming is a very costly process with lots of lime needed in the subsoil.

"That's why I invented Calbud 12 years ago. It's a formulation with nano-size particles with a large surface area and a highly concentrated calcium carbonate solution.

"This solution contains trace elements and because it is ground to nano forms it is more accessible to the microbial community and neutralises hydrogen ions a lot quicker.

"It's basically a band-aid; you will still need lots of lime to go on over the next few years but, like a band-aid, it can arrest further 'bleeding', if you like.

"Calbud won't replace calcium but in the BioFurrow™ hypothesis there will be enough concentration to sufficiently elevate soil pH to a more acceptable level as long as we know what we're dealing with.

"Some soils will be more acidic than others and will have to be dealt with accordingly.

"So you could argue for ameliorating the soil pH first before starting a BioFurrow™ system, because there's a fine balance in dealing with some soils.

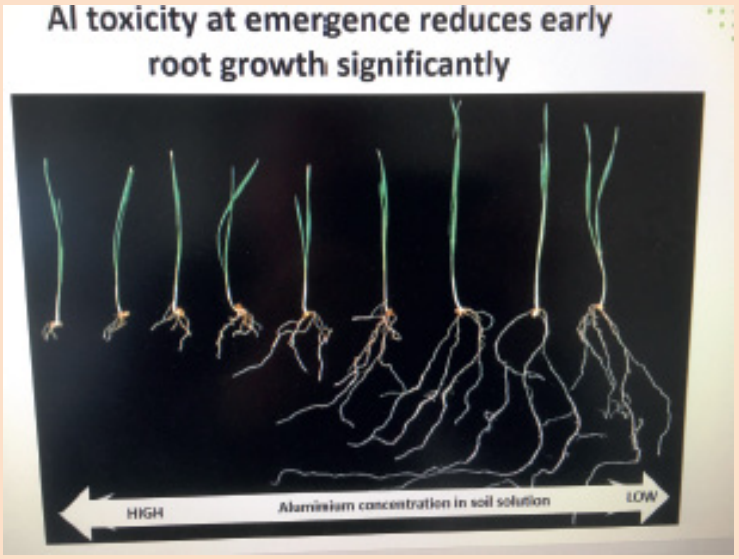
"The other subject to touch on is phosphorous because elevated soil pH is critical for phosphorous to work.

"Below a pH of 4, phosphorous can become tied up quite dramatically, the same as nitrogen. High levels of aluminium may complicate this even more.

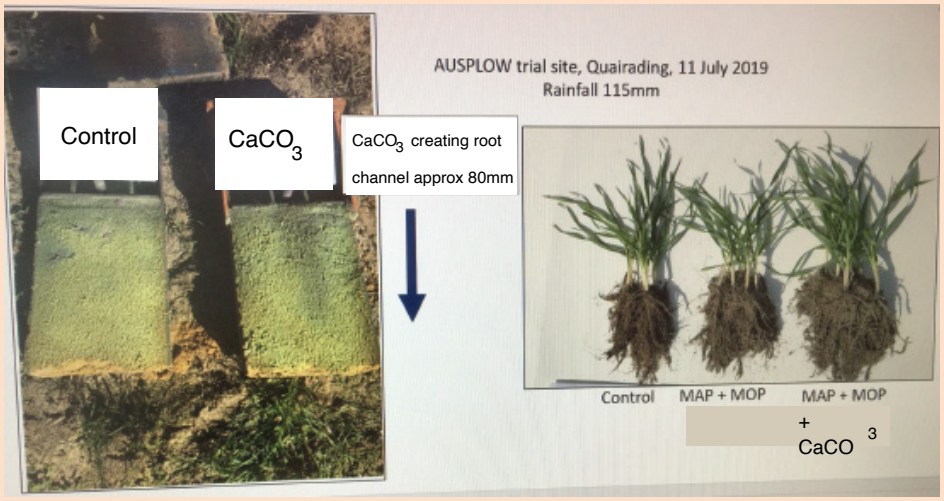
"Farmers see leaf tests indicating that they need more phosphorous when in fact the phosphorous is tied up in the soil.

"So more phosphorous goes on which can result in using more than is required and leading to it being toxic to mycorrhizal fungi, the building blocks of soil structure.

"Farmers using Calbud have seen phosphorous and calcium levels increase as well as an increase in microbial populations in the presence of moisture and air, which is the typical environment of a BioFurrow™ created by the DBS. "However, always remember that



Wheat seedlings grown in soil with different aluminium concentrations. Concentrations of aluminium in the soil become toxic to roots when soil pH falls below 4.8. Ausplow BioFurrow™ trials show how establishing an optimum environment for early plant development can mitigate aluminium toxicity



there is a complex interplay so you need that balance."
Also, with Calbud, it effectively neutralises hydrogen ions using the carbonate form of calcium.
"It is the form of calcium that is critical because a lot don't neutralise the hydrogen ions," Dave said.
"Achieving an optimum environment, where soil pH is relatively balanced allowing for chemical interplay with nutrients and microbes, will take time.
"It's not a quick fix within one year," Dave said. "After five years you may start to see results because you will be achieving higher organic carbon levels through building soil humus."
(The tell-tale sign of positive progress are the so-called dreadlock roots on plants).
According to Dave, the challenge for farmers is to understand their soil tests and select the right products accordingly.
"There are a lot of products in the market but it's not the case of everything works for your situation," he said. "Do trials and see for yourself."

