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Western Australian No-Tillage Farmers Association (Inc)

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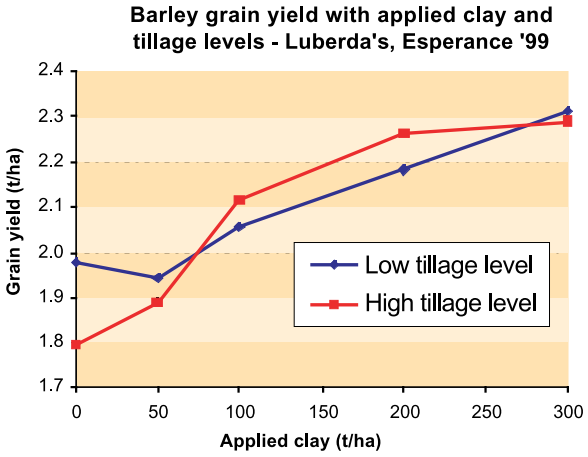
Esperance clay trials suggest high rates work!

The first trial in Western Australia to test high rates of applied clay suggests that 100 t/ha may not be enough on deep, water-repellent sands. Many farmers have been anguishing over what rate of clay to apply.

Farmer observations of last year's poor crop growth, where 50–100 t/ha of clay subsoil had been applied (about 30% clay content), left many farmers confused and disappointed with their grain yield results. These clay rates have been promoted by Agriculture Western Australia as the 'recommended rate' on the basis of one South Coast trial. This advice contrasts with the views of claying pioneer of 30 years, Mr Clem Obst from South Australia. Clem believes that deep sands need 200–250 t/ha of subsoil clay.



Farmers have been cautioned not to use high rates of clay because it may cause surface sealing. However, if properly worked into the soil, the high rates of clay did not cause problems in this trial. Wind erosion has also been observed to be minimal with the higher rates. Low rates of clay will overcome water-repellence. However, the question farmers may be asking is, "What will the grain yield response through time be with different rates?" See Page 306 for more on this issue.

Annual Conference—bigger and better!

WANTFA's 2000 Annual Conference will be an exciting opportunity to share with relevant agricultural leaders in no-tillage, including farmers, researchers and extension workers.

You may have heard Dwayne Beck speak in 1996 when he was in WA. Now here's you chance to meet him! But beware! Last year Muresk was fully booked the week before the conference began, so please register immediately to be sure of a place. See details on Page 302.

Beck is back for Conference

Note that the programs differ slightly for each Conference venue. Professor Jim Pratley (NSW weeds expert) and Dr Jim Peacock (a key Australian figure for genetic engineering from CSIRO Canberra) will only be present at Muresk (7–8 March), while Dr Damian Heenan (an Australian authority on no-tillage rotations and consequent soil changes) will attend the Geraldton (28 February), Katanning (1 March) and Esperance (3 March) days, but not Muresk.

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Agriculture WESTERN AUSTRALIA

Calcium, magnesium balance issues

Presently, there is much discussion on balancing soil cations, liming having been a catalyst. Simplistically, there are two views. The traditional view is that we need to apply enough nutrients to meet a plant's requirements. The alternate view is that we need to achieve the right balance of Ca, Mg, K and Na in the soil complex.

This issue is also being debated internationally. Several well known international speakers are visiting numerous countries, presenting the same soil balancing argument for all the soils of the world. There is common acceptance for this thinking among organic growers and horticulturists. Some no-tillers are sympathetic to this alternate view.

A scientific background encourages scepticism. However, there is a groundswell of opinion that the nutrient-balancing hypothesis needs acknowledging and testing. To this end WANTFA has planned three approaches, including:

1. **TRIALS:** Two long-term experiments that were begun at Meckering this year. They will run for 5 years.
2. **SPEAKERS:** Our Muresk Annual Conference will feature a speaker who has studied soil cation balancing in South Africa.
3. **INFORMATION:** Articles on the subject will be included in coming newsletters.

Liquid P is good for alkaline soils

For those farmers with alkaline soils, Dr Bob Holloway from Minnipa Research Station, SA has some good news. Several years of experiments have shown that a continuous stream of liquid phosphorus at seeding ensures a higher phosphorus uptake by the crop than if standard granular forms were used.

The improved uptake gave significant grain yield increases and could be adopted by farmers. If marketed at a reasonable price such products could become a standard fertiliser addition for farmers with alkaline, particularly free lime, soils.

Beware of spreading weed seeds at harvest

Dr Martin Entz from Canada (fax 00111 204 261 5732) has shown that weeds taken through the harvester can be dispersed over a long distance. Martin found wild oats were transported more than 200 m through a harvester. Incidentally, sheep do the same thing, but over a longer distance. Prof Jim Pratley will tell us more at Muresk.

Weeds from wet hollows have particular importance, not only because there is more of them, but also because they have a higher frequency of herbicide resistant genes in them. The safest approach is to spray out these weedy areas before seed set and rotate the herbicide groups to reduce the risk of resistance developing.

Above: This farmer is not letting the ryegrass weeds escape—even if the crop has to die also.

Dr Bob Holloway shares his innovative research.

Willy-willies move resistant seed

We often hear of unexplained herbicide resistance that develops in paddocks that have never had the herbicide applied. Obviously cross-resistance is one explanation, but so too could be willy-willies. Willy-willies can easily take dust and weeds from one paddock to the next, and across property boundaries.

Overall good farm hygiene has merit for minimising weed-seed spread. Keeping non-crop areas like rock heaps, fence lines, road verges and areas near trees weed free could help here.

Trifluralin movement in the wet!

There was a three-day period, in late May last year, when many farmers experienced significant trifluralin damage to emerging crops. Heavy late–May rainfall apparently moved recently applied trifluralin into the crop furrows, causing 30% crop emergence damage for those who had sown their crops immediately before the large rain event.

This observation shows that trifluralin can move into the soil if applied during a significant rain. This is common knowledge in South Australia. Kit Leake's experience at Kellerberrin this year also showed this graphically (see photo).

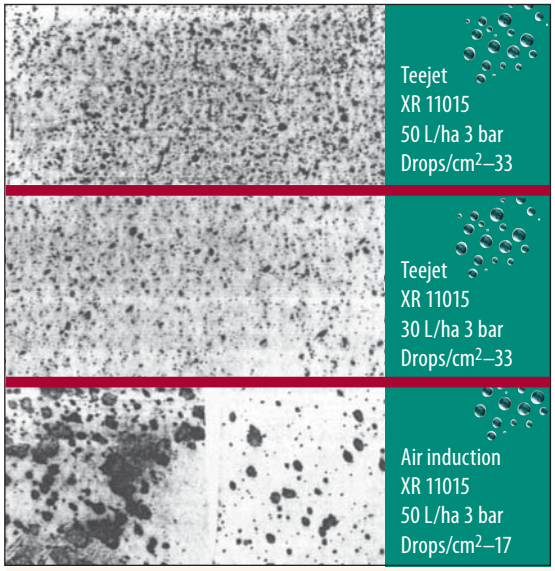
Trifluralin damaged wheat. It was sprayed 10 days before seeding without soil throw.

Kit applied 2.0 L/ha of trifluralin onto bare and flat soil during the large rainfall event. He sowed the paddock with a triple disc drill 10 days later, and yet, without soil throw or subsequent soil movement, there was clear trifluralin damage at 4 cm depth. The trifluralin evidently moved to this depth in the rain—even though chemists say it is not possible. What is possible is that the clay with trifluralin on it moved to this depth.

TurboDrop needs high pressure to work

More evidence is shown (right) that confirms the poor ability of TurboDrop nozzles to deliver even distribution. In the November 1999 WANTFA newsletter, Gordon Cumming from CropCare discussed some trial data on the TurboDrop nozzles.

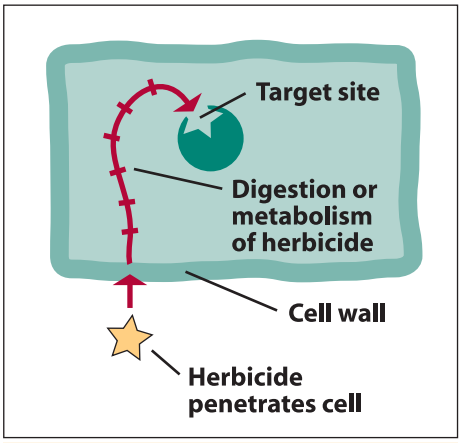
For TurboDrop nozzles to work effectively, 5 kPa of pressure is needed. Many boom sprayers are not capable of achieving this. There are other ways of reducing spray drift that you may need to consider.



Gramoxone spray is better with higher water volume and standard nozzles.

Target site or metabolic resistance?

It is valuable to know whether you have target site resistance or metabolic resistance. If your weeds have developed metabolic resistance then you may still get some useful activity from applying a sulphonyl urea (SU) herbicide.



An illustration of the herbicide pathway into the plant and target area (Target site).

Target site resistance is resistance that a plant has evolved to stop the herbicide getting into the target. It is the lock-and-key idea. If you put bluetack in a keyhole then the key will not work. The plant does the same thing—it changes the shape or position of the binding site which stops the herbicide from killing it!

Metabolic resistance is a less obvious type. The plant learns to digest the herbicide as the herbicide makes its way to the target site.

False wireworm eat more than fungi

Several years ago, when canola was being damaged by false wireworm, there was uncertainty that they could eat living canola tissue. The photo below shows how, after we turned the leaf, a false wireworm was caught in the act of eating canola. For more information see the April 98 *WANTFA Newsletter.*

False wireworm enjoys feeding on canola.

Wide row issues and opportunities

Wide row spacings reduce soil throw and stimulate less weed germination. However, weeds that escape control and germinate will grow with less competition. Wide rows can enable more stubble retention—which in turn improves weed control.

