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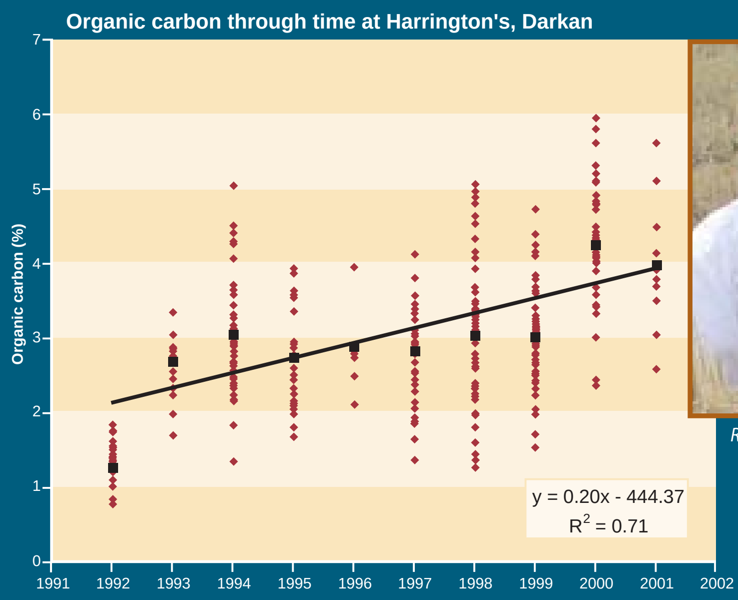
More organic carbon with no-till

More soil test data from Ray Harrington suggests that his soil's organic carbon content is increasing. This has happened especially over the last five years when there has been no sheep or pasture on the farm and no grazing of the stubbles (though with some burning).

There is some doubt that it is possible to double organic carbon from 2% to 4% in just 10 years. This increase was foreshadowed in the last *WANTFA Farming Systems* from only 3 paddocks—the graph below now includes 300 test results. (The graph equation shown is from using the mean year points.)

As background, the same method of sampling has been used over these 10 years. The surface organic matter has been removed before sampling to 10 cm depth and the tests have been done by CSBP futurefarm. The samples are not taken from same part of the paddock or the same paddock each time and this creates 'data noise'.



Ray Harrington

...Canadian scientists have measured a two-fold increase in organic carbon on Jim Halford's farm which has been no-tilled for 13 years...

Earthworms and grubs rely on organic matter as food—they process it into organic carbon.

Ray has been no-tilling for 18 years on some of his paddocks and has done some burning in recent years to improve canola growth on wheat stubble (see Ray's story in January 2002 *WANTFA Farming Systems*). This burning could increase the amount of inert carbon stored in the soil.

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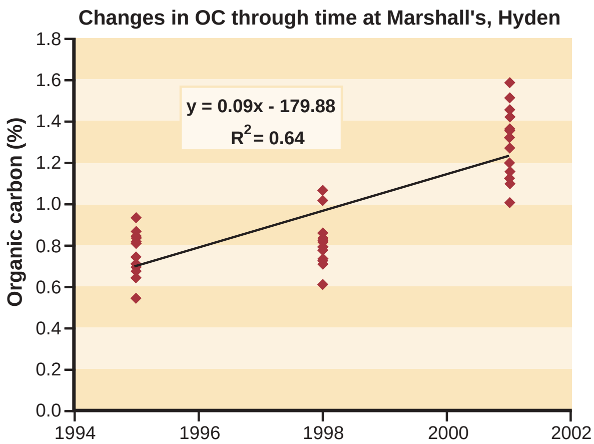
So how much carbon is it possible to deposit into Ray's soil environment? Let's say Ray averaged 5 t/ha of dry matter, or organic matter (OM), in each of the 10 years (plus he harvests 2–4 t/ha of grain that he exports from the paddock). Therefore, 5 t/ha over 10 years equals 50 t/ha of organic matter. Organic matter is 55% organic carbon, therefore 50 t of OM equals 27.5 t of OC.

The 2% increase in OC observed equates to about 30 t/ha of OC (with a bulk density of 1.5). This is close to the 27.5 t/ha of OC estimated. However, this is the maximum amount of OC that could be converted (with the assumptions used) and it is likely that at least 50% would be lost in converting the OM to OC. This would bring the increase in OC back to 1% over ten years—still a very healthy increase. The high point in 1994 is from a small fertile patch.

Canadian scientists, working with their no-till farmer groups, often report 1.2% increases in OC over 13 years—from 2.7% up to 5.1% organic matter (www.esso-farmtek.com/Spring 1996/page21.html).

Hyden OC increases with no-till

Similar to Ray's results are those from Geoffrey Marshall (see graph below) and his increases have been at a lower level but just as dramatic. This is not surprising, given the lower rainfall and slightly less years of no-tillage. Geoffrey has completely no-tilled since 1994 and before then was direct drilling since the early 1980s. Geoffrey has also had no sheep for five years and has done very little burning over the last four years.



The sampling technique at Marshall's has been identical during 1995, 1998 and 1991. The samples were collected from the top 10 cm (carefully increasing to 11 cm through time to take into account the softening of the soil through time), sampling between rows on a bare soil surface, using the same operator, using dGPS positioning and the same chemical analysis (Walkley–Black method).

Geoffrey Marshall has observed constant soil improvements with no-tillage at Hyden.

Twelve different paddocks were sampled in exactly the same six locations in each paddock. Each point represents an average of six OC readings.

A five year change

University research suggests that at least a five year change in management is needed before clear responses to soil organic matter are observed.

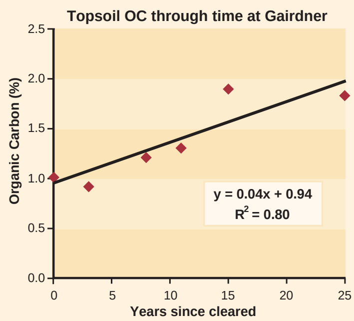
More soil test data is needed from other long-term no-tillers to improve our confidence in the level of OC increases with no-till. Also, fractionation techniques would be helpful to determine the 'alive OC fraction'.

So what is the maximum level of organic matter in our sandy WA soils? Most local researchers might say just over 1.0% organic carbon but this is only based on what has been achieved in the past under certain conditions.

Change the conditions, like Ray and Geoffrey have, and different results might occur. This issue needs more debate and more local data.

Organic carbon improves with agriculture

In contrast to many other parts of the world, the sandy soils of WA often have very low natural levels of organic carbon. During my soil science project at the University of WA in 1983, I compared similar soils from paddocks that had been cleared for varying lengths of time. I found that the longer the soil was farmed, the greater the level of organic carbon in the top-soil (see graph on right). The typical rotation during this time was one barley crop and two sub-clover pasture years.



Pacific Northwest farmers —paid for carbon

The Pacific Northwest Direct Seed Association (PNDSA) has joined with Entergy, one of the USA's leading utility companies, to reduce greenhouse gases. A historic letter of intent, signed on 15th Jan 2002, aims to protect the environment while keeping agricultural lands in production.

Direct seed (or no-till) cropping systems reduce carbon dioxide ($C0^2$) emissions and store it in the soil. Entergy will pay direct seed farmers for offsetting the $C0^2$ emissions from the company's power plants in the United States. With Entergy's support, the direct seed project would offset over 30,000 tons of $C0^2$ emission over a 10-year period.

"This is the first lease agreement for offsetting $C0^2$ emissions anywhere in the world," announced Karl Kupers, VP of the PNDSA. "This project opens the door to tremendous potential for the future. We are interested in leasing $C0^2$ offsets, sequestered in the soil, rather than selling them and permanently transferring risk to the landowner. We are excited about the positive implications this arrangement has for farmers, forward-looking industries and the environment."

Kupers started the transition to direct seeding six years ago and now farms 100% of his acreage near Harrington, Washington with this system. For more information see www.edf.org and do a search for "Kupers".

Deep ripping re-think!

Our recent observations of warm season crops, the arrival of tramlining, and the visit of nutritionist Dr Nigel Wilhelm for the WANTFA Conference (see his thoughts later in this edition of *WANTFA Farming Systems*) have all helped us to see more benefits to ripping duplex soils with less risk.

WANTFA held a small bus tour just prior to the Conference, which several of our visiting speakers joined. The core group inspected Owen Brownley's and Neil Young's warm season crop trials, and noticed that the warm season crop roots had not penetrated to depth to chase the stored soil moisture. The corn, sorghum and other crop's roots proliferated in the dry and fertile topsoil, and therefore were suffering from a nutrient drought. There was moisture at 40 cm depth—but few roots! A soil pit and auger holes made these issues clear.

Owen Brownley shows the group that the soil was moist at about 50 cm depth—which made digging the soil pit possible.

The corn roots proliferate in the dry surface soil at the edge of the soil pit.

Overview of the large blocks of different species. Assistance to help design and monitor these blocks has kindly come from Andrea Hills, Esperance Dept of Agriculture.

It is also likely that the compacted subsoil was restricting the rooting depth. Deep ripping is common for farmers on yellow sandy loams up north, but not on the more shallow duplex soils down south where the risk of water-logging and poor subsequent trafficability is high. Also, responses to ripping southern soils have been small and bringing up rocks is almost guaranteed.

Left: CSIRO's Dr John Williams discusses the subsoil problem with Neil Young and friends in Neil's 2.2 m high corn.

Below: The corn droughts and is nutritionally stressed even though this soil is moist from 40–100 cm depth.

It is possible to see that tramlines, and deep fertiliser placement when ripping these duplex soils, could give us reliable grain yield improvements with the warm season crops that we observed. Will the same hold true for winter crops when the topsoil stays moist for long periods? Who knows? We will do some trials to investigate these issues at Meckering this year.

Above (from left to right): Geoffrey Marshall, Toll Temby, Colin Steddy and Dr Nigel Wilhelm inspect some of Owen's better grown sunflowers.

Left: Sorghum roots at Neil Young's search sideways for nutrients and not down for the moisture that is there.

The nutritional challenges of growing warm season crops were clear throughout the Field Days. The below photo illustrates Mg and K. On most duplex soil in WA there is increasing levels of Mg in the subsoil—which the winter crops are likely more able to access with slower growing conditions than the warm season crops.