Lets start a conversation

SINCE ANNOUNCING OUR BIOFURROW™ STORY IN THE PREVIOUS EDITION OF AUSFACTS, I HAVE RECEIVED A LOT OF POSITIVE FEEDBACK FROM DBS OWNERS.
And the most striking comment came from New South Wales farmer **Greg Chappell, Glen Innes.**
"Wouldn't it be great if every farmer in Australia had a goal to lift the organic carbon levels on their farms by one per cent," Greg said.
"Imagine the enormous impact that would have on the nation's effort to sequester carbon and the increased respect it would have for agriculture."

I think Greg has hit the nail on the head and it is the reason, I think, we should start a conversation on the BioFurrow™. Central to everything we have written thus far on the benefits of the BioFurrow™, is the ability to sequester carbon while improving our soils and farm profits.
We are already planning our 2021 trial program at our Quairading Research and Development Centre and we also are excited about several DBS owners who are keen to be involved in trials on their own properties.
As part of the conversation on the BioFurrow™ we also present the following comments from DBS owners:

Theo Cunningham, Cranbrook:
We've been doing implement-steer near-row sowing for five years and this year we started trialling the BioFurrow™.
Previously we had been nudging across the paddock and I thought why not stick to the same row so we did a trial paddock where we nudged left about two centimetres and didn't disturb the stubble.
There were no negatives and it made it easier for the air seeder driver using the shift on our guidance.
We've kept a record of what we've done and for 2021 we'll nudge right near the same row and I expect that from now on we'll do it for our entire program.
It just makes sense and I'm excited by the innovation which can employ the latest technologies.
I think we'll also see some cost efficiencies because we will be using less diesel and perhaps we won't have to deep rip if we can maintain furrows for life.
(Theo's trial work this year was the inspiration for the Bio Furrow™).

Greg Chappell, Glenn Innes, NSW:
I've always said it's important to get the biology working and the BioFurrow™ will do just that.
It makes a lot of sense, particularly providing a stable environment where we can have a crack at building our organic carbon levels.
That's the crux to improve our water-holding capacity for growing crops in our variable climates.
Wouldn't it be great if every farmer in Australia had a goal to lift the organic carbon levels on their farms by one per cent.
Imagine the enormous impact that would have on the nation's effort to sequester carbon and the increased respect it would have for agriculture.

Brendan Smart, Keith, SA:
The BioFurrow™ makes irrefutable sense.
Although we don't have the guidance technology of implement steering to do it yet, I knew something was going on in the late 1990s when we were establishing crops with the DBS on the inter-row with no guidance.
We were on 10 inch spacings and you could see every time we got closer to last year's row, the crops were better.
We still see that today and we have put it down to roots accessing more nutrients near the old row.
But I 100 per cent agree with the BioFurrow™ concept.

Nick Gillett, Bencubbin, WA
I definitely agree we should start a conversation about this concept because it makes fundamental sense to build our soils and enhance water-holding capacity for our broadacre cropping systems.
We have been inter-row sowing since 2003 with a sidearm marker but it was generally seeding freehand and we definitely noticed a positive to crop growth with plants closer the last year's rows.
Since 2005 we have been on RTK guidance and in years when conditions are right we will sow into the old rows chasing moisture where's there's not a great stubble load.
In principle I support the work being done by Ausplow and I'm keen to do some trials.

Peter Alexander, Glenn Innes, NSW:
I think the BioFurrow™ is just commen sense and it's certainly the way to go for broadacre cropping.
At the moment we're trying to combat new country with the DBS and it's not the sort of country that lends itself to precision guidance.
But with our experience with the DBS and what it is achieving for us it is easy to understand why establishing a furrow for life would have a lot of benefits.

Jeff Edwards, Kweda, WA:
We'll definitely give it a go because it makes sense to us.
It will cost us about $8000 to upgrade to RTK guidance and there's a tower next to the farm so that will get us started.
I'm excited that we're now getting opportunities to build organic carbon with a lot more tools in the toolbox.
It's a big challenge but we're up for a goal of lifting our organic carbon by one per cent.
At the moment it ranges from 0.5 to two in the long term pasture paddocks.
One subject that came up with many DBS owners we spoke with related to stubble, particularly if it's a wet season.
Implement steering to a large extent should mitigate problems with stubble wrapping around tines but leading disc coulters will greatly assist by cutting old lateral plant roots to prevent bulldozing which can also lead to dragging in stubble into the tines.
Those involved in near-row sowing know that while we've had several years of dry starts it's only a matter of time before a decent wet start is experienced again.

Bencubbin farmer and Nuffield Scholar Nick Gillett said the BioFurrow™ "makes fundamental sense to build our soils and enhance water-holding capacity".

SA farmers back BioFurrow™ sowing

EYRE PENINSULA FARMERS PETER AND STEVE GLOVER ARE KEEN SUPPORTERS OF THE BIOFURROW™ HYPOTHESIS.