50 cm row spaced lupins, enjoy less disease splash but the lupins will have increased weed competition because the canopy closes later.

Weeds and tillage

Autumn tickling is promoted as a part of integrated weed management for reducing weed numbers in, and for subsequent, crops. However, in a trial at Merredin in 1999, more ryegrass germinated in the crop with a tickle than with no-till. Therefore, if considering autumn tickling, ensure it is done with time to kill the stimulated weeds before seeding. Otherwise no-tilling is likely the next best option to stimulate less weeds.

Peas on the left were sown into cultivated soil, peas on the right were no-tilled with knife points.

Left: Soil in foreground was cultivated only at seeding time with knife points (no-tilled), the second block was cultivated with reduced tillage and the rear block (with the most weeds) was fallowed with several cultivations. All blocks had weeds killed at seeding time, but were not sown.

Blocked Flexicoil grain flow

Flexicoil airseeder cart owners—you might wish to try this! Morawa farmer, and WANTFA committee member, Derek Chisholm has developed a quick release mechanism that encourages regular checking. Derek has made a quick-release handle for the top of the primary seed delivery head. Knowing that checking all the heads will only take a few minutes is a great incentive to check them.

Chisholm's quick release handle encourages more regular checking.

Deep knife points on clay are risky!

A common experience on heavy soils for new no-tillers, is a desire to crack the hardpan! With a poor natural soil structure, there is a significant risk that a deep knife cut of 15-20 cm will create more problems than it will solve.

Deep knife points on clay soils followed by rain can cause sealing and seed dropping deeper into the deep slot.

Heavy clay soils do not generally respond to deep tillage. The hardpan is not hard when wet—or at sowing! The ripping exercise is hard on machinery and fuel use—and it can create a slot of air where the seed is placed. This air slot is often not adequately closed by a press wheel. Even after rain, the seed can be located below the surface in an air pocket and with poor seed-soil contact.

Looks like RLN not rhizoctonia!

In the first few years of no-till adoption in WA in the early 1990s, we had a clear view of what rhizoctonia looked like. Patches were circular with no healthy plants growing in the middle of the patches. However, with stubble retention and no-tillage, evidence suggests that we have also encouraged the proliferation of root lesion nematodes (RLN). See the article by Grant Holloway on page 304 for more information on RLN's.

Barley plots at Wellstead showing uneven wavy crop growth. This looks more like RLN than rhizoctonia.

Unicorn creates ryegrass killing window

It has to be seen to be believed! Unicorn barley, which has recently been accepted as a manufacturing barley, ripens extremely quickly, and yet it can still be sown late. This quick maturity and head filling beats Stirling barley by nearly 3 weeks and creates an ideal swathing window to manage ryegrass.

Brett Roberts, a farmer and Nuffield Scholar from Balaklava, SA has been spraying ryegrass while swathing since 1996. Brett will speak at our Annual Conference on this technique.

Ryegrass is still flowering while Unicorn is nearing the swathing stage.

Warm season crops at Quairading and Bodallin

Two local farmer groups have decided to conduct their own trials on warm season crops. The Quairading—Southern Mortlock Catchment Group (SMCG) trial will be discussed at a WANTFA members' and SMCG field day on Tuesday 2nd March at Robert Peacock's farm at 1.00 pm. Dwayne Beck from South Dakota will be there. Please call Wayne Davies on 9641 6055 (or fax 09) to express your interest, and for directions.

Above: Members of the Southern Mortlock Catchment group discuss the progress of sorghum, millet, chickpeas and sunflowers sown in September.

Right: Bodallin farmer Toll Temby discusses the growth of sunflowers with the local community Landcare group.

President's Report

Geoffrey Marshall, Hyden (08) 9880 0038, fax 18

Agriculture is changing quite markedly and it must continue to do so, as there are many different pressures exerting their influence. Be proud of the fact that as a farmer-reader and WANTFA member you are likely to be innovative, prepared to accept change and some risk in making change.

Change is with us

WANTFA, through this newsletter, and other forms of communication, accepts this challenge to help lead change where needed, help increase profitability and address sustainability issues wherever possible. Our non-farmer readers are also very much a part of and contributors to this change.

Generally, farmers are becoming increasingly professional and looking for better ways to do things. Productivity performance, cost control and cost reduction in a period of low commodity prices are key drivers of this trend. I see some excellent examples of wives working alongside their husbands in a much more equal role of awareness and decision making.

Computers now allow an office to be run in such a different way, with an explosion of possibilities realistically at our fingertips. Wives, partners and children will all play a major role in the future of farming families and communities—get involved! E-mail, Internet, GPS (with yield mapping and prescription farming), and a "shrinking" world (with travel and communication) all create an exciting and challenging era for us - to say the least! As farmers, we will not be able to divorce ourselves from this change.

Annual Conference

Our Annual Conference period from 28th February until 8th March (full details in this issue) is to be a great time. We will be bringing an exciting group of relevant speakers to compliment local speakers at Geraldton, Katanning and Esperance before the main two-day Conference and AGM at Muresk. I look forward to meeting many of you at one of these venues.

The Conference has been carefully planned and will build on past experience. This will give some take-home messages and provide a valuable opportunity for us to interact with other farmers and researchers. Thanks to Neil Young, Bill Crabtree and John Duff for their large contribution to the planning process!

Committee activities

Your committee continues to deal with many exciting issues—too numerous to mention here. Our next meeting is on 2nd February and we welcome any member input to that meeting through one of your committee. Thanks to Mick Poole and CSIRO for providing a venue and hospitality for this occasion. Many of our meetings have been held at the Grain Pool building in Perth and I thank the Grain Pool (Jan in particular) for both the venue and the hospitality.

The R&D Sub-committee has been very active in recent months to ensure thorough planning of the Meckering Site. Bill Porter, AGWEST Northam, is heading a large project, funded by GRDC, principally looking at lucerne and deep-rooted perennials in our farming system. A workshop on 14th December will examine where Warm Season Crops will fit into this project. Bill, Colin Steddy and I will be representing WANTFA.

Off to the States

In January, Bill and I fly to the USA to attend two major North American no-till conferences. Bill is an invited guest and speaker at both conferences due to his close association with no-till in this part of the world. We have a strenuous timetable including visiting Dwayne Beck, his research farm and his farmer Board of Directors. This will be an intense update on no-till and a wonderful opportunity for Bill and I to provide feedback to WA.

Being an invited guest, most of Bill's costs will be paid for, and thanks to Monty House and his office, $4,000 of my costs also. To be able to see Dwayne at his home and then later in February host him here in WA will be quite special, particularly with our ongoing work to establish a Rotations' site.

Thanks AGWEST

Apology to AGWEST who were not acknowledged in the "Thanks Partners" section of our November 1999 *Newsletter*. AGWEST has assisted WANTFA greatly in giving us independence and financial strength with a grant of $20,000 per year, for the five years of our Scientific Officer Project. Thank you AGWEST, as this is a valuable and highly respected contribution to WANTFA and no-till in general.

By the time you read this I wish you well with your completion of harvest and assessment of 1999. Planning for 2000 will continue. Enjoy the festive season, take a well-earned holiday and start the year refreshed with a very positive attitude. I wish you well.

WANTFA Annual Conference

John Duff, Consultant, Belmont (08) 9277 9922

"High Yield Sustainable Agriculture into the Next Century" is the theme of the WANTFA 2000 Annual Conference.

Key speakers are Professor Dwayne Beck from Canada, Dr Damien Heenan, Professor Jim Pratley, Dr Jim Peacock, Dr Nigel Wilhelm, Brett Roberts, Peter Burgess and Bill Crabtree. These highly relevant speakers will be joined by many locally based specialists and practical farmers speaking on topics that will be of great interest to you. Please see the enclosed seminar program and registration sheets for details.

Extra Katanning Seminar

This year we will include a Katanning Conference to cater for the people who could not get to Muresk for the main two-day event. Last year places at Muresk filled fast so we encourage you to get your forms in early.

FarmBis Support

We are very pleased to announce that FarmBis will provide financial support for farmers (those who derive 50% of their income from farms and devote 50% of their time to farming) to attend the conference. All farmers need to do is fill in the straightforward questions on the back of the registration form, attach a cheque for the full registration fee and mail it WANTFA Administration, 5/110 Robinson Avenue, Belmont 6104. We will forward a copy to FarmBis who will then send a cheque directly to the farmer.

In 1999 and 1998 FarmBis provided their valued support directly to WANTFA, thus reducing the price for all attendees. However, as the money is provided to assist farmers, the method this year will provide support directly to that group.

CropCare Flights

CropCare will again sponsor the successful strategy of flying speakers to the country locations of Geraldton, Katanning and Esperance. This ensures that we can provide the conference to regional people over a week, without exhausting the speakers, and gives our interstate and international visitors a chance to see more of our great state.

Media

Farm Weekly are running a series of articles and the conference registration form and program as they have done over the last two years. Last year's coverage of the event was very helpful in having it widely publicised and also featured important messages from speakers.

Major Sponsors

The major sponsor(s) for the conference will be announced in *Farm Weekly* during January.

For registration inquiries phone Mary or Samuel on 9277 9922 or fax 9475 0322.

No-Till and Water Use

Kevin Bligh, Committee-member
(08) 97557589

No-till sowing increases rainfall infiltration during high-intensity storms. Surface runoff was halved on a loamy sand 35 km north of Geraldton. But soil loss was reduced to only 0.1 t/ha, (about the estimated soil formation rate) from 3.5 t/ha.

With 253 mm of rain, 96% infiltrated a sandy loam soil under no-till over a whole growing season near Beverley, compared with 86% under direct drilling, and less than 79% under the traditional three workings.