Mg deficiency is the stripes in the middle of the leaves, while K deficiency is evident on the brown outer 1 cm edges around the same leaf and also in the photo below.

Brett Roberts farms in a 400 mm rainfall area in South Australia. This season he deep-placed some compound fertiliser 25–30 cm below his corn and sunflowers at 70 kgN/ha, 10 kgP/ha and 20 kgS/ha. This has contributed to the growth of some magnificent crops on limited summer rainfall (10 mm from December to March). His crops are a long way ahead of anyone else's in SA.

South Australian agronomists look on in surprise at Brett Robert's healthy looking corn and sunflowers (photo from Wayne Smith). The crop had 150 mm of rain during October and November and the sunflowers yielded 1.1 t/ha at $680/t.

Sub-soil acidity and no-till

There is renewed discussion about ways to overcome subsoil acidity. The simplest way is to apply more surface lime and it will get in! The three long-term "lime by tillage" trials at Meckering presented in previous *WANTFA Farming Systems* editions show that the subsoil pH has lifted by 0.6 of a unit with 4 t/ha of lime with knife-points. This is equal to the annual full cultivation treatments.

Organic material also seems to aid in the movement of lime to depth. Fulvic acids are water soluble and can aid in lime movement. No-tillage systems, with full stubble retention, contain higher levels of fulvic acids in the surface where the lime is placed. Recent studies in South America have shown that black oat (Siai oats—*Avena strigosa*) material is very good at moving lime to depth. Their research shows that lime will move adequately in disc zero-tillage.

2001 South American no-till study tourers inspect an oat cover crop in Paraguay.

Glyphosate resistance and full tillage!

At the recent Crop Updates, concern was again raised about glyphosate resistant ryegrass. Knockdown sales in the northern agricultural region are 90% glyphosate and many paddocks are being sprayed within a few days of the opening rain. This is not giving ryegrass enough time to grow past the one leaf stage—making both glyphosate and SpraySeed less effective.

What to do? Two options were presented to farmers, being;

1. Use the double-knock technique of SpraySeed following glyphosate; and
2. Use a soft form of full cultivation.

The type of full cultivation that was promoted is the most thoughtful way of doing full cultivation. Low-angle wide-points (see photo below) would slice under the top 3–5 cm of topsoil, and should not throw soil. Trifluralin would most likely still work and both a knifepoint at depth and press wheel, which was also advocated, are compatible with this type of wide point.

Perhaps the most gentle full-cut cultivation possible.

While there is no doubt that this type of cultivation will work for ryegrass control we need to remember some possible negative effects of this and consider other options. The full cut points will not always flow well through thick stubble and will disrupt ant nests and other soil insects (which eat ryegrass seeds).

Full cut points may also loosen the soil enough to create wind and water erosion on parts of the paddock that have limited organic matter cover. Such erosion would be reasonably serious as a history of no-till ensures that the most fertile organic matter fraction is on the surface. Also, the full cut points may be difficult to keep at a shallow depth across the bar.

Some other ways to kill ryegrass!

Farmers in southern regions can easily delay spraying knockdowns by 8–10 days after the opening rains. The season is longer and conditions are less likely to dry so quickly—with more frequent and effective cold fronts. Mixing chemistry types and good crop competition with banding of fertilisers are important tools.

It is not possible to sow all paddocks in a large program in perhaps less than 10 days. Therefore, the order in which the paddocks are sown—and sprayed—could be changed each year. This would mean that on at least 33% of the program you could be spraying 7-day-old weeds with SpraySeed each year. The efficacy of SpraySeed can be improved by lifting water rates and spraying in the dark, or in overcast or drizzly conditions.

The other option is to use disc seeders that do not stimulate so many weeds. With this system the crop can be planted 0–5 days after the rain and then sprayed with a knockdown just before the crop emerges. The precise seeding depth of the discs ensures precise emergence of the crop.

Another option is to sow pulse crops on wider row spacings and use shielded sprayers to apply SpraySeed in the inter-row and new chemistry in the furrow.

Erosion in Brazil improves

The famous Iguassu waterfalls used to flow red with the loams of central South America. The local scientists and farmers were keen to assure us that no-tillage is what has made the difference to the colour of the water. See the starting difference in the photos below.

Iguassu Falls in 2001—clean and almost free of soil.
Inset: What the water used to look like with significant tillage.

Soil damage from sheep

After returning from the South American study tour, a central wheatbelt farmer remarked at our recent Study Tour reunion, "The care that the people we visited had for their soil made me realise that we must learn to farm differently—we are overgrazing our summer paddocks too hard, too often!"

Between Cunderdin and Quairading there are several paddocks that have been grazed quite hard.

Apply K now!

It is surprising just how K-deficient our soils have become recently. The problem seems to be widespread. Have you done any canola swathing and windrow burning and observed the famous 'wave effect'? Or have any of your neighbours?

Even with soil tests of 72 and 121 mg/kg, at our Meckering site in 2000, we were able to get an economic response to 100 kg/ha of potash in wheat and canola respectively (see our data on the website). Be aware that deficiency is common throughout WA. Remember: it's one of the 'Big 3'—N, P, and K!

Beware 2,4–D upsets warm season grasses

During our warm season crop tour we often observed corn and sorghum damage from 2,4–D use in the wrong window. Be aware that there is a window—outside of which reasonable crop damage may occur (see photo below).

2,4–D damage in corn.

Weed seeker

This technology has real potential, according to Dr Warwick Felton who spoke at our Conference. Warwick has worked closely with this technology for many years and, when he travelled the state in February, he remarked that this technology would be a perfect fit for WA.

You could easily imagine a spray contractor travelling all over the state in summer applying 30–50% of the herbicide that you would need to. And perhaps he could make a living off the herbicide savings? If you are interested see www.weedseeker.com or talk to Warwick on (02) 6763 1100.

Pesticide Free Production

An exciting group of innovative farmers and high-powered researchers in Canada have formed a new group (www.pfpcanada.com).

Pesticide Free Production Canada (or PFPC) is dedicated to research and education activities that support reduced pesticide crop production. The members of PFPC have developed a crop production system that reduces the use of in-crop pesticides.

Dr Doug Derksen is one of those researching thoughtfully with this PFP group. Doug spoke at our Conference in 1999.

This idea fits nicely with WANTFA Farming Systems—which is keen to promote ways to reduce chemical input. The other foci of the PFP group include sustainable agriculture, farmer flexibility, and market awareness and sensitivity.

PFP aims to empower farmers to reduce input costs by substituting "free" knowledge inputs for chemical inputs which must be bought. Growing crops in a pesticide-free manner requires the use of diverse cropping systems and pest control practices. This helps to create more stable agro-ecosystems in which the chances of pest outbreaks and development of pesticide resistance are minimised (see Dirceu's comments following). Including PFP crops in a rotation also helps to decrease pesticide loads in agricultural systems.

PFP is more flexible than organic farming, as it allows the use of fertilisers and some pesticide applications outside of the PFP crop's growing season, and it does not require a long-term commitment. Production of PFP crops may result in the development of new markets for traditional crops, with the possibility of market premiums. This would provide an incentive for more farmers to grow PFP crops, and could also ease the transition for farmers who are converting to organic.

Insights from Brazilian entomologist

Unfortunately Dirceu Gassen, our no-till insect expert, was unable to secure an Australian Visa in time to make the WANTFA Conference. He did however, speak in SA and NSW and he passed on the following thoughts on the phone—some of which he linked to his Australian experience. (Dirceu's general talk is in this edition—see the Science Section.)

No-till has dynamic insect systems

With no-tillage systems there are more insects in the soil—both good and bad. With conventional tillage the insect systems tend not to be complex. Here, you can transfer your pest to a glasshouse or laboratory and generate a good understanding of the pest problem and this model is likely to relate well to the field. Pests often appear in 'boom and bust' cycles.

With no-tillage the biological systems are much more complex with dynamic interactions. This can often buffer against the dramatic 'rise and fall' of pests. While life cycles can still be developed in the laboratory, the other powerful and perhaps equally important factors are probably lost through the nature of experimenting in isolation.

Alive no-till soils have a constant background of soil fauna.

The use of antibiotics by humans might be a useful analogy. Antibiotics either kill or inhibit the growth of bacteria in the body, creating space for new bacteria to fill—hopefully more positive bacteria. Destroying almost all pests with tillage, burning and the widespread use of general insecticides invites another boom and bust cycle at some later stage.

Protect the crop—for a while!

The key to Dirceu's philosophy is to give the crop the insect protection precisely when and where it is needed for the time it is needed, then allow the remaining insects to work on the weeds in the inter-row. This might mean specific seed treatments and precise band spraying of insecticides—just enough to allow the crop to become strong enough to fight for itself.

The bands would be narrow and only in the crop row. Obviously broadleaf crops that can be sown on wide rows amplify the potential of this approach. These narrow bands create the opportunity for a whole range of insects to persist in the inter-row. Broad spraying techniques invite specific pests to proliferate (slugs are a good example of this).

Slugs survive when predatory insects are removed

Dirceu says that slug eggs are an abundant food source for many insects. Insects easily find them as the eggs are laid in the organic litter above the soil. In virtually every case in Brazil, where a farmer that Dirceu has spoken to has big slug problems, broad-spectrum insecticides have been applied over the whole surface. The key is to be precise, perhaps by placing a band of appropriate pesticide in the furrow while seeding.

For immediate relief of slug pressure, where perhaps 70% control of slugs (and perhaps snails also) might be achieved, farmers could apply some salt in the evening. The salt could be UAN (Flexi-N) or potash dissolved in water, or even urea dissolved (with heat) in water. It must however, be applied at night—while the slugs and snails are on the move.

South Australian farmers have a constant battle with snails—will UAN work?

False-wireworm and ryegrass

Apparently, false-wireworm feeds on ryegrass seeds. Dirceu suggests that an expected diet might be 5 seed per week. Is this why, in many situations down south, ryegrass numbers are declining in the zero-till (disc) system? We know that wireworm abound in no-till systems—perhaps they are harder to target as they hide under the stubble. Is it possible that this is a good thing?

We also know, that without tillage and heavy grazing, ryegrass is left on the surface—in clear view of a hungry wireworm. If one wireworm can eat 5 seeds per week, that is 50 seeds in 10 weeks. And if there are 10 wireworm/m^2 this is potentially 500 ryegrass seeds that could be eaten in 10 weeks—if they are left on the surface. Could this be what Wayne Smith and others, as well as myself, have been observing?