In fact, for the past 20 years the brothers have unwittingly been using two 60-foot (18.2 metre) DBS precision seeders in what might be called defacto BioFurrow™ crop establishment.
Having bought their first DBS in 2000, the brothers, soon noticed better germinations sowing across the previous year's furrows.
"We've got a significant percentage of our program (9000 hectares) that is non-wetting," Steve Glover said.
"And it was evident that where we sowed close to the old rows, we got a strike, whereas we got nothing in the dry soil between the rows.

in the dry soil between the rows.
"It ended up like a chequerboard pattern in the non-wetting paddocks and while germinations were staggered we got about 60 per cent of the plants up, which was a better result than previous attempts which might have germinated between 10 and 20pc.
"It was very obvious there was residual moisture in the old root pathways that was available to the seeds suportinig information that I had heard about sowing in-furrrow.
"We wanted to retain our stubbles which is why we went for 12 inch spacings and on our worst non-wetting paddocks, crop is now established on an angle from the previous year's rows.
"These paddocks tend to have less stubble residue, and so physically getting through the stubbles is less of an issue.
"It was no surprise to me that there would be a moisture band that seeds could capitalise on if they were closer to those old rows."
Steve said sowing straight either inter-row, in-row or between 20-30 millimetres from the row would be a way to repeat every year.
"But we've two 60-footers and you can get it wrong, even with RTK guidance, if you say sow 100mm off from the row because nothing will come up (in the non-wetting soil)."
(The reason for this is that some spacings are not exactly 12 inches and some rows, because of the tine layout for stubble handling, mean spacings can be 11 inches or 13 inches).
"So sowing across the rows is all about accessing moisture and in the non-wetting soils it is a compromise but it gets a better result than sowing up and back," Steve said.
"And with the two bars we're not necessarily going in the same direction every year like you would if you just had one bar."
After 20 years of "angle sowing" there remains a lot of old root pathways but interestingly Steve says the majority of moisture tends to congregate in the previous year's rows.
The other observation is that the sandy loams, red loams and limestone soils have become softer.
"There's no argument that the one-pass and knife blade technology of the DBS had helped considerably in making the soils softer," he said.
"The key is moisture and air and the action of the DBS creates some deep ripping to allow moisture to get down with nutrients so there's also some amelioration going on too.
"And we know where you've got moisture you got biological activity which is probably another name for Mother Nature.
"The DBS had been a great machine for us and its technology is helping us to achieve more consistent yields every year particularly in those low moisture seasons where it would have been hard to achieve meaningful yields if you didn't have that DBS technology.
"And it really shines in the non-wetting soils.

South Australian Ausplow dealer Ramsey Bros director Hamish Ward (left), Cummins, SA and Eyre Peninsula farmer Steve Glover.

WA research points to natural disease supression

WA SCIENTISTS ARE INVOLVED IN WORLD-LEADING RESEARCH INVESTIGATING THE POTENTIAL OF SOIL-BORNE SUPPRESSION OF CROWN ROT IN WHEAT.
And it could lead to identifying other positive attributes of soil biota associated with disease suppression of plants, such as sclerotinia in canola, and root diseases including rhizoctonia, take-all and pythium root rot in cereals.
Involved with a research team, which released a paper earlier this year on the subject, was Ausplow consultant and former CSIRO scientist and microbiologist Dr Margaret Roper.
According to Dr Roper the soil contains a huge variety and number of soil biota, "capable of many positive functions in the soil".
In the paper's conclusion, it said the screening of 53 isolates from a collection of endophytic Actinobacteria revealed several promising isolates.

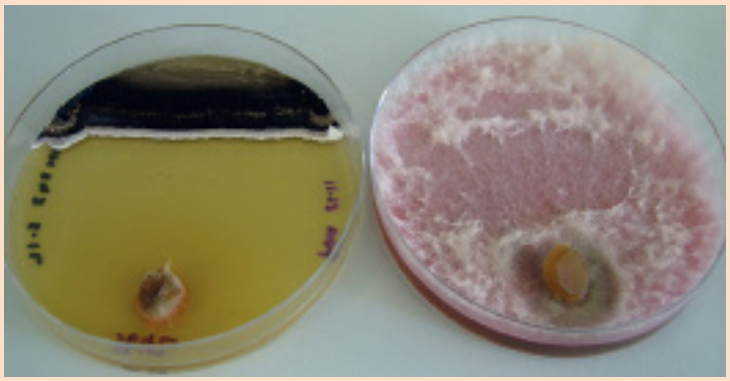
"Two in particular, strongly suppressed growth of the (crown rot) fungus in plate cultures, and resulted in increases in grain yield compared to diseased controls in glasshouse experiments," Dr Roper said.
She added that further studies were needed to verify the efficacy of the treatments at the field scale and to determine the mode of action and underlying genetics of biocontrol activity.
According to Dr Roper, management strategies to control crown rot are somewhat limited. "Fungicide seed dressings are available, but they are often inactivated over time by environmental conditions," Dr Roper said.

Ausplow consultant and former CSIRO scientist and microbiologist Dr Margaret Roper is part of a research team involved in world-leading research into the potential of soil-borne suppression of crown rot in wheat.