No-tilled crops typically stay green longer than even direct-drilled crops, using more stored soil water. Wheat may use stored soil water to a depth of about 1.5 m. Sub-clover uses water to about 0.5 m depth. However, some warm-season grasses and broad-leaved crops can use water to 2 m or deeper. Therefore, apart from agronomic advantages of warm-season crops, such as a disease break, recharge to saline groundwaters may be reduced as well.

Waterlogging increases recharge, because water flows down macropores such as old root channels. A common observation of people who have grown sorghum, such as Ken de Grussa at Esperance, is that waterlogging is greatly reduced in subsequent years.

Therefore including warm-season crops may significantly reduce recharge. However, as Dr Tom Hatton of CSIRO observes, even halving recharge may still leave 4.5 million hectares (instead of 6.2 million hectares) out of only 15 million hectares of WA cropland salt-affected in 40 years time! Can no-till do better?

To hear how warm-season crops may increase crop yields, come and hear Professor Dwayne Beck at WANTFA's Annual Conference. Dwayne increased wheat yields by 1.0 t/ha in a three-year rotation, and by 1.5 t/ha in a four-year rotation, by including a warm-season grass crop such as sorghum, and/or a broad-leaf such as sunflowers or safflower.

Dwayne is a hands-on man, and an entertaining speaker. He was a big hit when he spoke at eight regional WANTFA meetings in 1996! Dwayne may also discuss likely new varieties that will probably be needed, such as cold-hardy sorghums from China.

If sorghums could be sown before or during winter, and survive occasional frosts like sunflowers or safflower, providing markets can be developed, salinisation as well as water and wind erosion may also be profitably reduced with no-till.

Meanwhile, you may wish to consider sowing nearly on the contour to minimise water erosion next seeding. Contour-sown crops hardly eroded at all in the heavy rainfall in the Northern Agricultural Area last May (see the July '99 *WANTFA Newsletter*).

If approximate contours aren't readily available, the water level in a 12-mm transparent tube tied from in front of the windscreen of the cab to a vertical mounting on the seeder (in a big "U" shape) can be marked on level ground. Then simply steer to keep the water level in front of the windscreen at the mark. On the Ord Regeneration Area forty years ago, the device went by the glorified title of a "hose level"! The important thing is to sow more-or-less on the contour, to minimise downhill washing of soil, seed and fertiliser in the seed furrows.

WANTFA Annual Conference 2000

When?

March 7–8, 2000

Where?

The WANTFA Annual Conference is at 4 locations this year, including Pre-conferences at:

- Geraldton on the 28th February
- Katanning on the 1st March
- Esperance on the 3rd March.

The big two-day Conference will be 7–8th March, 2000 at Muresk.

Speakers

Lots of excellent speakers, including:

- Prof. Dwayne Beck (South Dakota) —a spectacular communicator…
- Prof. Jim Pratley (NSW) —recognised authority on weeds…
- Dr Nigel Wilhelm (SA)—from the SA Research & Development Institute…
- Dr Damian Heenan from NSW Agriculture…

plus, several AGWEST staff, several private consultants and researchers and many excellent local farmers.

Register Now!

Register before 1st January 2000 and get your Early bird discount.

More Information?

See the next edition of the Newsletter for full program, sponsorship and cost details and Conference registration forms.

Enquiries, phone: John Duff

(08) 9277 9922

Root lesion nematode management in an intensive cropping rotation

Grant Hollaway, Agriculture Victoria, Horsham, Vivien Vanstone,University of Adelaide and Sharyn Taylor, South Australian Research and Development Institute.

(Editor: There is increasing damage being observed from root lesion nematodes in WA. No-till cropping systems and the demise of sub-clover based pastures is encouraging nematode damage in crops. The three authors of this article are our southern Australian authorities on nematodes.)

Current research in Victoria and South Australia is involved with assessment of field crop varieties for resistance and tolerance to root lesion nematodes (*Pratylenchus* spp.). Grain growers can use this information when planning rotations to manage nematode populations, and reduce the yield loss caused by these nematodes.

Root lesion nematodes are worm-like organisms less than 1 mm in length, which feed on root tissues, impairing ability of the roots to take up water and nutrients. The nematodes can move freely between and within the roots and the soil. *Pratylenchus* multiply rapidly, and can have several generations in one growing season.

Root lesion nematodes. Photo: Grant Hollaway

During summer, when the soil dries out, the nematodes survive in the soil in a dehydrated state. Following rain, they rehydrate and move through the soil in search of roots to invade. During false breaks the nematodes are able to hydrate again, ready for the next rain.

Root lesion nematodes are present in a wide range of soil types in south eastern Australian cropping areas. There are two species of *Pratylenchus, P. thornei* and *P. neglectus,* that are common in south eastern Australia. Both species are found in a range of soil types and are often found together. These species are also common in Western Australia however, other species of root lesion nematode may also be important. The other nematodes include *Radopholus, P. zeae* and likely *P. penetrans.*

Grant Hollaway

Sharyn Taylor

Symptoms

Root lesion nematodes cause indistinct crop symptoms. Plants may appear unthrifty, stunted or prone to wilting, even when there is adequate subsoil moisture. Lower leaves of some intolerant cereal varieties may turn yellow and die back from the tips as a result of nutrient deficiency.

Roots of infested plants have fewer lateral root branches, fewer root hairs and may have indistinct brown lesions. Similar lesions can be caused by fungi, so cannot be relied upon solely for identification. The only reliable means of diagnosis is to observe the nematodes through a microscope after extracting them from the roots or soil, or by staining them in the roots.

Yield loss

Yield losses due to root lesion nematodes are difficult to measure due to the presence of other pests and diseases, and the influence of environmental factors such as soil type, nutrition and rainfall. Severity of yield loss also varies between sites and seasons.

Field trials with *P. thornei* have measured yield losses of up to 50% in severe situations where intolerant field crop varieties are grown. Losses of 20% are common with *P. neglectus.*

South Australian research has shown that *P. neglectus* and *P. thornei* significantly reduce yields of intolerant wheat, and the nematodes can be responsible for as much as 74% of the observed varietal differences in grain yield. Tolerant varieties can yield up to 33% more than intolerant varieties, and resistant wheat may result in 70% fewer nematodes in the soil than susceptible varieties.

The magnitude of the yield loss caused by *Pratylenchus* nematodes is related to the density of the nematode population present in the soil (as the population increases, so does the yield loss) and the tolerance of the field crop that is grown. Field crop varieties which are intolerant to root lesion nematodes are more likely to suffer a yield penalty in the presence of the nematode, whereas a tolerant variety is less likely to suffer a yield loss.

Control

Control of root lesion nematodes can be achieved by avoiding rotations which include consecutive good hosts (susceptible crops), and by choosing crop varieties that are less susceptible (see wheat table). When a susceptible crop is grown, the nematodes are able to multiply and therefore increase the population present in the soil. A resistant crop, however, will greatly reduce nematode multiplication, and therefore reduce nematode density in the soil, and limit the potential for yield loss.

Other important management practices include spraying weeds out on a false break, sowing early to minimise yield loss and ensure adequate nutrition. Weeds growing before sowing allow the nematodes to multiply and damage the crop sown later. An adequate supply of all nutrients is important for early crop vigour; this includes the trace elements.

A collaborative research project between Agriculture Victoria, SARDI and the University of Adelaide (funded by GRDC) is screening field crop varieties for resistance and tolerance to *P. thornei* and *P. neglectus.* The latest results from this research are below. Farmers can use this information when planning their rotations, to minimise the impact of root lesion nematodes on production.

Crops such as rye, triticale, field pea, faba bean and safflower are poor hosts for both *P. neglectus* and *P. thornei,* so will reduce the population of nematodes available in the soil to infect subsequent crops. However, it is important to recognise that different varieties and crop species can react differently to the two types of root lesion nematode. For example, sub-clover is quite susceptible to *P. thornei,* but more resistant to *P. neglectus.*

Within some crops, such as wheat, there is a large variation in the resistance and tolerance of the varieties. For example, Meering is susceptible and intolerant to both *P. thornei* and *P. neglectus* while Krichauff is moderately resistant and tolerant to both species. Therefore, in the presence of root lesion nematodes farmers can still grow wheat, if a resistant and tolerant variety is selected. Current research is screening individual field crop varieties for their resistance and tolerance of root lesion nematodes.

In the future there will be a wider range of wheats with resistance to root lesion nematodes available. Wheat breeding programs in Victoria and South Australia are currently developing wheat lines with resistance to root lesion nematodes.

The best way for farmers to determine whether they have a root lesion nematode problem is to conduct a soil test. A test is available through the Root Disease Testing Service by contacting your local agronomist.