Why so many ants?

After talking to Dirceu I wondered about the high prevalence of ants that I see every summer in long-term zero-tilled paddocks. Why so many ants? Is this natural—and healthy? We know ants eat weed seeds, so this too could be a good thing! Perhaps we are killing ant predators with non-selective insecticides. Perhaps many of the ants are in their nests when the pesticide is applied—thus providing them with an advantage that other insects might not have.

David Minkey from UWA has put ant cages on the Meckering site to learn more of their habits.

Research encouraged

This could be an exciting field of new research; "insect population dynamics in no-tillage and full stubble retention cropping systems" and "the role of insects in ryegrass seed predation in zero-tillage systems on the south coast".

Thankfully, some research is being conducted by David Minkey at UWA into the relationship between ants and weed seed predation—keep at it, Dave!

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South America study tour again

A group of NSW no-till farmers are heading to South America from 29th July to 19th August 2002. If you would like to join them call John Lawrie on (02) 6845 2488 or email him on jlawrie@dlwc.nsw.gov.au.

Some places and people they will be visiting include Papeete (Tahiti), Concepcion (Chile) with Mr Carlos Crovetto, Rio de Janeiro, Mr Manoel Pereira (Brazilian no-tillage pioneer), no-till trials at University Research Farm (UEPG), Mr Frank Dijkstra, Iguassu Falls, Rolf Derpsch, Dirceu Gassen, Santa Fe AAPRESID No-Till Conference, Buenos Aires and Easter Island. There will also be an extra week of holiday if you wish.

Hooded sprayers—three available!

There are at least three spraying shields available in Australia. Feel free to mention WANTFA when inquiring.

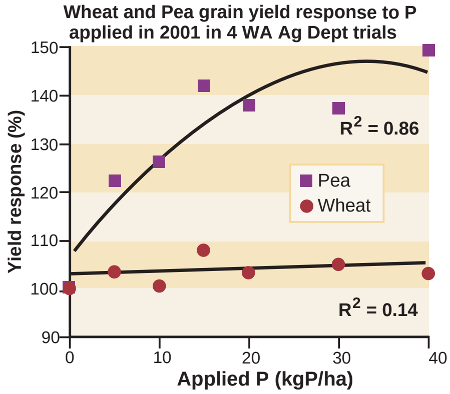
Red Ball, from Ellis Equipment, was mentioned in the January 2002 issue of *WANTFA Farming Systems*, page 488. Phone (07) 4162 1244—ask for Dave. Cost is $816.

Armour Industries produce a polyethylene shield with low drift nozzles, a rubber skirt on both sides, and ground following press wheels that don't lift dirt. Apparently the wheel bearings are very good (eight years is the track record). The shields are parallelogram mounted and are height and width adjustable. They are 900 mm long x 350 mm high x 900–1000 mm wide and cost about $800 each. Ring Gary Armour on (02) 6742 5600.

Clark Plastics—these plastic hood shields cost $86.50 and are 800 x 400 x 300 mm. They have no skirt or parallelogram and are oval-shaped. Talk to Wally on (07) 4669 8040 or see: www.clarktanks.com.au/about.html

Department trials show pea response

Five Department of Agriculture trails were conducted throughout WA to compare the responsiveness of field peas and wheat to drilled phosphorus. The P requirements for field pea are not known. The trials were located at Circle Valley, Mullewa, Williams, Merredin and Corrigin. The trial at Mullewa was droughted and the Williams trial was frosted. (All trials have been included in the graph below except the Mullewa trial.)



The trials were supervised by Dr Mike Bolland and Dr Peter White and the following is taken from their *Crop Update* paper: "The 2001 season was very dry early, and in July and August field peas showed large visual growth responses to applied P fertiliser at all five sites. Above about 10–15 kg P/ha, the field peas looked much better, with few gaps between plants, greener foliage, and much healthier appearance. By contrast, at all sites during 2001, wheat showed no visual responses to applied P, suggesting the soils had already had adequate P for wheat production."

From the President

Neil Young, Kojonup (08) 9821 0026, fax 01

Conference 2002

Conference 2002 was a great opportunity for members to meet each other, to hear differing opinions and experiences, and to then go home with a new determination to make no-till work for them. The opinions of visiting guest speakers added some new insights and stimulated ideas to test out closer to home.

Delegates enjoy refreshments in the Trade Exhibition area during the well attended 2002 Conference.

Thank you to Bill Crabtree for arranging and co-ordinating speakers, John Duff for taking care of logistics and Matt Beckett for making the valued technical trickery work effortlessly.

Subsoil problems

Subsoil problems became apparent on the paddock trips made by the key visiting speakers during Conference week.

Nigel Wilhelm's talk on his work with deep placement of nutrition in South Australia added to the jigsaw and, when added to the work done by Hamza of the Dept of Agriculture at Merredin, many people now think we should be paying more attention to this area. I suspect only some soils will be responsive, and they may well be easily identified.

Subsoil issues may be the unidentified constraint to consistent crop performance in the high rainfall areas at least, and with this in mind Mike Wong from CSIRO has taken soil tests from under the corn on my farm.

Committee news

Our AGM this year saw the retirement of Kevin Bligh, Owen Brownley, Colin Pearse, John Stone and Paul O'Meehan. Their contributions have been appreciated—thank you.

In turn, I welcome Kit Leake and Kellie Shields to the Committee. The new Committee has already spent time together at York so we can have a clear set of priorities for making no-till work better in WA.

We have confirmed the present practice of working in with key industry partners and existing research institutions, with our role being to keep the focus on practical, sustainable agriculture. There is a lot to do, and never enough time to do it all, so we welcome input from any and all members of WANTFA.

Machinery investment in cropping systems

Ken Sevenson, Farmanco Consultant, (08) 9641 2299

The progression towards no-till in WA began over 25 years ago when farmers started adopting a plough-seed system. This was soon followed by Direct Drilling, using a full cultivation at seeding after the application of Spray Seed.

A study on Productivity in the Australian Grains Industry was conducted from 1978 to 1998. This time frame coincided with the adoption of minimum and no-till. The study shows that productivity in WA has continued to improve against deteriorating terms of trade and that WA grain growers are some of the most productive farmers in Australia (see www.abare.gov.au/pdf/agi20abs.pdf).

This success has meant some major changes to the farming system, but the changes do come with some warnings. The study shows that crop farming has been the most productive of all broadacre farming systems (producing 37% more income than mixed farming). This has occurred while the National farmers terms of trade (prices for outputs and inputs) has deteriorated at about 3.5% per year. In contrast to this WA has made an average productivity gain of 3.5% per year—through producing more outputs and a more efficient use of inputs.

WA leads no-till adoption

Based on an Australian-wide measurement by ABARE and the GRDC, WA has the highest level of no-tillage (direct drilling and minimum tillage) of anywhere in Australia, with traditional cultivation practices being almost non-existent in many WA areas.

In other parts of Australia traditional cultivations still represents a third of the crop establishment systems. The high level of no-tillage adoption in WA corresponds with an increased use of crop sprays. The WA farmers increased their crop spray inputs at 8% per annum, with the Eastern and Northern areas of WA it is over 10%. This compares to a 4% increase in GRDC's southern Australian farms (SA, Vic and southern NSW). The fertiliser inputs in WA have increased at an average of 4% per annum—being lower than eastern Australia at 7%.

WA forges ahead

This 20 year study shows that WA agriculture has thrived under adverse conditions. WA has shown its ability to adopt new concepts and technology during some difficult seasonal and economic conditions. The changes include, adopting lupins, good disease and nutrition management, no-till farming systems, plant breeding and larger scale farming.

There are lots of interactions and inputs that go into creating the optimal rotational plan and cropping system. The complexity of these interactions makes it impossible to attribute the WA success story to any one management change. Some of these include choice of enterprise, soil type, rainfall, paddock history, agronomic practice for pest control, product price, farm operating costs, attitude to risk, management ability, rotational benefit and plant and machinery investment.

Benchmarks for machinery investment

Plant and machinery investment is a component of the successful farm operation. It is not the cause, the focus or the main functioning point—but it is a critical issue! It is a key issue that can lead us to longer term farming success. Then, "What are the key benchmarks we are seeing in machinery investment with cropping?"

Farmanco Profit Series

The Farmanco Profit Series is a review and analysis of the profitability of a number of our farm businesses. In 2000 we analysed 192 businesses. Following is the machinery component of that data.

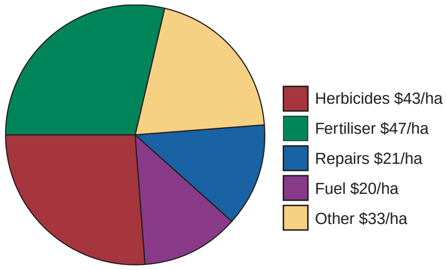
The two key assets of the farming businesses are land and plant and machinery. On average each business has over $500,000 worth of plant with total assets of $2.7M. These businesses also have liabilities of about $660,000, of which $98,000 is in financing of machinery. Therefore about 18% of the assets of the business are tied up in plant and machinery, only second behind land, and 15% of the liabilities are tied up in machinery finance.

The 18% of assets invested in plant machinery seems to be ever escalating. Through the 1990's machinery values steadily increased and this was a concern as it does affect overall profitability. In 1994–95 most businesses had just over $350,000 worth of machinery and by 1997–98 it was $550,000. But it seems to have stabilised now. Although, given the better season in 2001, for many, we wonder if the increasing trend will return?

The average business has $211 per effective hectare tied up in machinery, being $333 per cropped hectare. The top 25% of farmers have $373 per cropped hectare in machinery. The ratio of machinery in relationship to crop income is 0.96—meaning, the value of machinery is equal to the cropping income. For every labour unit there is about $280,000 worth of machinery. These benchmarks help to indicate where farmers might have too much or too little invested in machinery.

The cost of machinery just doesn't go away. Steady and healthy businesses seem to be paying 10% of their income on servicing machinery debt. However, machinery debt is competing with other parts of the business and therefore has to be monitored carefully.