"Research has shown (anti-fungal) protection is usually best in the early stages of the plant growth cycle.
"Plant breeding has produced some more resistant varieties but none of these show robust and durable disease resistance in the field.
"An additional problem for crown rot control is that the fungal pathogens that cause the disease (F. pseudograminearum and F. culmorum) survive and continue to grow in the stubble left after harvest, increasing the risk of infection in the following crop.
"This can happen regardless of the level of resistance/tolerance of the wheat variety in the living phase of the crop."
Dr Roper said studies from various locations around the
world have shown that micro-organisms (bacteria and fungi), that produce secondary metabolites, play a significant role in the formation of disease suppressive soils.
Such work suggests that there remains considerable unexplored potential within soil microbial populations for further novel biocontrol products.
"One group of bacteria (actinobacteria) are very common in soils, survive well in our extreme WA soil environments and produce various bioactive agents including antibiotics, enzymes, and vitamins," Dr Roper said.
"Actinobacteria can reside within a plant where they are protected from adverse environmental conditions and other microbial competitors.
"There are also other soil microbes which can colonize plants as endophytes and these are likely to be the most successful in suppressing plant pathogens."
The research work, which Dr Roper has been involved with for more than 30 years, is an exciting development as Ausplow promotes its hypothesis of the near-row BioFurrow™ system of crop establishment
Dr Roper said in the past inter-row sowing had been used to decrease disease risk, but trials in South Australia by Dr VVSR Gupta (CSIRO) have shown that the expression of root diseases such as rhizoctonia was less under near-row seeding, as distinct from inter-row sowing.
Dr Roper listed the following benefits of near-row seeding relative to inter-row sowing as:

1. Larger and more diverse microbial communities.
2. More water available to a new crop (in water-repellent soils).
3. Improved crop establishment.
4. Repellency declines during the season.
5. Improved yields in some years.
6. Fewer weeds.
7. Greater disease risk, BUT less disease incidence and severity.

Dr Roper's research has shown that plant roots, preserved by no-till, behave as pathways for water infiltration, particularly in water repellent soils, to create an environment which can include the above benefits.
She said the combination of near-row sowing with the DBS sowing system creates the BioFurrow™ system of crop establishment, and this can provide significant benefits for a developing seedling.



An actinobacteria culture (left tray in black at top) inhibiting growth of a crown rot pathogen in a laboratory plate test compared with the control plate (right tray) showing the uninhibited pathogen spread.

Dr Margaret Roper CSIRO

"Firstly, the provision of liquid nutrients directly below the seed provides a source of water vapour for seed germination," Dr Roper said.
"The 'precision seed bed', created by the DBS closing tool to provide a firm and aerated base for the seed,

A tell-tale sign of crown rot in a wheat plant compared with healthy green heads in the background.

contains fine capillaries through which water vapour (from the liquid nutrients) can rise to the seed and promote germination.
"Scientific research also has presented evidence that water vapour is the primary source of water for seed germination in unsaturated soils."
(This arguably, could be part of an explanation for why DBS owners report quicker germinations in dry sowing compared with other tillage systems.
The main conversation over the past nearly 30 years in regard to dry sowing, is that the DBS penetrates hard pans and promotes water capillarity, from subsoil moisture, to wet up the seed bed).
Ausplow will continue to support and promote Dr Roper's research in field trials at Quairading.

Science Spotlights Soil Biology

IT IS INTERESTING THAT SCIENCE HAS BEEN AWARE, FOR DECADES, OF NATURAL PROCESSES FOR PRODUCING HEALTHY PLANTS.

Yet little of the huge amount of scientific research that has been done on the subject, has impacted on agriculture – in terms of establishing healthy crops and pastures.
There has been little commercial enthusiasm for what we might call Mother Nature's inherent mechanisms that can produce healthy crops and pastures, build soil carbon and mitigate fungal diseases and insect damage.
One example of these natural processes was cited in the last edition of Ausfacts for Profit, relating to plant inoculants protecting roots against diseases.
In the right soil environment, beneficial soil micro biota flourish naturally, providing all the benefits that are claimed by popular commercial inoculants.
The right soil environment can be described as soil with organic matter, structure, balanced soil pH, moisture and oxygen.
So, what about the studies that have found that the plant's internal defences (such as insect and disease resistance) are significantly affected by the nutrition of the plant?
That domain has largely been left to commercial interests, plying synthetic fertilisers, pesticides and fungicides, ostensibly to keep plants healthy.
In this edition's lead story, Ausplow and former CSIRO scientist and microbiologist Dr Margaret Roper reveals research from laboratory experiments that have shown how naturally occurring soil microorganisms suppress crown rot in wheat.
While Dr Roper is keen to remind farmers that field trials are now needed to substantiate the research, Ausplow managing director John Ryan believes we are now moving into a science-led era that can also substantiate Ausplow's BioFurrow™ hypothesis.
"If you look at what scientific research has revealed it presents a range of questions to me that has helped me in the design evolution of the DBS, leading to our hypothesis on the BioFurrow™," John said.
The BioFurrow™ crop furrow concept is based on creation by the DBS system of a moist, aerated and nutrient-rich environment where microorganisms flourish and plants thrive.
According to John, the history of agriculture has proven the pitfalls of over-cultivating and low soil pH – loss of topsoil and, particularly in Western Australia's wheatbelt, salinity.
"Farmers throughout the world have led the way in overcoming these challenges, to some extent, through minimum cultivation and soil renovation," he said.
"But what science is now showing us through decades of work by researchers such as Dr Roper, is a bigger picture.
"Science is breaking through myopic views that our 'conventional' methods of crop and pasture establishment will stand the test of time.
"But nowhere have we evidence of such a fact.