Crop	P. neglectus		P. thornei	
	Resistance[A]	Tolerance[B]	Resistance	Tolerance
Wheat	S-MR	I-T	S-MR	I-T
Durum wheat	S-MR	MI	MR	MT
Barley	MS-MR	MT	MR-R	T*
Oat	MS-MR	I-T	-	-
Rye	R	-	R	-
Triticale	R	MT	MR-R*	MT
Chickpea	S	-	S	MI
Field pea	R	-	R	T
Faba bean	R	-	MR-R	MI-MT*
Lentil	MS-MR*	-	R	T
Lupin	MR-R	-	R	-
Vetch	MS-MR*	-	MS-S	I*
Medic	MS-MR*	I	R	-
Sub-clover	MR*	-	S	-
Canola	S	MI*	MR	-
Mustard	S	-	-	-
Safflower	R*	-	R*	-

Crop	P. neglectus		P. thornei	
Wheat	Resistance	Tolerance	Resistance	Tolerance
Ajana	VS-S*	–	–	–
Amery	S*	–	–	–
Arrino	S*	–	–	–
Brookton	MS	MI*	–	–
Cadoux	S-MS*	–	–	–
Calingiri	MS*	–	–	–
Camm	MS##	–	–	–
Carnamah	S-MS	MI*	–	–
Cascades	MS-MR	–	–	–
Corrigin	S-MS*	–	–	–
Cunderdin	S-MS*	–	–	–
Datatine	S*	–	–	–
Eradu	MS*	–	–	–
Excalibur	MS-MR	MT	MS	MT
Frame	S-MS	MT	S	MT
Janz	S-MS	MI	S	MI
Kalannie	S-MS*	–	–	–
Krichauff	MS-MR	MT-T	MS	MT-T
Machete	S	I	S	I
Meering	S	MI	S	MI
Nyabing	MS-MR*	–	–	–
Perenjori	S-MS*	–	–	–
Spear	S	I-MI	S	MI*
Tincurrin	S*	–	–	–
Westonia	S*	–	–	–
Yitpi	MS	MT*	–	–

* *Preliminary information only.*

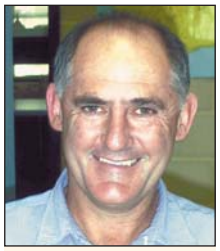
* *## In previous information, Camm has been listed as Resistant. Our data shows Camm is MS with confirmation from further field and pot trials available early in 2000.*

R - Resistant,
MR - Moderately Resistant,
MS - Moderately Susceptible,
S - Susceptible.
I - Intolerant,
MI - Moderately Intolerant,
MT - Moderately Tolerant,
T - Tolerant, – Not Available.

A Resistant lines minimise nematode multiplication.
B Tolerant lines suffer minimal yield loss in the presence of the nematodes. Individual varieties of each crop can differ in their resistance/tolerance (eg wheat S-MR).
* *Based on limited data.*

Ryegrass resistance to Groups A & B is widespread!

Rick Llewellyn & Prof. Stephen Powles, WA Herbicide Resistance Initiative, University of WA, (08) 9380 2536, wahri@agric.uwa.edu.au.



Prof Stephen Powles

Prior to harvest in 1998, 260 paddocks were surveyed to determine the extent of Group A & B herbicide resistance within annual ryegrass populations in WA. The survey, which gives a measure of the percentage of cropping paddocks containing a resistant ryegrass population, was the first of its kind conducted in WA.

Thirty-three in-crop paddocks were randomly selected from within each of eight AGWEST crop variety testing areas (see the table below). Ryegrass seed was collected where more than 10 seed producing ryegrass plants were found within a 100 m x 100 m sampling area. Plants were grown for testing with Group A & B herbicides in 1999.

From May–August, sets of about 25 plants from each of 185 populations were grown outdoors for herbicide resistance testing. Initial Group A testing was performed using diclofop (1.0 L/ha Hoegrass). Populations with greater than 20% of ryegrass plants surviving were classified as 'Resistant'. Those with some plants surviving but less than 20% were classified as 'Developing Resistance' and where all plants were killed they were classified as 'Susceptible'. 'Resistant' populations were later tested for resistance to clethodim (200 mL/ha Select).

Initial Group B testing was done using chlorsulfuron (40 g/ha Glean) with populations being classified as 'Resistant', 'Developing Resistance' or 'Susceptible'. 'Resistant' populations were later tested with sulfometuron (40 g/ha Oust).

Results and discussion

Ryegrass was observed in 87% of paddocks surveyed.

The proportion of populations resistant to diclofop varied greatly between agronomic areas. As expected, it was high in the Wongan Hills and Coorow (M2) area—with 73% being 'Resistant'. While in the Williams and Darkan (H4), there was no diclofop resistance found. Of the 185 populations tested

23% were 'Resistant' and 54% were 'Susceptible' to diclofop. No Select resistant populations were found. The overall percentage of tested paddocks containing a chlorsulfuron 'Resistant' population was 38%, with only 36% being classified as 'Susceptible'.

Area	Resistance to Diclofop			Resistance to Chlorsulfuron		
	Yes	Developing	No	Yes	Developing	No
H2	12	12	76	9	27	64
H4	0	4	96	0	21	79
M2	73	23	4	62	26	12
M3	24	38	38	18	46	36
M4	13	26	61	58	17	25
L2	40	40	20	67	11	22
L3	15	15	70	50	30	20
L4	7	30	63	44	26	30
All	23	23	54	38	26	36

All populations classified as 'Resistant' to chlorsulfuron were resistant to Oust, indicating that target site mechanisms were responsible for 'Resistant' classification at the 40 g/ha Glean rate. Enhanced metabolic resistance mechanisms are likely to have resulted in populations being classified as 'Developing Resistance'.

Nearly half of all paddocks tested contained a ryegrass population classified as 'Resistant' to diclofop and/or chlorsulfuron. Some 12% of paddocks tested contained a ryegrass population 'Resistant' to both diclofop and chlorsulfuron and only 28% were 'Susceptible' to both herbicides.

Conclusion

The results highlight both the seriousness of the resistance problem in WA and also the opportunity to take action. Whilst some areas already have extremely high levels of diclofop and chlorsulfuron resistance, farmers in other areas still have the option of avoiding the path to rapid and widespread resistance. The low level of resistance to Select across all cropping areas is encouraging for future ryegrass control, however, it also suggests that the issue of conserving the effectiveness of ryegrass herbicides remains important for all WA farmers.

Wild radish herbicide resistance survey

Dr Michael Walsh, Ryan Duane and Prof. Steve Powles, WA Herbicide Resistance Initiative, University of WA. (08) 9380 7980, wahri@agric.uwa.edu.au

In June–July of 1999, we conducted a survey of the Northern, Central and Eastern wheatbelt regions of WA to establish the levels of herbicide resistance in wild radish. We wanted to know the level of resistance that exists in randomly selected wild radish populations to Atrazine, Brodal® (Diflufenican) and Glean® (Chlorsulfuron).

Wild radish was randomly collected from canola, lupin and wheat crops in over 200 paddocks. Plants were trimmed and allowed to re-establish in the glasshouse for about 10 days before being sprayed. Wild radish plants collected from canola crops were treated with 2.0 L/ha of Atrazine, plants from lupin crops received 200 mL/ha of Diflufenican and plants from wheat crops were sprayed with 20 g/ha of Chlorsulfuron. After three weeks the wild radish plants that survived were trimmed back, allowed to re-establish, and treated again with the same herbicide. Any plant that survived the second treatment was declared herbicide resistant.

Only 58% of the paddocks surveyed contained wild radish, of which, most was within wheat, then lupins and then canola (the amounts being 65, 55 and 45% respectively). This probably reflects seasonal effects on the respective herbicide efficacies and cropping practices.

Crop	Number surveyed	Samples collected	Resistant populations	% of populations collected resistant
Wheat	206	133	28	21
Lupins	119	66	0	0
Canola	75	34	2	6

We found 21% of wild radish populations, collected from wheat crops, survived two applications of Chlorsulfuron and are deemed resistant. Inconclusive testing indicated moderate levels of resistance to Diflufenican with several populations of wild radish suspected of being resistant. Further screening work is required before these results can be confirmed. Of the forty populations collected from canola crops, two were Atrazine resistant.

The survey results highlight the current extensive levels of chlorsulfuron resistance in randomly selected populations of wild radish. This level of resistance will most likely force farmers to make major alterations in their management practices away from their reliance on this and similar Group B herbicides for weed control.

Also of significant concern is the apparent development of resistance to the Diflufenican and Atrazine herbicides. These herbicides are currently being relied upon for wild radish control in non-cereal crops. Increasing levels of resistance to these herbicides would, in many instances, prevent the use of either canola or lupin crops in a rotation.

Claying in South Australia is full steam!

Melissa Cann, PIRSA, Struan SA (08) 8764 7419, fax 77

Applying clay on non-wetting sand in SA has become a very popular activity. From October to May contractors are working flat out to keep up with the demand of spreading subsoil clay onto sandy water-repellent soil. Both local contractors and farmers are purchasing their own machines to get the job done quickly.

Melissa Cann

Extent of clay spreading

About 50,000 hectares of water repellent sandy soil has been clayed in the South East of SA, with approximately 8,000 hectares in the West Wimmera of Victoria. The West Wimmera farmers began claying 3–4 years ago and it is only in the last 2 years that 6 clay spreading machines have come into the district. The predominant areas of land in the South East that have been clay spread receive 450–500 mm rainfall.

Over the last 4 years, a lot of claying has begun further north in the 350-450 mm rainfall areas of the Upper South East and Southern Mallee. Over the last year, farmers in the Lower South East (greater than 550 mm rainfall) have become quite interested in clay spreading and already a machine has been bought into their district.

It is estimated that 15,000 ha of sandy soil have been clay spread on the Eyre Peninsula. Many farmers are keen on claying but are still waiting to see the results of trials and the success of local farmers. Delving in the shallow sand over clay soils also has great potential across the state and some farmers are attempting it.

Machines being used in SA include the Carry Grader, Claymate, Lehmann and Road Scrapers, and Marshall and Gypsum spreaders. There are about 35 such machines in the South East and Southern Mallee of SA and Western Victoria. There are also 7 clay spreading contractors on the Eyre Peninsula. Work done on the Yorke and Fleurieu Peninsulas has been undertaken by contractors from the South East.

Clay delving is also gaining momentum where there is shallow sand over clay. Delving can effectively bring clay to the surface and break-up sodic subsoil clays. About 10 delving machines are being used for contract work in SA.

After opening rains in 1995. Note the clayed paddock in the foreground compared with the paddock with no clay.