Item	% of income spent on businesses that are Steady	or Healthy
Farm Operating Costs	60.2	62.2
Farm Operating Surplus		
Personal	10.3	7.3
Finance	6.7	4.6
Machinery	10.3	9.6
For debt and tax	12.5	16.3
	39.8	37.9
Total income (%)	100.0	100.0

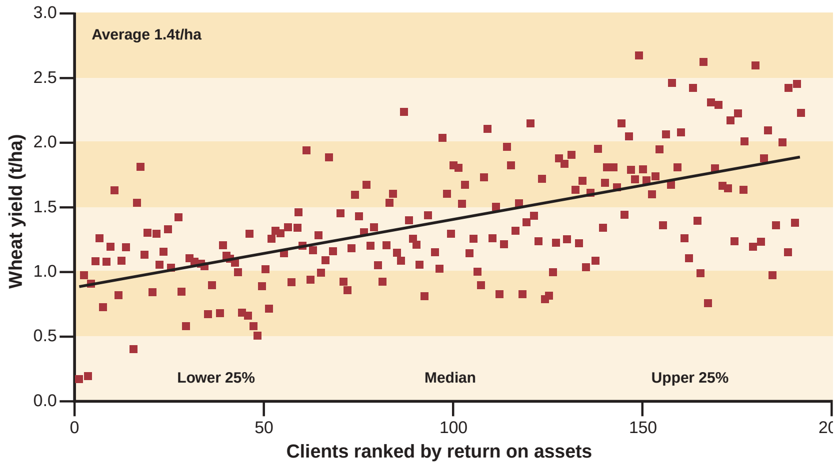


Personal expenditure, which includes education, also caters for about 10% of the income. Financing of long-term debt is about of 5–7% and taxation also needs to be considered. The farm operating costs are around 60%, in other words, 60% of every dollar is being used to get a farm operating surplus so you can afford to purchase machinery. You can have a low investment in machinery but this is likely to require greater repairs and maintenance costs.

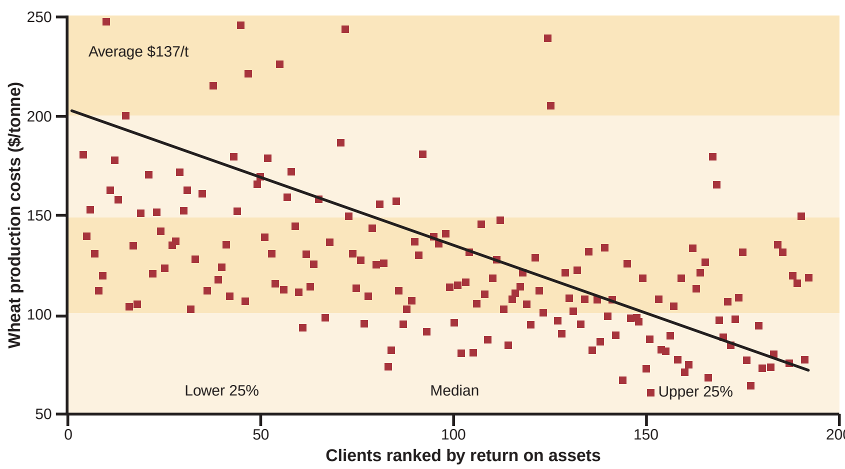
The costs of growing a wheat crop were about $160–170 per cropped hectare. The pie graph above shows that there is a balance between the four big costs and this effects profitability.

Trends and ratios

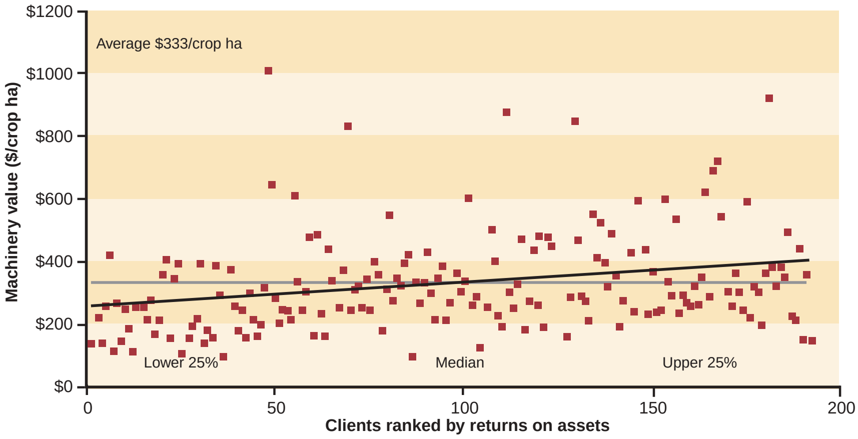
Eric Nankivell, our consultant in Narrogin, has explored this Profit Series data for trends. The trends do not relate strongly to specific seasons. Not surprisingly, increasing wheat yields shows increased profitability.



It is important to keep input costs under control as the cost of production is closely related to the profitability of wheat.



In contrast to previous observations we can see there is greater profitability with increased machinery investment. It may pay to have more machinery investment per cropped hectare than in the past. Too low an investment will reduce overall profitability.



A previous analysis showed the most profitable businesses had $385 per cropped hectare tied up in machinery compared to the less profitable businesses which only had $292. It may be that more capital invested in machinery is more profitable.

Some rules of thumb for a healthy business

1. The farm operating costs should be less than 60%. This ensures efficient use of key inputs, and not substituting those for lack of capital in other areas.
2. Machinery expenditure should be about 10% of gross farm income.
3. Machinery investment should be around $350 per cropped hectare.
4. Machinery investment should be a 1:1 ratio against crop income. This measures the efficiency of producing grain income from cropping plant investment.

Summary

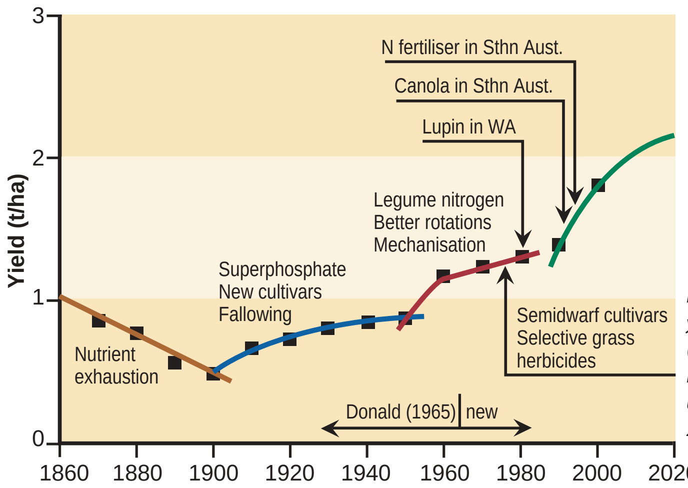
- Machinery investment should be guided by production. Such an investment should not be an excuse for avoiding tax or for no-till zealots, who haven't addressed the important production issues that make more sustainable and profitable rotations.
- Top farmers use robust farming systems. They have access to good agronomic advise and they use it. They don't substitute capital for good management ability.
- Keeping the critical ratios of machinery investment in non-compliant zones for extended time can result in terminal damage to a farm business.
- Finally, ratios don't lie, use them to your advantage and not to your detriment.

Future farming improvements

Dr Nigel Wilhelm, SARDI (08) 8303 9353

Dryland cropping industries in Australia are experiencing one of their most exciting periods of productivity ever. If you consider the trend in national wheat yields (see graph), you can see that there has been a spectacular increase in yields over the last ten years, at a rate that has never been seen before. State records for total grain harvests have been regularly broken in the southern states over the last five years (without extra arable land).

I see no reason why these increases cannot continue. Certainly our current levels of water use efficiency allows plenty of room for improvement, with most crops using only 50–60% of the rain which falls, at best. What is currently holding back our productivity?



National wheat yields in Australia (originally by Donald 1965, updated by Angus 2001).

Several of our major productivity constraints are subsoil based. *(Editor: See more detailed article inside by Nigel Wilhelm in the Science Section).* I believe that more efficient fertiliser use and techniques that improve the condition of our soils for crop production will increase productivity, and will also reduce the footprint of agriculture on the Australian landscape. The long-term future of agriculture is dependent on halting and reversing many of the detrimental effects agriculture has had on Australia's natural resources now.

2002 Meckering dates for your diary

Tuesday 23rd July
Meckering R&D post-sowing field walk

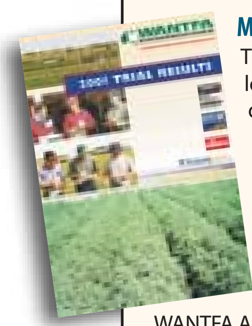
Monday 16th September
Meckering R&D Diamond Sponsor's dinner

Tuesday 17th September
Meckering R&D Field Day

Tuesday 22nd October
Meckering R&D pre-harvest field walk

More innovation at Meckering for 2002

There will be about 20 trials exploring ways to improve our soils—both surface and subsurface, agronomy and nutrition. Crops on show will include all pulses, pea agronomy, lupin agronomy, oats for hay, wheat, canola and lots of CLIMA pastures. Weeds will be controlled with wide rows and different chemistry. It will be an exciting field day that you might regret if you miss it. Put the dates in your diary.



Meckering Book for sale

The Meckering book contains lots of graphs and data on the 25 different WANTFA trials conducted during 2001. Most of these trials are from Meckering and they provide useful innovation for high yield sustainable farming. The cost is $22 (includes postage and handing), please contact WANTFA Administration on (08) 9277 9922 for a copy.

And also on the web…

The same book will also be on the WANTFA website: www.wantfa.com.au. To access this you will need to hit the Meckering R&D button and follow the instructions.

Meckering 2001 Trials summary

Bill Crabtree and Matt Beckett (08) 9690 2157

Below are the main results from the Meckering site for 2001. These results are also posted on our website for members to view—see www.wantfa.com.au. A booklet of the results is also available at $22—call WANTFA Administration on 9277 9922.

01W01 Broadleaf herbicide tolerance demonstration

- Biomass was rated for 26 species treated with 60 different herbicide applications.
- Some unexpected results were obtained—available in Field Day book.
- Pasture species emergence was poor due to dry conditions after sowing (on heavy soil).