"We do have evidence of 'sugar hits' through deep tillage, rotary hoeing, spading and mouldboard ploughing but I've never heard anybody talk about the longer-term residual benefits past five or six years.
"What I do know is that soil microbes have been around since before the start of agriculture.
"These soil microbes (or soil biota) physically contribute to soil structure and help build organic matter (by sequestering carbon), leading to healthy plants.
"Scientists have long despaired that our 'conventional' agricultural methods and inputs are killing these microbes.
"Hence the microbes don't get much chance to show their wares.
"But when they do, they conclusively prove what scientists have been saying for decades and what recently, New South Wales farmer and DBS owner Greg Chappell, has revealed to us in his Ausfacts stories.
"Briefly, since 2008, Greg has been re-building his soil by increasing organic carbon content through things like mulching weeds, manuring and using a liquid potassium mix based on plant analysis.
"Crops and pastures really took off when he started using the DBS in 2017.
"When he started, paddock measurements were below one for organic carbon and now it's around 3.5.
"With soil pH, measurements have gone from between 4.4 and 5.7 to between 5.9 and 7.1.
"He says he's retaining organic carbon and this is increasing the water-holding capacity of the soil; he attributes these benefits to the positive contribution from soil microbes.
"His parting message in his story in the October 2018 edition of Ausfacts was:
'Let's give biology a go.'
"I can only encourage DBS owners to critically evaluate what they want to achieve with crop and pasture establishment and at least trial a bit of biology.
"Even if it's only one run to establish, for example, a BioFurrow™ trial as a control, at least you're on the road to meaningful comparisons.
"The DBS is only one tool, but I believe biology is the toolbox.
"Why not discover what other tools you can find in the toolbox?"

Scientific research is showing soil biology can play a bigger role in producing healthy crops.

Moisture, air, key to BioFurrow™

SOIL MICROBIOLOGY - IN THE PRESENCE OF MOISTURE AND AIR - IS THE KEY TO THE BIO-FURROW™.

That's the opinion of former CSIRO scientist and microbiologist, Dr Margaret Roper.
Dr Roper makes the point that there are between one and two tonnes a hectare of microbes in the top soil with around 70 per cent in the top 10 centimetres, equating to more than 10 billion microbes in a kilogram of soil with literally kilometres of fungal hyphae.
Fungal hyphae spread like a network to capture nutrients and in a highly complex symbiotic relationship, bacteria and fungi provide nutrients to plant roots while accessing food in the form of exudates from the roots.
A classic visual of this process is the 'dreadlock' roots you find on healthy plants, with soil and microbes adhering to roots.
But conventional practices such as deep tillage, mouldboarding and spading, while deemed necessary for soil amelioration, can have a detrimental effect on drying out soils and thereby destroying microbial populations which thrive in moist conditions.
According to Dr Roper, what science is now showing, through trial research, is a better way to grow crops – by utilizing microbial communities and root systems in the soil.
And that is the pith of explaining why the BioFurrow™ - we call the furrow for life – works to enhance this microbial activity for the benefit of plant roots and to aid in building organic carbon levels.
The concept of the BioFurrow™ is not new and is often referred to as near-row sowing, with implement steering guidance.
The difference with the BioFurrow™ is that the same row is used to seed crops every year rather than 'nudging' across the paddock to establish the next season's rows.
Interestingly Dr Roper's research started 25 years ago and she is

confident the hypothesis of the BioFurrow™ is now at a stage to trial over a range of moisture and soil conditions.
Dr Roper said the DBS sowing system, particularly, provided significant benefits for a developing seedling.
"Firstly, the provision of liquid nutrients directly below the seed provides a source of water vapour for seed germination," Dr Roper said.
"The 'precision seed bed', created by the DBS closing tool to provide a firm and aerated base for the seed, contains fine capillaries through which water vapour (from the liquid nutrients) can rise to the seed and promote germination.
"Scientific research also has presented evidence that water vapour is the primary source of water for seed germination in unsaturated soils.
"This surprising result stems from the fact that although hydraulic conductivity decreases by several orders of magnitude as soil water content decreases, relative humidity within the soil remains near 100 per cent, as long as the soil water content is above wilting point."
Dr Roper also said the provision of liquid nutrients directly below the seed provided an immediate source of nutrients in available forms in close proximity to newly emerged roots.
"And the soft-closing press wheel of the DBS covers the seed, creating a firm but not compacted indented surface which collects water and enables air exchange around the germinating seed," Dr Roper said.

This photograph clearly shows the importance of building soil structure to allow access to moisture and air. On the left is a typical 'brick' of compacted soil compared to a clod on the right showing roots moving at depth through aerated and structured soil. The latter is the type of result created by the DBS and clearly demonstrates the 'pot plant' analysis of how the DBS establishes the right environment for plant root growth. heads in the background.

Make money and build the soil

By JOHN RYAN

IT IS CLEARLY EVIDENT THE FEDERAL GOVERNMENT WANTS SOIL CARBON BACK ON ITS AGENDA.