Beware of high pH clay in low rainfall

There have been P, Mn and Zn nutritional problems with claying when high pH clay is used. This is particularly so on the Eyre Peninsula, where hostile clays sometimes have to be used. These problems occur mainly in the first two years of application. These alkaline subsoil clays are also high in magnesium and sodium and can have high clay (>50%) and lime percentages.

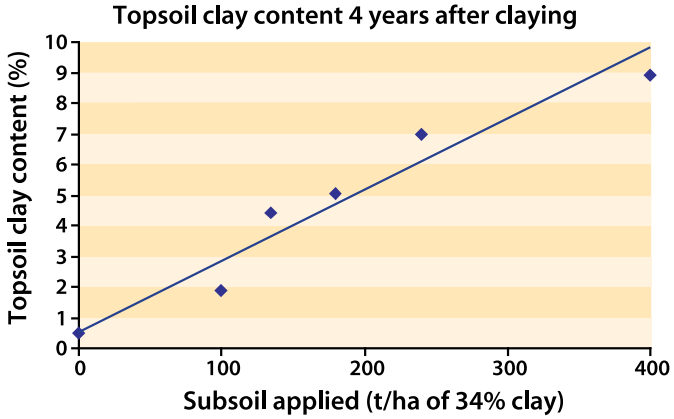
Applying this clay at high rates with insufficient incorporation has made the problem worse. Farmers should be careful with such subsoil clay, as the lime ties up phosphorus, zinc, manganese and other nutrients. After claying, farmers will generally need to apply more of these nutrients and should monitor their crops closely.

In low rainfall areas where claying has been done, crops tend to finish early due to water stress. A trial has been established on the Eyre Peninsula which will help determine the best clay rate for lower rainfall areas.

Changing Clay Percentage of sand

Water repellent sandy soils in SA typically contain 0.5%–2.5% clay. Claying these sands increases the clay percentage of the topsoil. Obviously, applying subsoil with a high clay content will increase the topsoils clay percentage the most. A farmer trial at Western Flat, demonstrates this (see graph below). The subsoil clay used had 34% clay and the clay was applied in 1995 and the soil analysed in 1999.

Applying 180 t/ha of subsoil increased the topsoil clay percentage to 5%. This soil is now categorised as a loamy sand (5%–10% of clay in sand). However, the 400 t/ha rate contains 10% clay and is not as profitable as the lower rates as the incorporation of the clay into the top 10 cm has been inadequate. Deeper and extensive incorporation, of perhaps 20 cm, is needed to improve productivity with this high rate.



Irrigation bays. The middle bay has been clayed and frost is not as significant.

Overview

Water repellence can be overcome by very small amounts of clay. However, higher rates of clay give other benefits, such as, increased soil moisture and nutrient retention, improved cation exchange capacity and higher soil pH (where acidity may be a problem).

The economics of clay spreading depend on a number of factors. The biggest expense is travelling distance. Pits need to be close to the treated area—preferably less than 500 m, the overburden needs to be shallow—preferably less than 1.0 m, the rate of clay spread may vary with the soil type, the efficiency of the operator and machine used, and the incorporation costs.

It is important to know the details of the clay being used. These include, topsoil and subsoil pH, the degree of non-wetting, the clay content of the subsoil and the slaking and dispersive nature of the subsoil. Rainfall and topography may influence the desired rate of clay to be spread and its other associated benefits.

Incorporating clay on non-wetting sand is a key component in combating dryland salinity. A case study in the South East demonstrates that claying could significantly reduce ground-water recharge. Claying encourages moisture retention and a greater number of plants per unit area, earlier crop establishment and greater water use, with less leaching into the subsoil and water table.

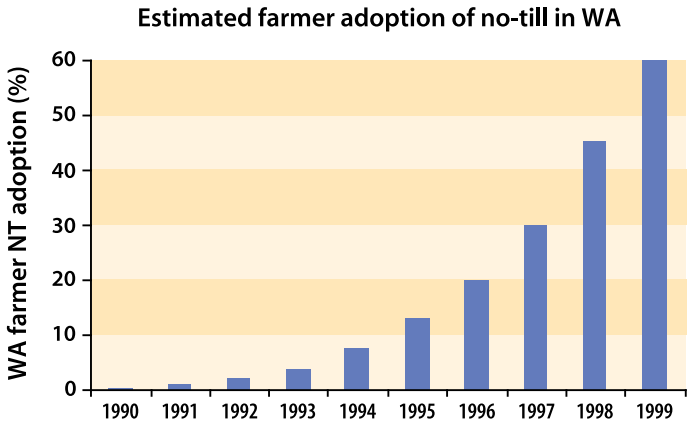
Claying sandy soil has decreased the area of wind-blown sands, reduced groundwater recharge on sandhills and improved the agricultural viability of sandy soils across South Australia.

Incredible no-till adoption in WA

Bill Crabtree, WANTFA's Scientific Officer

It has been a rapid revolution! The change from full tillage systems in Western Australia to knife-point seeding or zero-till disc seeding has been explosive. The adoption was farmer-driven. Much of the scientific data being presented during the time of explosive change—the early 1990's—was negative towards no-tillage. However, the larger systems and longer-term sustainable benefits that farmers were observing helped no-till to forge ahead. Information provided by, and shared through, the Western Australian No-Tillage Farmers Association's (WANTFA) network was and continues to be an important key to the massive adoption.

The above graph is a WANTFA estimate only but it has been confirmed by several surveys. These surveys include the Australian Bureau of Statistics who, in 1993, determined that WA farmer adoption of no-tillage was 3.8%. An



AGWEST survey from the Katanning area in the mid-1990's gave similar pattern, as did the Kondinin Group's own National Survey in 1998.

What were the no-till issues?

The massive amount of wind erosion that occurred in WA, in particular, along the south coast in the early 1980's and early 1990's, created a fertile atmosphere for change. Farmers—and their partners —were tired of severe wind erosion and dust problems. Not to mention the loss of a very useful sandy soil that was shallow and overlying inhospitable clayey subsoil.

Once farmers experimented with no-till they discovered lots of unexpected benefits. They could not only stop wind and water erosion, but they could seed into drier soil, they had improved earthworm activity and yields were not decreased (when put into the right part of the rotation). Farmers also found they could spend more time with their families during seeding times, trafficability was improved, they could sell excess equipment, they had more seeding management flexibility and they found their over-all agronomic knowledge improved. This was because mistakes are more obvious with no-till and better monitoring was essential and, indeed, more possible with no-tillage.

Farmers also discovered within a few years that weeds could be more effectively controlled if they were left on the soil surface with no-tillage —particularly when using trifluralin with knife-points on wide row spacings (225–275 mm). In fact, all soil active herbicides were more effective in the no-till systems, compared to full cultivation systems. With the widespread severity of herbicide resistance to many herbicides, particularly to the groups A and B, this better weed control has been a driving force for no-till adoption in recent years.

Another most powerful observation has been the better crop yields in drought years. Each cultivation encourages about 20 mm of rainfall to evaporate. Not only does no-till conserve soil moisture, it allows farmers to seed into dry conditions and ensures that water harvesting into the furrows occurs at the beginning and the end of the season. This extra moisture is channelled to where the crop roots and fertiliser is placed, making it more difficult for weeds to compete with the crop.

What are the current no-till issues?

We are at a time of continued great change in our cropping systems in Western Australia. Some of these changes include; the diminishing role of sheep; trying to find more diverse and

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Soils are alive!

A/Prof. Lyn Abbott and Dr Daniel Murphy,
Centre for Land Rehabilitation, UWA (08) 9380 2503

An overview of soil biological fertility

Starting this issue, we present a regular discussion of Soil Biology…

Dr Daniel Murphy

Did you know that there are more organisms in a handful of soil than there are people on Earth?

A/Prof. Lyn Abbott

That's not to say that your soil is full of beetles, bugs and earthworms. Most of the organisms in soil are too small to be seen, except under a microscope. Both the large soil animals and the millions of unseen micro-organisms play an important and diverse role in the fertility of your soil. This article examines some of the key roles that soil animals and micro-organisms have in soil. Some practical implications for managing your soil to promote biological fertility are then discussed.

What roles do organisms play in soil?

The major beneficial microbial processes occurring in agricultural soils can be summarised as:

(i) Nutrient cycling.
(ii) Symbiotic nitrogen fixation.
(iii) Enhancement of plant nutrients.
(iv) Degradation of herbicides.
(v) Biological control of plant pathogens.
(vi) Development of soil structure.

Nutrient cycling

The breakdown (mineralisation) of plant organic matter to inorganic soil nutrients (e.g. N, S) results from the activities of a diverse group of micro-organisms and soil animals. Initially, soluble compounds are released and used by micro-organisms. Other compounds in the plant material, such as cellulose and lignin are degraded more slowly by the activity of enzymes produced by some micro-organisms. Soil animals play an important role by breaking up the organic matter into smaller pieces making them more readily colonised by micro-organisms. The result is faster breakdown of the organic material. A succession of bacteria and fungi are involved in this process. These organisms use the carbon and other essential elements for their own growth and any excess, such as nitrogen, is released into the soil. If there is a relatively low level of nitrogen in the organic matter (i.e. if it has a high C/N ratio), the micro-organisms will take nitrogen from the soil to make up their requirements. This is usually the case for wheat straw. Legumes have a higher concentration of nitrogen and their degradation generally leads to an increase in the level of nitrogen in the soil.

Symbiotic nitrogen fixation

In agricultural soils, nitrogen fixation may be either carried out by free-living organisms in soil or it may occur in symbiotic association with legumes. Species of bacteria that can fix atmospheric nitrogen in soil may do so in association with other organisms, which provide them with a source of carbon. This cooperative process can occur in association with the degradation of organic matter such as wheat straw. Symbiotic nitrogen fixation by rhizobia and bradyrhizobia in association with legumes is well known as an essential component of sustainable agricultural systems in Australia. This process is highly specific. Particular bacteria are required for each legume.