01W02 Shochu barley—for Japanese Shochu (distilled spirit) market

- Requires malting standard barley with protein between 9.0–10.5%.
- The highest grain yield, and economic return was from the highest rate of applied Flexi-N (120 kgN/ha), and this was above Shochu protein window.
- The timing of applied Flexi-N had no impact on grain yield or protein.

01W04 Flexi-N timing for wheat

- Two trials, same design (one not randomised), were sown on different sites.
- Both trials demonstrated a significant yield increase to applied N.
- Un-randomised trial hinted at a benefit in split-timing application.

01W05 Cover crops

- Long-term trial, set-up to test the effectiveness of different species as cover crops in 2002.
- Wheat, followed by black oats, and then lupins, produced the most biomass.

01W06 IBS herbicides by tillage

- The trifluralin/diuron mix gave best ryegrass control, then trifluralin alone and then Stomp.
- No-till increased wheat emergence, and ryegrass control was increased by 38% over DD.
- Direct-drilling (DD) yielded 7% more than the no-till system used.
- The seed-bed was cloddy and ryegrass numbers were low.

01W07—Managing wheat residue improved canola emergence.

01W07 Managing wheat residue improved canola emergence

- Retained wheat stubble hindered canola establishment.
- Produced evidence that residue managers would improve canola yields with no-tillage.
- Despite emergence problems the disc zero-till gave better grain yields than the no-till.

01W08 Wide and paired row lupins and canola

- Lupin grain yield did decrease with increasing row spacing—canola was not harvested.
- Yield reductions were small (5%) for doubling the row spacing to 42 cm.
- Solid rows seemed to perform better than paired rows.
- Main-stem pod height increased by 5 cm with the widest row.

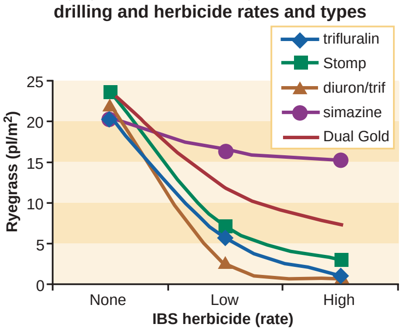
01W09 Fungicides for wheat

- The season did not favour disease.
- Jockey showed a hint of improving grain yield with the wheat on wheat.

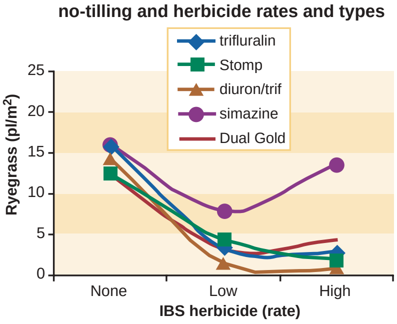
01W10 Seeding rate for 1 metre wide row lupins

- The 70 kg/ha gave the best grain yield—a higher rate may have even been better.
- Pods on the north side of the row were more prolific and weighty than south facing pods.
- Hair-pinning with the disc seeder reduced plant establishment, which reduced yield.

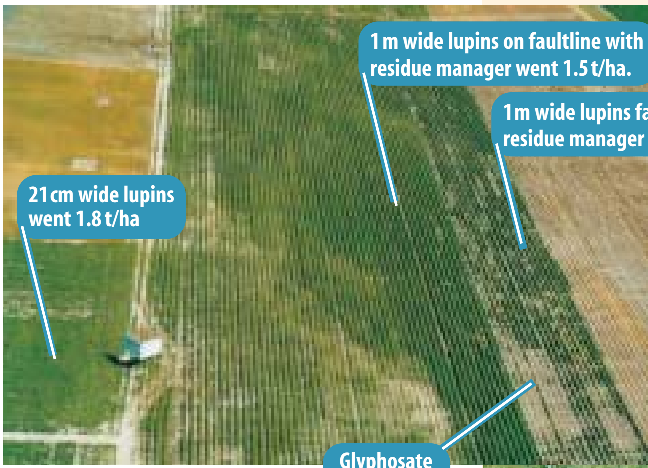
Ryegrass counts 53 days after direct drilling and herbicide rates and types



Ryegrass emergence 53 days after no-tilling and herbicide rates and types



01W08–Wide and paired row lupins and canola.



PR-70 with no P (right) performed better than no PR-70 and some P.

01W12 PR-70 fungi for better P uptake

- It greatly improved early dry matter (DM), but not grain yield—only by 5.4%.

01W14 Liquid versus granular P

- Liquid P was more effective than granular P. The site gave a 20% response to applied P.
- There appears to be greater liquid P efficiency at the 5 kgP/ha than at 10 kgP/ha.
- Liquid P performed better with urea than with Flexi-N.

01W17 Flexi-N placement

- Separation of Flexi-N can be effectively achieved with a range of openers.
- Flexi-N can probably be banded safely up to 60 kgN/ha with separation.
- 60kgN/ha gave best grain yield on the lupin stubble.

01W18 TT and IT Canola varieties

- Surpass 501 clearly performed best, yielding 1.8 t/ha with 1st June sowing.
- Pinnacle did not perform, yielding 1.0 t/ha, while Karoo yielded 1.5 t/ha.
- Of the IT lines the Pioneer 44C73 yielded 2.2 t/ha and Surpass 603 went 2.0 t/ha.

01W19 Farmers Carbon

- The addition of the complete Farmers Carbon package did not increase grain yield.
- Applying urea, to the same cost of this package, increased returns by $172/ha.

01W26 Wheat varieties

- Tincurrin yielded best at 3.5 t/ha with 9.4% protein and gave the best economic return.

01W34 Liquid Cu and Zn

- The 15th June sown trial yielded 2.7t/ha—perhaps not high enough to induce deficiencies in copper or zinc.
- The tissue analysis showed improved copper uptake with applied Cu.
- There is a hint that powder (not granular) Zn gave better uptake than liquid.

Long-term trials

00W24–25 Calcium to magnesium ratios

- Salt levels from the treatments appear to be still masking grain yield responses.
- Hopefully 2002 will help show if these differences are due to the altered soil cation ratios.

00W24—Calcium to magnesium ratios are 6:1(centre), 12:1 (right) and 2:1 (left). Salts have upset emergence and growth.

00W26–28 Three state-wide claying rate by tillage intensity

- Meckering wheat gave a 1.3 t/ha response to claying—with maximum tillage being best.
- Esperance canola gave definite responses to increased rate of applied clay.
- Dandaragan wheat showed decreasing grain yield with increasing rate—don't know why!

00W29–31 Three Meckering lime by tillage trials

- Neither lupins, barley or canola gave a significant grain yield response to applied lime.
- In contrast to last year, lupins showed a trend to improved yield with increasing lime (ns).
- The disc opener gave poor emergence and grain yield with both lupins and canola.
- Barley showed no grain yield difference to tillage or opener type used.

Fauna and pests with no-till cropping systems

Dirceu Gassen, Technical Manager, No-Till Farmer Cooperative, Brazil

No-till is different!

The soil biological activity under no-till, with stubble retention and cover crops, will benefit biological activity—establishing food chains that are almost unknown in conventional tillage. When first adopting no-tillage, Brazilian farmers were sometimes worried about unknown fauna.

Traditional entomological research studies and technical recommendations for pest control are historically directed towards conventional tillage ecosystems, focussing on a few species that frequently reach damaging levels.

Studies can sometimes be made in laboratories under environmentally controlled conditions, the results of which are too simplistic for no-tillage systems.

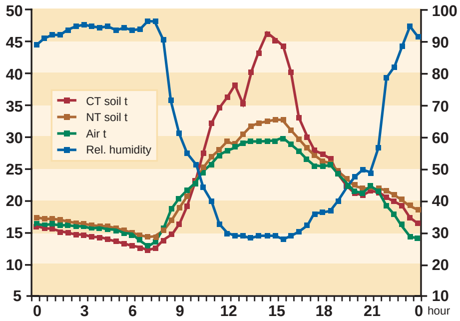
No-till fauna need to be analysed as a complex system with long-term interactions and intensive biological activity. Local research and field data need to be collected by scientists working in different research areas (pests, diseases, weeds, cover crops, organic matter, microbiology, allellopathic effects and plant nutrition) and analysed together. Stubble and organic matter will bring the soil to a biological, chemical and physical equilibrium.

Immigratory pests "r"

The pests and fauna under conventional tillage are classified as "r" strategists. They immigrate from other areas and have a high reproduction rate. In a short time they increase their population and reach damaging levels. A couple of weeks after spraying with insecticides the pest population may recover to again cause damage.

Aphids, caterpillars and stink bugs are typical "r" strategists and are common pests in conventional tillage systems. All of them immigrate from outside the field and are capable of flying long distances.

Soil dwelling pests are secondary under conventional tillage systems. Physical control with ploughing and disking, combined with high soil surface temperature (see graph) on sunny days and the absence of stubble, does not allow this fauna to establish under conventional tillage. There is not much macro biological activity to study.



Daily air relative humidity, air temperature and soil surface temperature under no-till (NT) and conventional tillage (CT).

Steady state "K" effect

With no-tillage, where stubble is left on the soil surface, resident fauna will establish throughout the year. Species with a low rate of reproduction and a long life cycle are classified as "K" strategists. These populations will build up slowly after some years under no-till.

In this group are pests, predators, parasites and saprophytic organisms.

The fauna under no-till is similar to the fauna of native pastureland. Insects such as crickets, white grubs and termites will occasionally cause damage.

Soil cover with stubble and no-till is an important strategy to stimulate increased soil fauna activity. Plants and stubble will maintain the soil surface temperature and humidity at levels that are favourable to living organisms.

Plants and stubble are the basic food for a group of organisms that will start food chains. Predators and other natural enemies will establish on these species in the field, and also will maintain pests under biological control.

With the increase of the species diversity, natural biocontrol will improve and population equilibrium will prevail. It is important to keep the soil covered with stubble and plants to improve natural control of pests, diseases and weeds.

Monitoring is important

Under no-till, monitoring the potential pest population is important in order to adopt strategies to benefit biocontrol and to suppress pest populations. Digging cores or scraping soil layers with a spade is useful in research but might not be practical for farmers. The use of a hoe or a mattock to scrape the soil surface is a practical and quick way to search for soil dwelling insects (see photo above).

If there are open holes in the harder soil layer it will be necessary to excavate deeper to find the insects.