Recent comments by Prime Minister Scott Morrison that he wants to initiate a soil carbon capture scheme involving the agricultural industry are encouraging.
And it follows on from our January Ausfacts article 'Let's start a conversation', relating to our BioFurrow™.
Farmers are becoming increasingly aware of the importance of soil organic matter – otherwise known as soil carbon, which is essential for crop production.
And the United Nations Food and Agriculture Organisation (FAO) has also weighed in, citing the fact that the world's soils have become degraded, particularly as a result of chemical-heavy farming techniques, deforestation, etc.
So it is up to us to develop farming systems that nurture the soil and its components, including organic matter and microbial communities that drive soil health and function, and plant growth.
Ausplow's R&D work with is exploring how the BioFurrow™ (which is aligned with the DBS system of crop establishment) is exactly can be used the pathway to sequester carbon, .aligned with the DBS system of crop establishment.
I can only assume many scientists are unaware of what agriculture has achieved over the past 25 years as witnessed by the stories of DBS owners, two of which are partly re-printed in this edition.
If scientists want ways to improve carbon sequestration, come and have a look at what DBS owners are achieving in Australia.
It was always my intention in designing the DBS to enable accurate seed placement while building the right soil environment for seedling growth and beneficial soil biota.
Soil biota is broadly defined as a group of microscopic life forms that include bacteria, viruses, fungi and other microscopic creatures which are critical for plant health.
And I have always maintained that using the DBS provides you with a tool to make money while building the soil.
That has been the experience with DBS owners.
First adoptees used to comment on the fact that they couldn't fill dams because

rain stayed where it fell, similar to Keyline Farming, invented by my uncle PA Yeomans in New South Wales. Within five years owners were telling us the ground was softer and more friable and easier to work. This is what happens when organic matter levels build up in soil. And it didn't take long for owners to discover that the DBS was perfect for dry sowing and breaking hardpans to allow subsoil moisture to rise to the seedbed.

NSW farmer Greg Chappell exams a stand of millet sown into lovegrass on his Glenn Innes property. The lush feed is the result of years of composting and 'renovating' pastures with the DBS. Greg is a keen supporter of the BioFurrow™ and is keen to promote "biology" which is resulting in increasing organic carbon levels on his property.

All of this remains true today but the evolution of the DBS has seen it as the perfect vehicle for BioFurrow™ farming, turning my 'pot plant' description into a 'furrow for life'.

As DBS owners recognise - and hopefully scientists will start to understand - such a system will stop soil degradation and start soil recovery.

As this slowly occurs side benefits become readily apparent as some DBS owners already have experienced - elevated organic carbon levels, more normal soil pH, increased organic carbon and nitrogen levels, and healthier crops, pastures and livestock.

I am sure this would be music to the ears of scientists pleading for the adoption of "new approaches" to build and conserve our soils. I would encourage them to visit DBS owners and see what is already being accomplished.

For DBS owners I see the BioFurrow™ as the pathway to greater profits while maintaining soils that can sequester carbon.

Remember NSW farmer Greg Chappell's words in the January Ausfacts: "Wouldn't it be great if every farmer in Australia had a goal to lift organic carbon levels on their farms by one percent."

Patience the big message to building healthy soils

GLENN INNES, NSW, FARMERS GREG AND SALLY CHAPPELL ARE REAPING THE REWARDS OF A PATIENT ENDEAVOUR TO IMPROVE SOIL HEALTH ON THEIR SHANNON VALE PROPERTY.

But the latest message from the couple, who also run Dulverton Angus stud, is that they've got more to do.

As a result of the recent three year drought, the couple had to reduce their numbers of registered Angus cattle to 330 PTIC females, 120 sale bulls, 164 weaner bulls and 151 weaner heifers.

The Shannon Vale property totals 3600 acres (1450ha) and when the Chappells bought property in 2001, it was immediately apparent a strategy was needed to overcome a long history of degraded and compacted soils.

With an annual rainfall of 875mm (35in), it was imperative to take advantage of the available moisture and so began a program to improve the soil's water-holding capacity by building up carbon levels.

Weeds were the main problem, particularly African lovegrass, which had negligible nutritional value yet dominated over more palatable pasture species.

"Since about 2008, we have been re-building the soil by increasing organic and carbon content, through things like mulching weeds, manuring and using a liquid potassium mix, based on plant analysis," Greg said.

The herd becomes the mechanised process of smashing up weed 'stubble', including lovegrass, bringing it in contact with the soil where biological processes start material decomposition.

This 12-inch long chicory root on Greg Chappell's property is indicative of the many rotation options Greg is trying. As is evident, the root 'tills' the subsoil as a biological plough and is an excellent way to provide air and moisture access at depth