Enhancement of plant nutrients

Arbuscular mycorrhizal fungi are the most common of all soil fungi. They form a symbiosis with almost all agricultural plant species. However, it is interesting that they do not form associations with lupins and canola. The fungi cannot be grown in artificial media in a laboratory. They need a living plant to gain carbon for their growth. The hyphal strands of the fungi proliferate in soil and lead to enhanced phosphate uptake in soils where phosphorus is present at levels insufficient for the plant's requirements. The hyphae also help to support the formation of soil aggregates and to stabilise them.

Degradation of herbicides

Some bacteria and fungi produce enzymes that can break down agricultural chemicals or other toxic substances added to soil. Degradation of agricultural pesticides is primarily a microbial process. The length of time these substances remain in soil is related to their susceptibility to enzyme degradation.

Biological control of pathogens

Some micro-organisms and soil animals (e.g. some—but not all—nematodes) infect plants and reduce plant yield. Many plant pathogens are specific to a particular plant whilst others are able to cause disease in a variety of plant types. However, many organisms in the soil control the spread of pathogens. For example, predation by some protozoa reduces the occurrence of pathogenic fungi in soil. These predatory soil food webs are complex and still not completely understood.

Development of soil structure

Microbial processes that occur in soil can contribute to the development of stable soils. The role of soil animals is particularly important to soil structure. Just consider how quickly earthworms can 'turn over' a soil. During the degradation of organic matter, some bacteria and fungi produce polysaccharide gums that chemically and physically bind soil particles. There is a synergistic effect of roots and soil organisms on the development of well-structured soils.

Soil biological fertility

The overall fertility of a soil is dependent on three major interacting components: (i) biological, (ii) chemical and (iii) physical. We know quite a lot about the desired chemical (e.g. salinity, pH) and physical (e.g. texture, structure) status of a soil. But the desired biological fertility of a soil is still hard to define. The living component of soil changes on a much shorter time scale than many of the chemical and physical processes. Thus biological fertility provides us with great opportunities for land management and monitoring. However, we need more information on the desirable levels of activity, numbers and diversity of organisms to maintain a fertile and productive soil.

There are some key points that will help to preserve your soil's biological fertility.

1. Minimise soil erosion, as organisms are predominately located in the surface layers.
2. Try to maintain/increase organic matter contents, as organic matter is very important for nutrient supply and soil structure.

3. Use diverse rotations as biological diversity depends on diversity of organic matter and habitats.
4. Select N fixing bacteria to match the host plant and soil characteristics (e.g. pH) as N fixing bacteria form specific associations with legumes.
5. Fertiliser applications should be calculated to account for soil nutrient supply as nutrients (e.g. N and S) are released into plant available forms during mineralisation.
6. Fertiliser inputs should complement the activities of Arbuscular mycorrhizal fungi as they can increase phosphate uptake into plants in P-deficient soils.
7. The impact of any addition to soil should be considered as it might change the physical and chemical environment in which the organisms live.
8. Remove practices that promote plant pathogens as some crop rotations and management practices decrease the suitability of soil for plant pathogens.
9. Consider management practices and commercial products for their capacity to enhance soil fertility, as production systems based on soil biological fertility can be profitable.
10. Be patient as soil biological processes take time to develop and you will not improve the fertility of a soil overnight.

Conclusion

Soil micro-organisms and small soil animals are a valuable living resource. These organisms significantly contribute to the potential of soil to provide a sustainable agricultural system. The limited understanding of the dynamics of these organisms in soils has lead to them being generally undervalued, leaving their potential untapped.

The many microbial and animal activities described above lead to a considerable proportion of organic material in soil that is not directly of plant origin. The living organisms in soil are relatively short-lived and contribute substantially to the pool of organic matter in soil that is important for nutrient cycling. In contrast to plant organic matter, the microbial biomass in soil is degraded fairly rapidly. The microbial component of soil can be used to predict changes in the nutrient status of soil before there are detectable changes in total organic carbon.

The biology of soil is complex, dynamic and poorly understood. Enough is known to demonstrate that this dynamic system has great potential to balance itself. It is quick to respond to changes in the environment, but also quick to regain stability after change. There is ample evidence that this living system has much to offer sustainable agricultural production.

Did you know?

…that the weight of organisms in the surface 10 cm of a WA agricultural soil can be as much as 2 t/ha?

… about 1/4 of all the organisms in a WA agricultural soil are located in the surface 2 cm of soil?

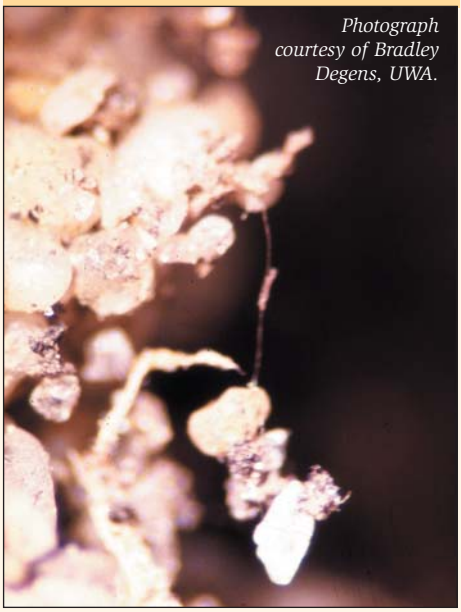
…that most (>70%) soil organisms are usually inactive as soil conditions are not usually optimal?

…that while there are only a few pest nematode species there are more than 95 non-pest species?

…soil disturbance changes soil fertility. Thus differences in plant growth occur due to a complex set of interacting biological, chemical and physical soil properties.

…disturbing a soil directly affects:

- Biological fertility—e.g. modifying the distribution, numbers and activity of organisms. This impacts on soil nutrient supply and the level of plant diseases.
- Chemical fertility—e.g. changing the distribution of nutrients.
- Physical fertility—e.g. soil structure, porosity, oxygen concentrations and the location of organic matter.



Photograph courtesy of Bradley Degens, UWA.

Reduced soil disturbance encourages the growth of hyphal networks in soil, which help to bind soil particles together.

from page 308

appropriate rotations; and trying to survive with increasing herbicide resistance.

Over the last decade, poor wool prices have encouraged many to abandon sheep completely. Without sheep there have been improved crop grain yields from retaining stubble, better times of sowing, and less weed spread over the whole farm due to the sheep. Conversely, not having pasture in the farming system removes grazing as a management tool for herbicide resistance weeds. This subject alone warrants many more pages—but space does not permit.

The fading of sheep has created a niche for other options. Increased hay growing, green or brown manuring is being considered, and warm season crops are being experimented in Western Australia.

Herbicide resistance is without doubt the biggest threat to no-tillage seeding. Without herbicides and the plough (with all the damage it does to the soil) how else can we no-till? Most of our problem weeds have demonstrated resistance to most herbicide groups. There are more reports of glyphosate-resistant ryegrass occurring each year, and some farmers believe they have to apply higher rates than they used to—just to get the same kill.

Farmers have been making changes over the last decade to manage this emerging resistance problem. Farmers are swathing, using chaff carts, mixing up rotations, changing seeding time, burning header rows, adopting no-till, using the Chaff Top, growing short season crops, waiting for a germination before spraying and then seeding and green (or brown) manuring. Some have even bought sheep back in (though the sheep may not be profitable alone).

It is clear that we must develop more diverse ways of killing all weeds. In Western Australia, this is particularly important for ryegrass and radish. No-tillage has provided significant biological weed management tools such as allelopathy, surface placement rotting, and predation (by ants, in particular). However, these must be complemented with other physical tools, particularly tools that are still to be developed–like crushing the seed.

No-till means more even crops

Garry Manning, Yerecoin (08) 9654 6095, fax 97

With my wife Kim and father Rob, I farm 3,000 ha 10 km west of Yerecoin in the Shire of Victoria Plains. A third of this land is leased. Our rainfall is 450 mm, and we have almost no sand with mostly York gum through to white gum loams and clays.

Our soil pH in the native state was 5.5 ($CaCl_2$) which is mostly currently about 5.0 after 1–2 limings. We initially limed all paddocks at 2.5 t/ha in the late 1980's and recently we lime at 1.25 t/ha. The first paddock we limed was in 1987 when the pH had dropped to 4.0 and our pasture growth was very poor.

Rotations

We have 2,400 ha of arable land. Of this, we crop 70% each year and have pasture and 6,500 sheep on the other 30%. We currently have 1,100 ha of wheat, 300 ha of canola, 100 ha of export hay, 120 ha of lupins and 700 ha of medic or clover pastures.

We're still trying to find the best rotation. On our York gum soils our rotation is typically W:C:W:L. This is our sixth year of growing canola, which grows well even on the gravelly ridges where clover struggles to finish.

Thicker straw and stronger plants

We started no-tilling four years ago with an Ausplow DBS seeder on 10" spacings. This system gives us excellent seed and fertiliser placement. With no-till, we find that our crops are far more even, with more crop production. Each plant is stronger and has thicker straw. This makes harvesting a lot easier.

At harvest, we find the no-till crops standing tall and at an even height, whereas the direct drill crops would often fall over and have heads at a large range of heights. For two years we ran two seeders lap for lap (no-till versus direct drill) and harvested them separately with a John Deere 9600. We could harvest the no-tilled crop 20% faster than the direct drilled crop. In the most dramatic case, we were able to harvest the direct drilled crop at only 12 t/hr, whereas we could harvest the no-till crop at 25 t/hr.

At harvest, we take as little straw as possible and spread the straw out evenly. Tall straw works against us for pasture growth in the following year. Sheep are unable to knock the straw down as easily as they do with the weaker straw from the direct drilled crops. Recently, we have successfully used the diamond shape Phoenix harrows to help break down the straw.