Farmers and consultants need to develop the habit of monitoring and sampling the fauna in no-till cropping areas to decide pest management strategies and predict damage potential.

Pest fauna under no-till can be grouped into soil resident fauna and fauna associated with previous plants.

The resident fauna will be present all the year, such as crickets, white grubs, wireworms, termites and slugs. These can be monitored, the damage potential predicted and control strategies planned in advance.

The fauna associated with weeds, soil cover and plants and crops present before sowing (see Table 1 following) can eventually become pests. Insects choose preferential host plants to feed on and live in. When these plants are killed with herbicides the insects will feed on the crop, causing damage.

Soil dwelling insects sampling strategy with hoe, for practical soil dwelling pest monitoring.

'...monitoring the potential pest population is important in order to adopt strategies to benefit biocontrol...'

Table 1. Fauna associated with host plants present in the field before sowing that can reach pest status on following crops under no tillage.

Host plants	Pest population
Avena sp., oat	*Pseudaletia* sp., caterpillar
Lolium spp. Ryegrass	*Listronotus bonariensis*, Argentine stem weevil
Raphanus spp.	Slugs and snails
Pastureland	Crickets, white grubs, locusts
Grasses	Trips
Legumes	Stink bugs

Use precision tools

Insecticides need to be directed to protect the seeds and plants, and sprayed less on the soil surface. Mixing insecticides with herbicides will kill natural enemies. This will destroy the benefits of the biological control activity that is established under no-till. When necessary, farmers should treat the seeds with insecticides or spray in the furrow only to protect the crop seedlings.

To develop no-till pest management it is important to produce life-cycles and life-tables which aim to suppress the pest population and to improve natural control factors.

Tropical examples

In tropical and subtropical climates the soil insects (like termites or white grubs) will develop upon stubble and plant residues, doing the initial fragmentation of the organic matter.

Some insects also dig holes in the soil profile, incorporating organic matter (see photos on right), allowing the absorbing and infiltrating of rain-water and the exchange of gases. Plant roots will grow through the insect holes.Soil dwelling insects, in tropical environments, do a similar activity as earthworms and ants in the more temperate climates.

We need to understand the systems

The main factor limiting robust integrated pest management strategies is our poor imagination or understanding of the biological complexities. I do not believe that there is a pest, disease or weed that cannot be controlled within the no-tillage system that requires a return to conventional tillage. There is a need for studying more and doing some extra work to adopt no-till. It depends on the human resources that do research, teach farmers or drive the tractors, and a desire to practice conservation agriculture.

White grubs (Bothynus sp. and Diloboderus abderus) holes in the soil after five years under no-tillage.

White grub (Bothynus sp.) holes with straw and dung deposits in no-till cropping area.

Pest	CT	NT	BC
Aphids (cereals)	+	–	+
White grub (*Phylophaga* sp.)	+	–	+
White grub (*Diloboderus abderus*)	–	+	+
Stem borer (*Elasmopalpus lignosellus*)	+	–	+
Argentine stem weevil (*Listronutus bonariensis*)	–	+	+
Crickets (*Grillus* sp.)	–	+	+
Slugs and snails	–	+	+
Army worm (*Spodoptera* sp.)	=	=	+
Stink bugs (*Phylophaga* sp.)	=	=	+
Miriapodes	–	+	+

Table 2. Population rates of pests in conventional tillage (CT) and no-till (NT) cropping systems and natural enemies (BC) under no-till.

'...it is important to produce life-cycles and life-tables which aim to suppress the pest population and to improve natural control factors...'

Fertiliser placement innovation

Dr Nigel Wilhelm, SARDI (08) 8303 9353

Editor: The following is an edited except from Nigel's 2002 WANTFA Conference talk.

Our soils are inherently low in fertility. Decades of agricultural production, however, have improved the fertility of the cultivated topsoil layer. Unfortunately the subsoil below this cultivated layer has remained impoverished.

A measure of the impact of this infertility was revealed in a novel set of experiments conducted by Dr Robin Graham (Adelaide University) in the 1980s.

These experiments involved removing the topsoil and digging a series of trenches and ameliorating the subsoil from each trench with fertilisers, conditioners or organic matter. The topsoil was then replaced leaving the site to be managed like the rest of the paddock by the farmer (including standard fertiliser additions).

Some of these subsoil treatments increased plant production by up to 300% and were effective for periods in excess of 10 years. The treatment that produced the largest and most persistent responses was lawn clippings (with nutrients and organic matter).

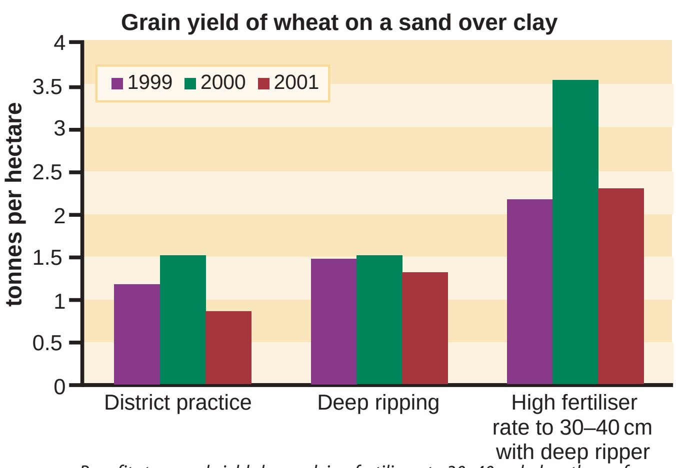
Above and below: The 'grave-yard' plots—showing how poor subsoil is limiting crop growth.

Deep placement of nutrients

This initial study has led to a series of attempts to realise some of these benefits from modifying subsoils in commercially viable ways. Twenty years later, a research program is using a para plough to place fertilisers deep (30–40 cm) in the profile of a sand over clay.

The paraplow is used to squirt liquid fertiliser to depth along the back of the blade —note the moisture.

Deep ripping alone has lifted grain yields only slightly, but high rates of nutrients "smeared" down the profile have increased cereal yields by 100–200%, from a level of about 1.2 t/ha with the district fertiliser practice being 50 kg/ha of DAP drilled with the seed (see graph following). The same high rate of nutrients applied just below the seed row had an intermediate effect. The best treatments have been from a mix of N, P and trace elements placed deeply. A reliable package of rates and types has yet to be developed.



Benefits to cereal yields by applying fertilisers to 30–40cm below the surface with a deep ripper. Sand over clay profile. S. Doudle, SARDI 2002.

The full mix of deep tillage plus nutrients applied deep (left) versus the control.

This technique, coupled with clay spreading, offers the very exciting prospect of transforming sandy country that is marginal (due to water repellency, low and uncertain yields and wind erosion) into reliable and productive cropping lands.

Banding fertiliser 2–4 cm below the seed

Deep banding is the latest evolution of the long practiced technique of drilling fertiliser with the seed. Drilling with the seed will efficiently provide nutrients to the emerging crop and give the crop a first shot at the nutrients before weeds can access them. But recent research in SA and WA has shown that the same rate of fertiliser applied as a split dressing between the seed row and 2–4 cm under the seed row will produce even better crops.

Lupins in WA sandy soils, where most of the P is concentrated near the surface, do respond well to deep placed P. However, cereals, peas and canola appear to do best where some "starter" fertiliser is placed with the seed but the majority of fertiliser is placed under the seed row. This technique is superior because most of the fertiliser is applied deeper in the profile where there is more moist soil for longer periods.

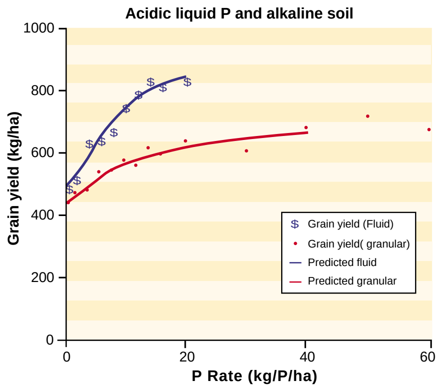
Splitting the fertiliser also reduces the risk of poor crop establishment due to fertiliser toxicity. This risk is greatest with canola which is sensitive to salts and ammonium–N during germination. However, all crops can suffer from the problem, particularly when knife points and wide row spacings are used, as these techniques concentrate high levels of fertiliser near the seed.

Banding fertilisers 2–4cm below your crop seeds will not produce spectacular yield increases (unless fertiliser toxicity has been decimating your plant stands), but it is likely all your crops will benefit over every hectare every year. This means that the investment in double shooting boots and multi-bin air carts is easily justified by the 3–5% yield increases which have been averaged in the research program.

Fluid fertilisers

Most nutrients applied to broad acre crops are currently granular products, with some also being applied to the foliage of crops as a solution. However, in some of our extremely calcareous soils, granular P simply struggles to deliver much P to the crop and P deficiency is severe and widespread.

In the last few years, Dr Bob Holloway from the Minnipa Agricultural Centre has headed a team which has been investigating the behaviour of fluid forms of P (and N and Zn) fertilisers in these situations. The fluids have had a spectacular impact on crop performance. Farmers in the Salmon Gums area in south-eastern WA have seen distinct benefits from the use of fluid forms of P and N fertilisers too. They are also on calcareous soils.



On acid soils the granular sources have performed adequately, though we have still seen slightly more efficient P uptakes from liquids. In some situations, the fluid P has been behind the granules. This happened in 2 trials in 2000—both of which received heavy rain soon after seeding. It is possible that the fluid P and N were leached away from the seed row area. The liquid fertiliser plots eventually caught up but were behind for most of the season.

Liquid P is considered more effective than granular P in USA and Canada. The liquids have other advantages in terms of ease of handling and prescription mixes of several nutrients. Some farmers in SA and WA are using fluid fertilisers (especially N) because of these advantages, not necessarily for agronomic gains.

These advantages include:

- being easier to mix and match seed row and below seed row fertiliser types and rates in one pass
- prescription mixes
- compatibility with trace elements and possibly pesticides
- being easily adapted onto existing seeders to introduce "double shooting" capabilities
- more flexible N and P ratios.

I guess the proviso is that their value is extensive enough to justify the development of an industry, and hence there will be sufficient economies of scale to make the products cost competitive.