"It's a long-term process but we're seeing encouraging signs from our measuring sites," Greg said.
"When we started we were below one for organic carbon and now it's around 3.5.
"With soil pH it's gone between 4.4 and 5.7 to 5.9 and 7.1.
"And now, none of the sites are measuring below 5.7."
His explanation for the change, after a period of only four years, was simple: "We stopped single super (too much acid) and started manuring.
In 2017 Greg established 84 acres (34ha) of pasture with an Ausplow DBS trial planter, using a balanced granular formula to plant ryegrass and Lucerne.
Greg was impressed with the result, particularly the under-seed cultivation and shattering of the subsoil, breaking up soil hardpans and encouraging water infiltration.
On the pasture renovation side, Greg says by using the DBS and Multistream they are accelerating the process he and Sally started, because, "we didn't factor in this type of deep tillage in the beginning".
"It is clearly evident how the DBS creates a water-harvesting effect to boost seedling growth and we've seen how a 10 mill rain event can really bolster seedling growth," he said.
"We are ecstatic with the result of establishments of Sultan Rye and tribute White clover.
"They are small seeds and the traditional wisdom has been for a really fine seed bed preparation to enable establishment, so to do what we've done with the DBS is a true testament to the machine's ability in a one-pass operation."
Greg has also used the DBS planter to establish forage sorghum and cow pea (for N in the silage), which is used as silage feed for the cattle.
Last year he bought a 15-foot (4.5m) DBS on 10-inch (25cm) spacings with a mounted Multistream on the bar and liquid tanks on the drawbar to provide him with the capacity to switch between granular applications and liquids, including a new Ausplow formulation.
Now he is looking at replacing the granular fertiliser box with a liquid tank to go "full liquid".
"The liquids give us a chance to move forward with a balanced nutrition package being introduced into the soil, providing more benefit for high performance pasture growth," he said.
"The liquids are doing a far superior job for us with quicker germinations and plant growth that outcompetes the weeds.

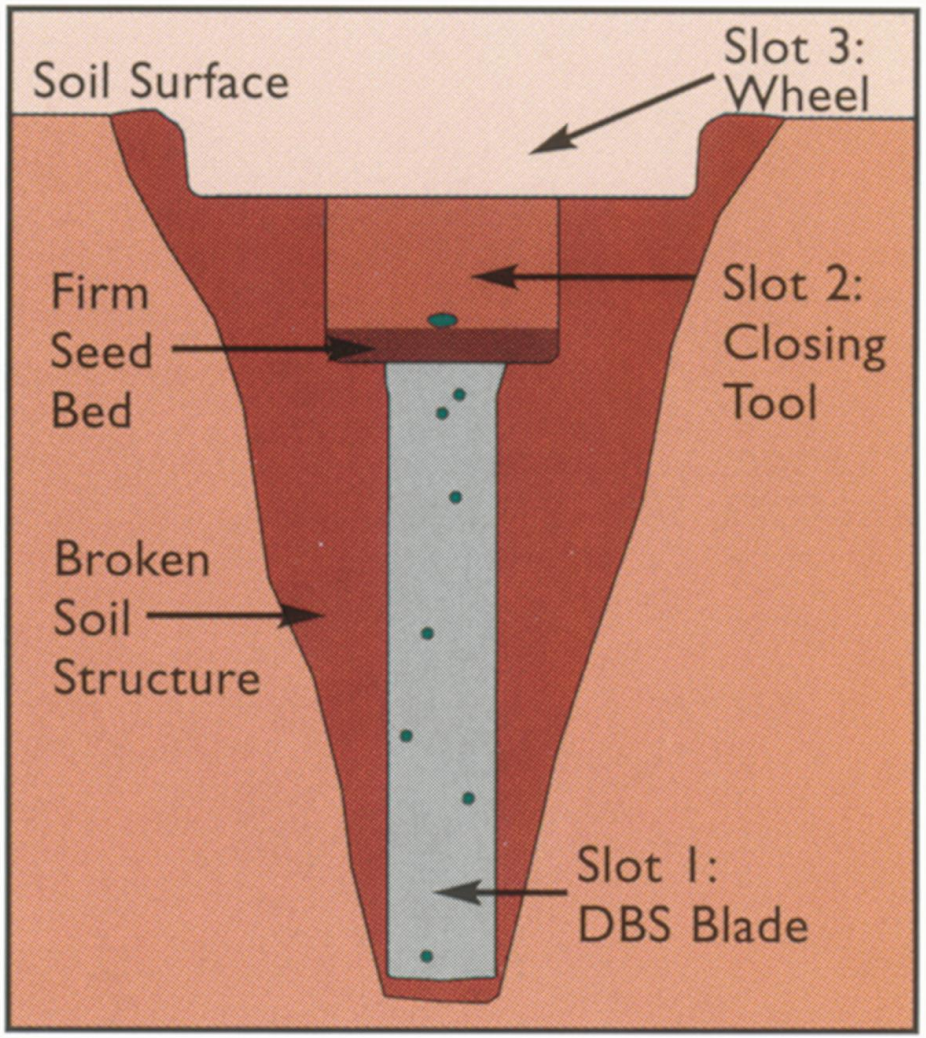
Building life in the soil is the focus of the BioFurrow™ hypothesis. It's an old message but a goodie.

A close-up photo, taken by Greg, showing how the twin Turbo coulters have split the lovegrass with oats growing through the broken thatch.

"For us, the DBS is our pasture renovator and it is working really well.
"Ausplow also added twin Turbo discs out front to cut the plant roots without disturbing the main tap root.
"The discs are the duck's nuts especially in lovegrass which is very clumpy.
"We're sowing oats into it with the idea of busting up the subsoil to get a more permanent pasture with a diverse plant mix.
"It will take time but we're retaining organic carbon and building moisture-holding soil.
"This in turn will improve the cation exchange capacity (CEC) which in our sandy soils is low, so we have no binding structure.
"By improving organic matter and holding water in the root zone, we achieve a higher CEC, which influences the soil's ability to hold onto essential nutrients and make them available to plants."