Canola growth is very poor in thick stubbles. These days we burn all our wheat stubble on heavy soil before seeding canola. On small areas, where the fire misses, the crop is sluggish. We are also experiencing damage from slugs and sulphur deficiency where we retain the stubbles.

Fertilisers

We now regularly add sulphur in the form of gypsum. Fortunately, we have lots more organic root material with no-till on our heavy soils which are becoming softer, despite some burning. Earthworm activity is greatly improved with the no-till as there is more food available. No-till is probably also encouraging root lesion nematodes and more marginal micro-nutrient deficiencies. We have used Agstar Plus this year for this reason.

Urea goes out before seeding with wheat. All Urea is post with canola. With wheat we use 70 kg/ha, and with canola we use 100 kg/ha. With wheat we split the fertiliser, so that 50% of the compound fertiliser is with the seed and the rest is placed below the seed. We profile fertilisers with lupins and canola. This year we used 120 kg/ha of Vigor (from Summit at 7:12:11).

We believe we need to use more potassium than we used to, even in our heavy soils. Ten years ago, our K levels in these soils were 300 ppm, now they are about 200 ppm and our tissue tests are low. This is somewhat confirmed by the rich crop growth in canola header rows. We now evenly spread the canola trash.

Pastures are treated like a crop

We have been running 8.5 DSE this year. Each year we top dress 100 kg/ha super on the pastures. We grow the pasture for N fixation and for weed and disease control. Contrary to some agronomists' views, we always remove grasses from the pastures early with selective herbicides. This allows the legumes to grow vigorously without competition and ensures they fix lots of N.

We would spend $20/ha on various herbicides in the pastures. The approach generally is selective grass herbicides and simazine, and then we clean the rest up with pasture topping with gramoxone at 400 mL/ha. We do not use glyphosate as it knocks the clover/medic seed set around too much. The grasses that are an issue for us are mostly barley grass, silver grass and some wild oats.

Flexibility

We can plant crops in soils much drier than we could before. No-tilling with press wheels seems to bring the moisture to the seed and the furrows harvest water effectively into the seed row, both at the beginning and end of the season. Even light rains are enough to wet the furrows and we often get better grain quality with no-tillage.

No-till has greatly improved trafficability, particularly in wet years like this one. However, the trench, or furrow depth, is probably a bit large for wet years. In 1999, much of our heavy country had to be re-sown after the high rainfall. The crops that suffered most were those on heavy soils sown 0–3 days before the rain, whereas, the light country was mostly only thinned—by up to 50%.

Tickle the pastures

We no-till all our continuous crop areas. However, with pastures, we get best yields with an April tickle, after an early rain, at 2–3" depth with knife points on a scarifier on our heavy soils. This softened surface soil cuts off capillary rise

Ask Doctor Dirt

Do you have general questions about life in your soil but don't know whom to ask?

Then ask Doctor Dirt.

General questions about soil biological fertility and the role of organisms in soil should be sent to the Editor. The best questions and answers will be published in the next newsletter.

and holds water to within striking distance of seed depth for longer. We sometimes include trifluralin immediately before the tickle—with good results.

We are now much more flexible due to no-tillage. In some years, the autumn tickle gives us better whole farm time of sowing. If conditions dry out a few weeks later, then we are still able to penetrate these more moist soils. This earlier seeding window improves our whole farm yields.

Weeds need more than no-till alone

Weeds are a lot more manageable with the no-till and treflan combination. However, I'm convinced that the best results for weed management with no-till occur if weeds are controlled for two years before cropping. No-till alone will not solve all weed problems as some farmers think. While no-till is a great tool against weeds, it is only one tool.

We would like to have our crops even cleaner than they are. However, our yield potentials are better with no-till, especially with more even crops and better timeliness of sowing.

Time of sowing and tillage

Yields with no-till can be 10% higher than with cultivation for May sowings. However, in June, or when conditions are wet, the opposite is often true by 10–20%. This is due to the furrows getting too wet and possibly less N being released in the colder conditions with no-till compared to direct drill.

No-till need not be expensive!

Doug Harrington, Narrogin p/f (08) 9881 1496.

I have been no-tilling now for five years as manager of Tim Cowcher's 3,200 ha property west of Narrogin. 2,000 ha is continuously cropped. No-till has given us some exciting benefits of improved yield and management flexibility without the expense that some talk about.

Machinery

The conversion to no-till machinery need not be as expensive as many people think. In 1995, we started with two 511 International Combines which were converted with Napier scarifier tines on three rows with a 170 mm (7") spacing undercarriage. In 1996, we increased the row spacing to 340 mm (14") because we couldn't handle the stubble, and we found no yield penalty.

Doug Harrington (right) discusses with a fellow worker the small cost of $12,000 to get the seeder unit up and running!

290 mm (12") row spacings improves stubble flow and increase seeding flexibility.

In 1997, we purchased a Gason Chisel plough for $5,000 and replaced the chisel tines with the Napier Scarifier tines from the 511. The machine is now on 290 mm (12") row spacing on the 5 row bar. I built the air system from 150 mm and 50 mm exhaust tubing and 50 mm poly pipe. It has sown three seasons of crops (1997–99). I bought a 3 box Gason Air Stream planter for $3,000 and replaced the walking beam wheels with 23.1 x 26 tyres. The whole set up cost around $12,000.

Fertiliser

We regularly apply Muriate of Potash (MOP) pre-sowing at 1 kg for every 2 kg of urea we use. This has boosted yields considerably and appears to have helped the sustainability of the program. The MOP and Urea is spread immediately after sowing with an air boom towed behind the airseeder. This provides very accurate placement and we can apply the urea regardless of moisture conditions.

We also use high phosphorus rates. We drill 100 kg/ha of Agflow with all crops except lupins, where we use 100 kg/ha of Megaphos. The Agflow has a lower N rate which solves the nitrogen toxicity problem on the wider row spacings. This year we will apply most N "down the tube" on 290 mm row spacings, and split the seed and Agflow in rows 50 mm to either side of this N. Watch this space for the results!

Seed and fertiliser is split.

Canola harvest losses

I believe that canola harvest losses has cost more in terms of yield and financial non-achievement than any other factor. Like many farmers I was somewhat complacent with my checking of harvest losses. *(Editor: Boyles from York concur with Doug's observations.)*

The purchase of a new header in 1997 encouraged me to be serious about the problem. I will call the machine the "Coke Can" due to possible manufacturers' litigation. I believe our losses in canola were between 3-500 kg/ha over the past two years because neither the dealer, the manufacturer, nor I could stop the machine from throwing it out the back.

Fortunately, with a closer look at the internals of the machine and a not too expensive modification, I have now achieved 20–40 kg/ha loss.

This loss can be easily measured and calculated. This is my method:

1. Remove the straw spreaders.
2. Slide a piece of 30 mm x 30 mm angle iron under the windrow. The angle iron must be long enough to exceed the sieve width, and have a piece of flat plate welded to one end to keep the V upright. I use 1.8 m of angle.
3. Drive over the angle at normal operation speed. Collect the grain from the V using a plastic kitchen colander. Weigh the grain on a set of digital scales.
4. Then calculate. The 30 x 30 angle iron is approximately 40 mm across the opening. Therefore, the grain caught is from an area equal to the width of swath (say 7.5 m) multiplied by 0.04 m (the 40 mm V opening), that is 0.3 m^2. Weigh the grain in grams, then multiply –(in this case by 3) to equal approximately 1 m^2, then by 10 and call it kg/ha (10,000 m^2/ha).

In our program of 500 ha of canola, a harvest loss of 300 kg/ha cost 150 tonnes of canola at 1998's price of $425/t. This equals $63,750. I would suggest this is the most significant factor I have become aware of in the past five years.

Your gravels may need more phosphorus!

Jim West, Kondinin (08) 9889 1116

In the late 1980s we became quite frustrated by our gravel ridges not yielding very well. We initially assumed it was due to very acid soils, but soils tests proved this not so. Our gravel sandplain soils generally have a pH of 4.5 in both the top of the profile and in the sub-soil, while the conglomerate gravel was found to have a pH of 4.8 in the topsoil and 6.0 in the subsoil.

We then assumed that it might be due to high levels of aluminium in the soil. Again, tests taken by the Lake Grace Department of Agriculture prior to some lime trials, showed there was no problem. We then assumed that because of poor production on these soils, that we should reduce our inputs and save money—wrong again!

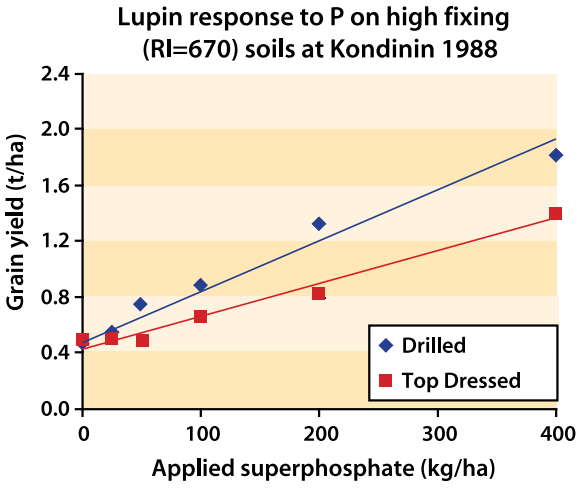
Then Peter Smyth, a CSBP representative in Corrigin, suggested that our high levels of reactive iron in the soil were probably tying up the phosphorus. We knew that in our granitic sands, where there were low iron levels, we had good P availability to the crops. Subsequently we have been involved in several P trials with the Department. A similar trial was also done on Brian Mayfields farm at East Hyden (see graph below) and later with CSBP. This work has helped me develop some rules of thumb, based on levels of reactive iron in the soil.