Overcoming subsoil constraints

Matt Beckett,
Scientific Officer
(08) 9690 2157

WANTFA will be conducting several trials aimed at ameliorating poor sub-soils this season at the Meckering R&D site.

One such trial, 'Topsoil slotting to depth', will be the practical component for the UWA Honours project (2 years part-time) that I am beginning this year.

The project involves investigating the potential benefits of redistributing topsoil into deep slots, cut into the soil profile. The subsoil will be removed from slots that are cut approximately 30 cm deep and 10 cm wide into the soil profile. These slots will be filled up with either topsoil (initially removed from the trial surface) or have the subsoil returned again (control treatment).

Currently the subsoil constraints at Meckering (and on many typical wheatbelt soils) are, decreasing pH with depth, increasing aluminium levels, poor soil structure, and limited moisture and nutrient availability.

This slotting technique will ideally relocate more 'friendly' topsoil into the poorer subsoil, resulting in deeper root penetration, and more vigorous root growth, hence better plant development.

A second chance with resistant weeds

Tony Seabrook, York (08) 9641 4025 p/f

By 1996 our yields had peaked and were falling. This was largely due to herbicide resistance and the measures we were undertaking to deal with it, specifically late sowing and more workings.

As it turned out we had managed to take every short cut possible to render some very useful herbicides useless. The lesson learned from this has been that it is essential to guard with great care the few remaining herbicides that still work. Fortunately, these particular chemicals are the ones that fit the no-tillage system.

Benefits from 'no-till herbicides'

Our arrival at the doorstep of this new way of farming was more a matter of necessity than free choice and, although the benefits are so great that we would have gone this way ultimately, I would have liked to have arrived without so many herbicide options being spent. Five years on, we are growing good crops with improving yields and have fewer weeds. Ryegrass and wild oats, in particular, are more under control than at any time in the last 20 years.

DBS is a magic seeder

We use a DBS bar which I believe has been a well kept secret for far too long. It is heavy to pull and must be worked slowly (6–7 km/h), however the job it does is exceptional.

Below: We imported the Terragator from America last year and equipped it with a new locally-made boom and spraying system.
Right: Our home-made batching and loading system.

Left: The DBS bar, with knife point, has made the no-till herbicides work like a treat.

Seed depth is infinitely adjustable and the press wheel arrangement is second to none.

I have been so happy with fertiliser placement that we bought a three section air seeder bin and will be 10-cm deep banding all the P and most of the N, with a top up later of N and K. The DBS bar leaves very defined furrows which ensure 80% of the top dressed fertiliser finishes up right on top of the seed in that furrow.

Sprayer for SpraySeed

The Logran/treflan/diuron/knockdown mix we use on wheat is expensive but very effective. Last season we bought a Terragator boom sprayer to allow us to get serious about using SpraySeed with a high water rate. The unit handled the boom and local conditions well and we hope that it will continue to perform in wet conditions—if they ever come!

We use a twin motor batching and loading system, mostly because I was unable to make it work on one engine.

Half of the system is clean water only and is protected by a non-return valve. The other half uses a diaphragm pump, micromatic couplings, a suction probe and a mixing vat to measure, mix and load the chemical. It then flushes itself and we have managed to make this all work with only two 3-way taps.

Pasture, hay and Chaff Top for weed control

Integrated weed management is critical and it is a pity that lupins, peas and canola do not yield very well in the Avon Valley.

We continue to use Medic pastures as part of our alternative nitrogen-fixing rotation, fertilising them well, keeping them clean and topping late. Export hay is a habit I would like to break—but we went this way to help manage herbicide resistant ryegrass. Hay is an expensive crop to grow and it requires the added expense of extra plant, labour and large nutrient replacement.

At harvest we use a 'Chaff Top' on the back of the machine which deposits all the chaff and weed seeds on top of the header trail—ready for baling or 'windrow only' burning.

GPS gives insights

This year we fitted a GPS unit on the harvester and 'yield mapped' for the first time—the results were fantastic and fascinating. We should have been doing this years ago!

We have now soil tested the highest and lowest yielding parts of the paddocks using GPS. This allows us to attain accurate positioning in order to try to discover what we need to do to get consistently high yields over whole paddocks. We are now waiting on the results. The high yielding 'knobs' are becoming more expensive and harder to find but there is still a lot more tweaking we can do. Pity there isn't a rain knob!

Caution urged with Roundup Ready crops?

Robert Stevenson, Kenton, Manitoba, Canada.
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Editor: Robert is a no-till farmer who is closely associated with ManDak. I met Robert while in Canada in 1996; he receives our WANTFA magazine and in November 2001 he gave a talk on his negative experiences with Roundup Ready canola to other growers. He is a certified seed grower and has been frustrated by problems of the RR technology. The meeting he spoke at was designed to ask the question "Will no-till Survive RR Crops?"

In Robert's email he said to me, "I know RR volunteers may react differently in your climate but you must consider the downside to this technology before it is released uncontrollably into your environment experimentally as it has been here." Kind thanks to Robert!

Background

My brother and I farm 65 km west of Brandon, Manitoba, and we have been no-tilling for 18 years. Our main crops are wheat, oats, peas, canola, and grass seed. Most of our acres are in pedigreed seed production including all of our oat program. We have an authorised seed plant and most of our seed used is from our own production. We do all our own seeding and harvesting. We have never planted Roundup Ready (RR) canola, knowing the volunteers will be expensive to control. Half our canola has been for seed production over the last ten years.

In 1999 we noticed very low levels of RR canola in a field that we chemically fallowed through summer. We fallowed it because it got too wet to plant within the seeding window (the frost risk gets too high, at the end of the crop's life if we sow too late). We saw more RR canola in 2000 on a late-seeded field, and in this 2001 summer our area saw high levels of RR canola on many fields that weren't planted to RR. There was nothing unusual about the 2001 season in our area, but we know now that we are selecting for RR weeds in our present no-till system.

Three neighbours' experiences with RR weeds in 2001

Gerry and Leigh Smith are seed growers and no-tillers that have never grown RR canola. They have a field that produced hybrid seed canola in 1999 (not RR canola) and durum wheat in 2000. In 2001 it was sown to hard fescue in late June. In spite of several applications of glyphosate before sowing to fescue, the canola flowered well. It was all over the field, but noticeably heavier behind the 1999 canola swaths. Genetic testing by Ron Rabe from Monsanto confirmed it as RR canola. The Smiths were not pleased and identified contamination on other fields also.

The second field was chemically fallowed by my brother Richard and was last sown to canola in 1995. The introduction of RR canola in Canada was in 1996 (on 25,000 acres) and none of this was on Richard's farm. There were significant levels of RR canola along one side of the field and it had scattered plants all over it. These plants had three applications of glyphosate plus 1.5 L/acre of 2,4-D in July (2001). We had hoped 2,4-D would be the easy answer for RR weeds.

The third field is my own. In 1999 it produced pedigreed seed canola, and last year I had an excellent, clean crop of wheat. On 5th June 2001 it was sprayed with 0.6 L/acre of glyphosate and then sown on 1st July to meadow brome for seed production. The canola was not dying and I contacted Monsanto who sent Garry Brollund to look at the field on 5th and 11th July. Another 0.5 L/acre of glyphosate was used on 11th July, followed by 0.6 L/acre of 2,4-D Ester three days later—with a check strip left to confirm our suspicions.

Double resistance confirmed

I invited Don Hodgson (Private Consultant) to document the events on this field. By 1st September my check strip had 3 plants/m^2 of RR canola. In places it was thick enough to be a crop. As the 2,4-D did not completely control the canola it was necessary to swath the field on 7th September to prevent seed set. We tested the seed harvested from the check strip to see if it was also Liberty Resistant. Lyle Friesen (University of Manitoba) testing it in November and reports, "It was quite a shock to see your canola sample was double resistant to Liberty and Roundup."

We found 83% of the plants were resistant to Roundup and 61% were resistant to both. I suspect double resistance on other fields also. Once we see Roundup/Liberty/Pursuit triple resistance we will have a weed resistant to more than 30 of the chemicals in our *Guide to Weed Control*. We now have a tough no-till weed that is going to cost us a lot to control—in spite of us never using RR technology.

Mr Monsanto (via Brollund) stated that the plants were too few and scattered to be of any real concern and that Monsanto could not be responsible for this perceived problem, as they are the result of poor farmer management and a seed industry that cannot even supply pure seed. He did offer to pay a rural youth club (4-H) to pick the few plants he could see, though he did not offer to organise the project. I informed him there aren't enough 4-H clubs in Western Canada.

On 2nd August, Monsanto (Brollund and Aaron Mitchell) visited our three farms and we tried to help them understand our concerns. Of course their job is to maximise their shareholders' returns—so our discussions will continue. We expect full compensation for now and the future.

In the case *Monsanto versus Schmeiser* (www.biotech-info.net/phillipson_commentary.html), Monsanto testified in paragraphs 96, 97, and 126 that they are controlling the unwanted spread and removal of undesired plants at their expense. Organic farmers, chem-fallowers and no-tillers should take note.

Left: Typical Canadian farmhouse with red barn and a flag.

Below: Lucerne hay is left to sit outside during a cool Canadian winter.

RR weed has spread!

We now see RR canola in so many fields, and I am in no doubt that it is on 100% of our farm and is being selected as a weed under no-till. RR wheat will move into our crops just as fast but will be much tougher to control both pre-sowing and in-crop. Where the canola can be controlled in every crop except conventional canola or mustard, RR wheat will only be controlled in broadleaf crops, and poorly at that.

Like RR canola, RR wheat will leak and trickle from trucks and harvesters; move by wind and water; be spread by animals; and move as an invisible weed through our pedigreed seed system. It will be unaffordable to control in our no-till systems. Like canola, it will be impossible to keep out of our fields and it will leave us with no effective, affordable, knockdown herbicide.

Extra cost to control RR canola

To remove canola from my grass crop costs me $13.32/acre, due to 2,4-D costs and we had to swath later to reduce seed set of plants that grew later and the plants not killed by the 2, 4-D not counting time. Also, if there is canola in next year's seed it may be rejected by the European seed market, which will not accept seed containing GMO canola.