Glen Innes farmer Greg Chappell, NSW, took this photo of his made-to-order DBS and Multistream liquid-ready air seeder, planting Colossus oats at 60kg/ha

DBS and the bio-furrow concept



Slot 3: Covering wheel - ***FORMS THE FURROW***

- Assists water harvesting,
- Contributes to soil water around seed
- Seed is covered by soil fines

Slot 2: Closing tool - ***FORMS THE SEED BED***

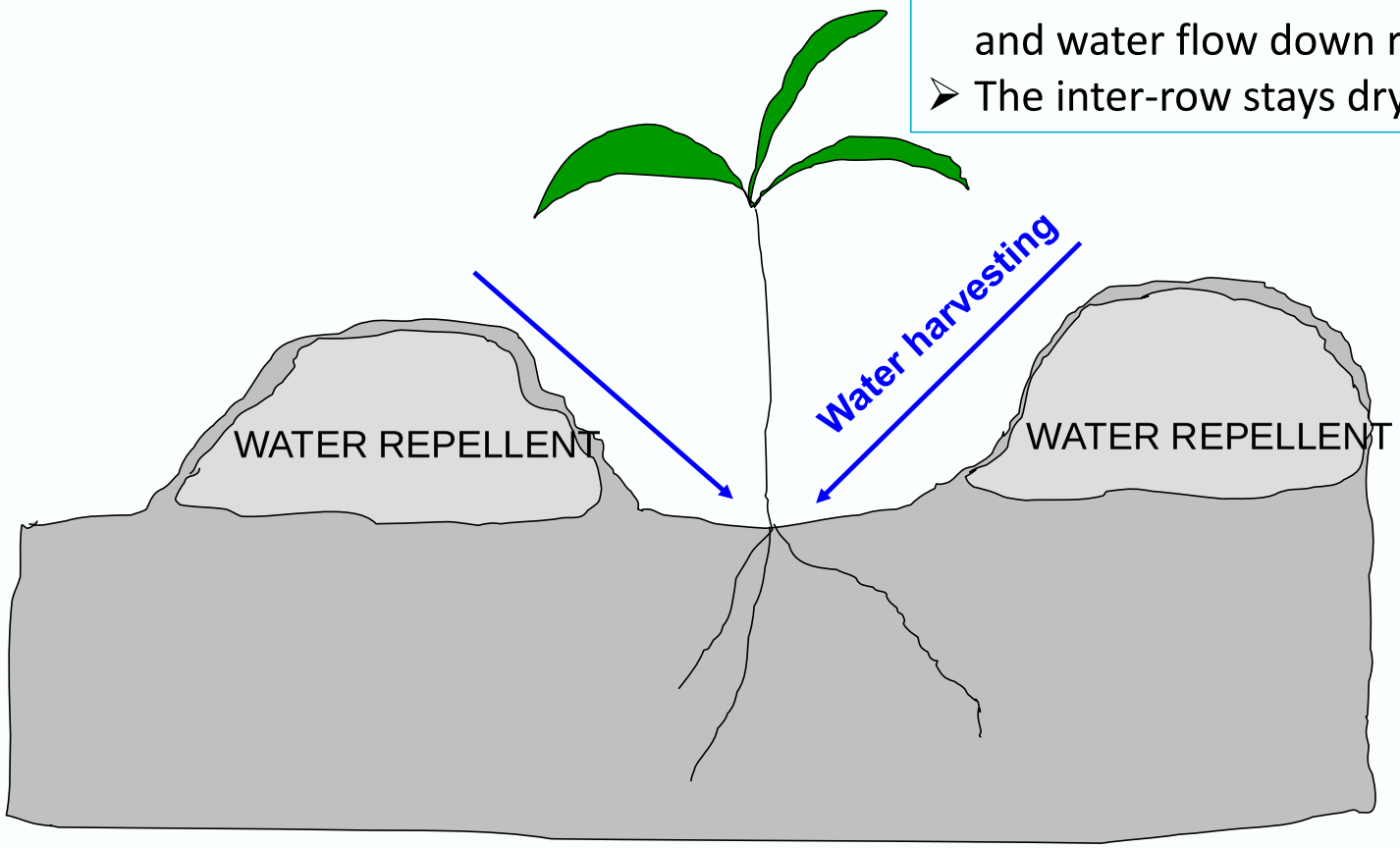
- Increased relative humidity promotes germination
- Water vapour in soil is the primary source of water for seed germination
- Relative humidity in this space will remain at 100% provided soil water contents are above wilting point

Slot 1: Vertical cultivation (DBS blade) and <u>liquid</u> fertilisers
FORMS THE ROOT BED

- Loosens soil for root development
- Increases water content below the seed
- Water vapour rises into space around the seed

Near-row sowing reduces weeds on water repellent soils

- Furrows remain wet through water harvesting and water flow down root pathway
- The inter-row stays dry and weeds cannot germinate



Plant emergence in near-row sown crops double that in the inter-row


Inter-row sown
On-row sown

A conventionally established crop sown inter-row.
While good results can be achieved,
the BioFurrow™ hypothesis can achieve an even better result.

An example of a BioFurrow ™ established crop

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