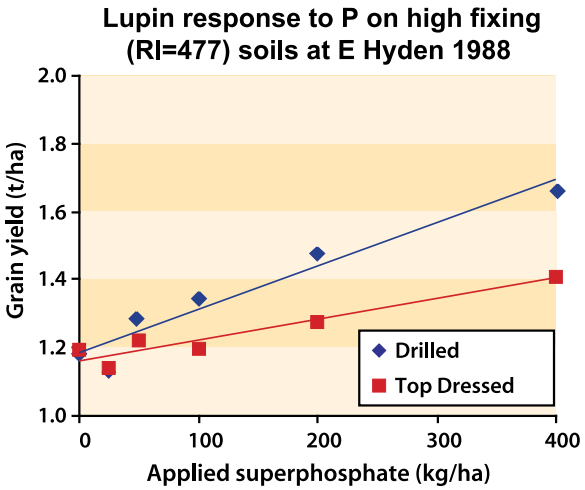
Snookes from Meckering experienced similar high P fixing soils—foreground had double P.

Reactive Iron levels	P needed (units P)	General comment
400	12	Apply the same amount as my other soil types. Often see some P deficiency in the coldest months.
600	18	Increase the drilled P by 50%. This is only just enough.
800 increase	24	Need to double P, and I believe I need to also my seeding rate also.
1200	24	Can't afford to lift the P more than 24 units. Fortunately I only have small areas of this size.

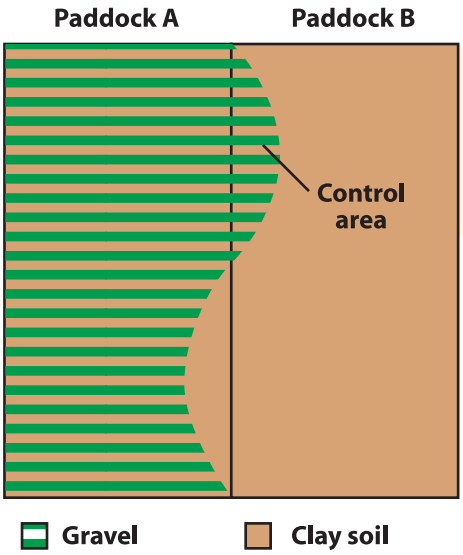
We have learnt that it is worth spending the money on extra P for these soils. Our production is greatly improved and the weeds find it harder to compete, especially when the P is placed near the wheat seeds with no-till banding.

The P held in the soil of the rows is also more available to crops in subsequent years, as it has had less surface area





exposed to the bulk of the soil. Work from the University of WA has confirmed this. We are now seeing longer-term benefits from the P held in the rows. The crop yields following P banding with no-till have improved. The crop growth is noticeably better in this regime than it is on adjacent paddocks, where normal P levels have been used.



The gravel patch in paddock B has not had higher P rates, yet is a similar soil type to paddock A and is comparatively poor yielding.

CSBP conducted an excellent trial in 1998. Unfortunately, it was severely frost damaged. However, the dry matter generated and the plant tissue data confirmed that the site was very responsive to phosphorus (see the table below). The soil was a gravelly loam with 14 ppm P, 756 ppm of iron and a pH of 4.6.

Units of P (kg/ha) applied	DM in November (kg/ha)	Plant P status, relative to adequate (%)
0	5.5	54
9	6.7	59
18	6.7	66
27	7.6	74
36	7.5	87

Apparently canola has a good ability to access P in these gravel soils. Therefore, this year, we have used the normal P rates in our canola and will use the high P in wheat next year. Peas have yielded well on these soils.

The cheapest way to apply the extra phosphate is to seed the gravel areas separately at different rates. This is a classic example where variable rate technology would be very useful, where varying rates on the go could improve whole farm profitability.

Direct drilling is too much tillage!

Geoff Bammann, Cleve, SA (08) 8628 2202, fax 898

Along with my sons, Paul and Neville (now working off farm), we operate 2,200 ha on four properties from east to west of Cleve on the Eyre Peninsula. Our rainfall varies from 325–375 mm and our soils include granite loams, sand-hills, sandy loams, red loam flats and some limestone (which is mainly limestone rubble on sodic clay subsoil).

The road to no-till

This probably began in 1990 when I sprayed a pasture paddock with a grass selective herbicide. From that we progressed to sowing and harvesting Parabinga medic in 1994 and then continued to sow all our lea ground with Parabinga until 1996. This was totally replaced in 1997 with Blanchefleur vetch (introduced in 1995).

In 1998 we trialed canola and faba beans for the first time. We intend to increase the areas sown to these crops in an attempt to widen our rotations. This will depend on a favourable start to the season and forecast gross margins. Blanchefleur vetch will still be sown on our drier country. Where we have problems with stones or broadleaf weeds, the vetch will be green manured with a dose of glyphosate and dicamba or 2,4-D Amine, given that volatile 2,4-D Ester is too risky at this time of year. A self-funding crop that needs little rain, has no pests and is easy to harvest would be very handy.

The mechanical side to no-till has also developed over several years. With cheaper and more effective chemicals and spraying equipment, we have progressed from multiple tillage to no-till. Although we tried direct drilling in the early 1970's, we did not do it again—except for medics—until 1994!

In 1994 we figured that there seemed little point in cultivating, because we could control weeds with the boom spray when going into a legume pasture. In 1995 and 1996, we did most of our seeding using lucerne points. We found that this left a better pattern for the press wheels that were installed in 1991, and resulted in excellent germination and better depth control.

Following an Ag Bureau trip to WA in 1996, we decided to take the next step by purchasing a set of Harrington knifepoints. We had already made the decision to go to total cropping and realised that one pass seeding was about all our soil would tolerate. We are still using the Shearer 4150 bar and 3 tonne hopper brought in 1984. The bar has been widened to 12 m and the row spacing taken out to 200 mm so that there are now 60 tines, each with a breakout of 200 lbs.

Last year we bought a 37 tine Shearer Hydraulic Trashworker which we widened to 40 tines of 12 metres, fitted with an air seeder kit and Harrington knives and split banding boots. With this we sowed canola, beans, vetch and some cereals. Next year we will add press wheels and trash tubes.

Geoff's father Felix and son Paul with Shearer Hydraulic Trashworker fitted with Harrington knives and split banding boots.

Our typical spray and sow program consists of:

- We apply a summer spray if necessary of 1.0 L/ha of glyphosate, 500 mL/ha of 2,4-D Amine, 0.5% Hasten and 70 L/ha of water.
- Before seeding and depending on weed growth we apply 500 mL/ha of glyphosate plus additives.
- Immediately before seeding we apply 1.0-1.5 L/ha SpraySeed and 1.0-2.0 L/ha of Trifluralin.
- We sow wheat at 50-55 kg/ha plus 80 kg/ha of 8:19:Zn-2% fertiliser.
- At post-emergent we spray at 3-4 leaf stage with 200 g/ha of diuron plus 300 mL/ha of MCPA. *(Editor: Diuron is much safer applied pre-seeding, especially in sandy water repellent soils with furrow from press wheels and at higher rates than this.)* We include Ally or Lontrel for legumes if needed.

Cyclone Vance, March 24th, 1999 – 96 km/h winds. This is the day we sold our sheep.

Advantages

- Makes you think.
- Reduces soil erosion; both wind and water.
- Builds up organic matter and improves fertility.
- Improves trafficability.
- Conserves moisture.
- Allows you to sow at the optimum time.
- Allows you to sow more hectares with same machinery.
- Reduces the amount of recreational tractor driving.
- Increases soil fauna, particularly earthworms.
- Improves stubble handling—much more stubble remains anchored.
- No changing points.
- Better depth control.
- Better results from chemicals, particularly trifluralin.
- Double knock is good on hard to kill weeds—even small boxthorns.

Disadvantages

- Requires good agronomics and planning.
- Does not level the ground.
- Requires greater use of, and reliance on, chemicals.
- A higher tine break-out is required and the deeper working depth can raise more stones.
- It may require full-cut working occasionally to control woody weeds (although only as a last resort).
- It may take up to five years for the benefits to become fully developed.
- It is advisable to include trace elements in fertiliser to be near the seed.

Experience of the dry 1999 season

It has been a very testing year with no-subsoil moisture, warm conditions and light showers, with the heaviest April–October rain being 15 mm. The growing season rainfall was 200 mm, but 70 mm of this fell too late in October.

The no-tilled crops tolerated the dry well, perhaps even better than the conventional crops. The harvest yields are better with the no-till and weed control was excellent, with no difference in weeds or yields with 200 or 300 mm row spacings.

We only have 14 sheep—14 too many! These will go. It is gratifying to drive around on a windy day and observe the lack of soil movement on no-tilled country. A local farmer said that they would probably be farming like us in ten years time—I hope it's sooner than that!

Conclusion

Although it requires a quantum leap, both physically and mentally, to change from minimum-till to no-till, the benefits are enormous. The middle area of direct drill with full-cut does not seem to work. The mixing of the soil only encourages weed germination over a prolonged period and it dilutes chemicals, making them less effective!

If you are considering changing over to no-till, I would strongly recommend that you contact farmers who are already involved. Join no-till groups such as WANTFA and SANTFA to benefit from other farmers' experiences. I consider the *WANTFA Newsletter* the best farming magazine I receive. *(Editor: I really like this comment!)*

WANTFA Coming Events – 2000

28th February	Pre-conference seminar	Geraldton
1st March	Pre-conference seminar	Katanning
3rd March.	Pre-conference seminar	Esperance
7–8th March	Annual Conference	Muresk

See page 282 for more details.

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