Other costs

- Loss of our seed canola business. Contacting companies are now looking elsewhere, even out of Canada, to produce pure seed, as there is too much contamination locally.
- It is hard to produce mustard and specialty oils such as Nexera under no-till.
- Pesticide Free Production does not allow residual herbicides such as 2,4-D to be used as a knockdown.
- RR wheat will be inseparable from durum, barley and oats. It will be tough to grow them under no-till.
- There will be additional chemical to buy and handle—with the inevitable effects on operator health and the environment.

Too reliant on Roundup

We cannot rely on one chemical for long. Roundup resistant weeds exist in Australia, the eastern States (USA) and now on my farm as well. Dwayne Beck tells me some weeds in the Corn Belt have developed true resistance to Roundup. Now that Roundup is used in-crop, resistant populations will increase rapidly as more of the gene pool is being sprayed.

Roundup Ready canola has only been grown for 4 years on significant acres in Western Canada, less than one rotation on many farms. Our problems have occurred much sooner than I would have expected. RR wheat will be difficult, if not impossible, to control in no-till, especially when we have the combination of resistant canola and double or triple resistance. Monsanto denies all this (of course). Do we introduce RR wheat and risk losing no-till? All this for a crop that consumers and many farmers don't want, just so a chemical company can maintain sales?

No-till is at risk!

At what point do we drop the chemical route and move back to tillage? No-till exists because it is the most profitable and environmentally sustainable system in this part of the world. I recently spoke to a farmer who has never grown RR canola but has switched back to wide sweeps to kill the weeds that his Roundup doesn't. The term "Strategic Tillage" is also cropping up at meetings.

I don't believe no-till will survive the introduction of Roundup Ready wheat. Potential loss of markets might lower wheat prices. RR canola is already an expensive weed for me to deal with and it will likely reduce no-till acres of some crops in my area, especially pulse crops. These effects increase as multiple resistance increases. RR wheat will cost even more to control.

The loss of no-till will be a tragedy for Western Canada and can farmers in the Northern Plains survive without no-tillage? I also feel that those who support the introduction of RR wheat in Western Canada are opposed to no-till. The cost of tillage will be less than the chemical cost of controlling weeds resistant to Roundup.

Claying with high rates in SA

Roger Groocock, Bordertown (08) 8754 6025 p/f

Applying subsoil clay on our farm at Bordertown, in the upper south-east of South Australia, has dramatically improved our productivity on our light sandy soils. This has been achieved using two closely related but different techniques—clay spreading and delving.

Roger explains the technique to some WA visitors in January 2001.

Our country is comprised of deep, light, acid, sandy rises with shallow sandy acid soil overlying heavy clay flats. Our average rainfall is 450 mm. During some winters we experience water flows through the property.

Spreading began in 1990

We decided to spread clay after seeing Clem Obst's work—just down the road at Mundulla. (See Clem's story in the *WANTFA Newsletter*, page 170 in April 1998.) We had the initial spreading done by contractors at 200–250 t/ha of subsoil—which generally contains 35–40% clay.

400 t/ha is applied on top of the grey water repellent topsoil band.

We took the clay from strategic sites in paddocks, creating dams in low lying areas or in water courses. During this time we clayed the worst of our sandy rises. We soon learnt the importance of fully incorporating the clay to 100 mm deep. Five years ago we realised that we had not come far enough down the hill slopes with the clay, so we bought a Lehmann scraper to do our own.

The Lehmann proved beneficial in many ways. After some subsoil clay tests, for pH and nutrient levels, we realised that it was possible and desirable to spread higher rates of clay. We have since re-clayed some areas and now believe it is useful to clay any sandy soils that have at least 30–35 cm of sand overlying subsoil.

High clay rates and trace elements

We have recently been aiming to spread 400–500 t/ha of subsoil and we incorporate it to 200 mm depth. In order to do this we have had to create a lot of soil disturbance to deeper than 200 mm. We modified a deep ripper tine to do this (see

The ripper is fitted with plates that almost overlap—giving thorough soil mixing.

photo). Our soil tests, after mixing, have shown we are still deficient in Cu, Zn and Mn. Our subsoil clay has a pH of about 6.5–8.5.

In the last three years we have been spraying $CuSO_4$, and $ZnSO_4$ onto the clayed areas before mixing it in. This gives us the perfect opportunity to mix the trace elements into the soil profile. Some foliar application of these nutrients to the crops has also been done as a top up, mainly for Mn.

Delving

Where the underlying clay is less than about 30 cm below the surface it is practicable to "delve". This involves deep ripping furrows to a depth of about 0.5 m at 1.5 m spacings. This is best done in spring when the clay is soft, using specially designed machinery since conventional deep rippers are not strong enough.

Delving tines can bring clay up from about 70 cm depth.

Delving brings football-sized clods to the surface allowing the undisturbed clay between the furrows to expand sideways into the subsoil furrows created. A newly-delved paddock is not a pretty sight and the neighbours thought we were crazy when we first began. However, greatly improved crop yields that followed have proved the system invaluable.

A delved paddock, waiting to dry. It is then cultivated with an off-set disc.

The lumps of clay left on the surface do dry out over summer so they can be easily broken up and mixed into the top 20 cm of soil. This is done in late summer using an offset disc, as described in Hanam (2000). The copper and zinc is applied as a spray before mixing it in, so it gets well mixed into the topsoil along with the clay.

The delving also encourages the subsurface clay to dry out. As it dries it also shrinks and vertical cracks open up that allow the water, air, surface sand and plant roots to penetrate more thoroughly.

Doubling of grain yields

The clay spread areas are now permanently changed for the better. These soils used to grow lupins and barley, with capeweed and silvergrass dominated pastures. Now they can profitably support canola, wheat, barley and legume rotations.

The delving tine up close —the leading edge is reinforced.

On the more shallowly delved-country, that has had strategic trace elements applied and mixed deep in the last three years, we have had yield increases of 75% over the previous 10 year averages.

Increased yields appear to result from a combination of several factors:

- Where the clay is near the surface, the hard pan is broken up, allowing deeper penetration of roots, less waterlogging in wet seasons, and better drought resistance in dry seasons.
- Sandy soils now have some soil structure, increased moisture-holding capacity, and increased nutrient content from clay, with good trafficability.
- Water repellent soils are ameliorated (Cann, 2000)
- Slope stability is increased.
- Frost resistance is improved.
- Overall increases in biological activity mean more evapo-transpiration, more of the rainfall water is available and is used, and there is less tendency for rising saline water tables.

References

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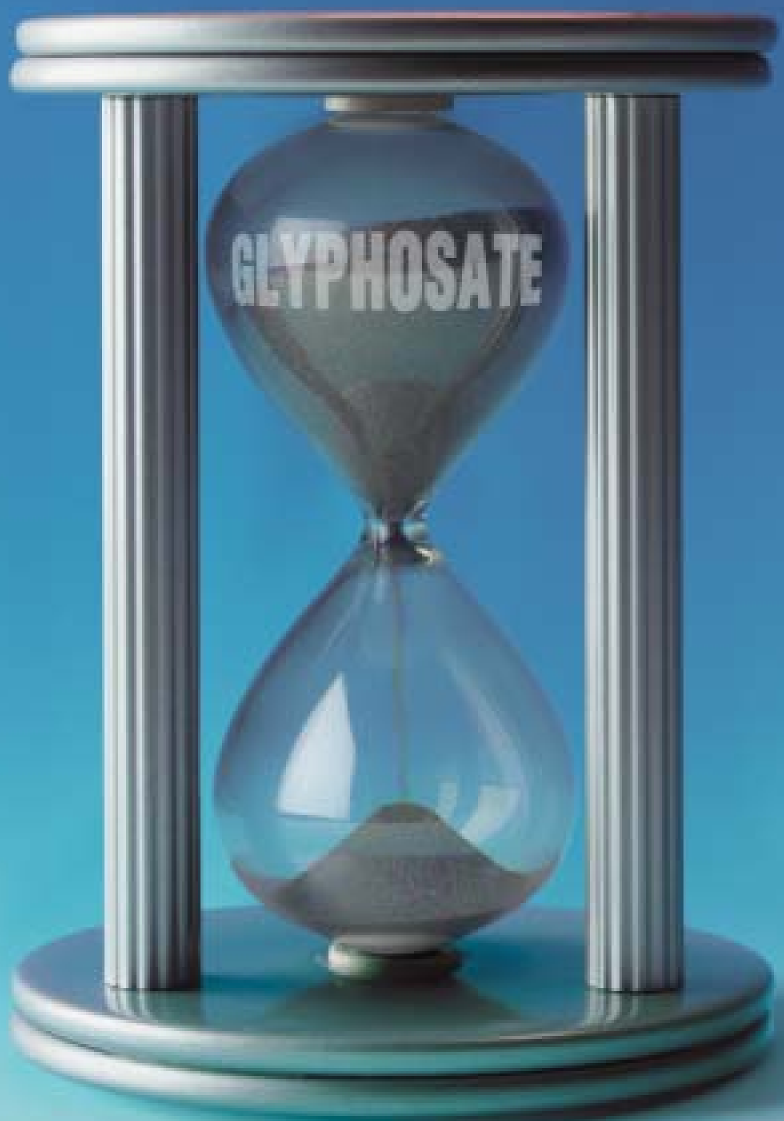
Obst C. (1994). Non wetting soils at Mundulla *2nd National water repellency workshop* 1–5 Aug 1994 p37.

Below: The mixing process is slow, but thorough!

IS TIME RUNNING OUT?



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- Real rainfastness in minutes
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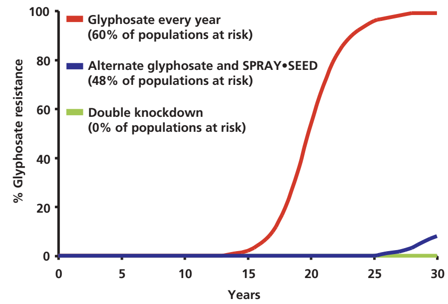
- Rapid root release
- Broad spectrum weed control
- Stressed weed activity

Predicted rate of glyphosate resistance in Annual Ryegrass *(Lolium rigidum)* in a continuous cropping, zero till system with one application per year



Initial Ryegrass seed bank density: 500 seeds/m²
Initial frequency of glyphosate resistant gene: 1 x 10^{-8}

Source: Resistance Model Results, WA Herbicide Resistance Initiative, University of WA, 2001

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