WANTFA
Western Australian No-Tillage Farmers Association (Inc)

GRDC

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Newsletter

SUSTAINABLE AND HIGH PRODUCTION AGRICULTURE – NOW!

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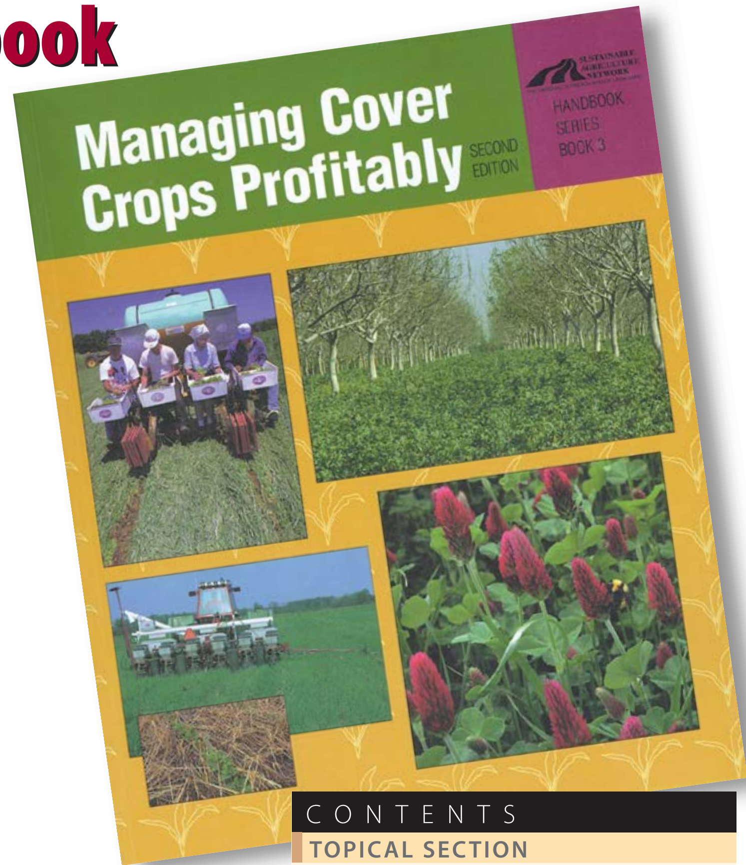
Excellent cover crop book

Cover crops are a new concept to many WA farmers, but they may become an essential part of continuous cropping system as they have in Brazil and Paraguay.

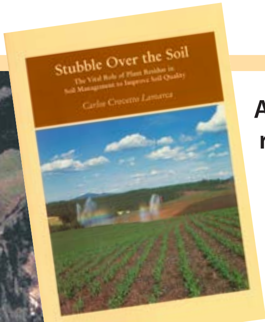
Both Rolf Derpsch and Fran Hoyle (AGWEST Northam) spoke at the conference on the merits of cover crops. Rolf was keen to emphasis that cover crops need no-tillage (with discs) in order to give the full benefits. If you want to know more about cover crops then the best book (or CD-ROM) to purchase is called *Managing Cover Crops Profitably* and can be found at: http://www.sare.org/htdocs/pubs/resources/index.html#Profitably.

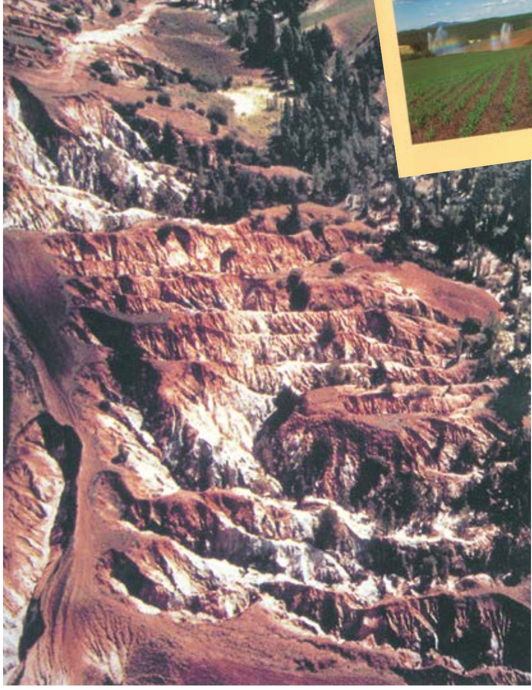
The book explores how and why cover crops work and provides all the information needed to build cover crops into any farming operation. This is the most comprehensive book published to date on the use of cover crops to sustain cropping systems and build soil.

Detailed charts of cover crop characteristics and management, adaptation maps and essays on soil fertility, crop rotations, pest management and cover crop selection are followed by comprehensive chapters on eighteen of the most commonly used and widely adapted cover crops in continental United States. The book costs $US18 and the CD is $US10—plus postage and handling.



Carlos Crovetto's plea!





250 years of cultivation has stripped one metre of topsoil from many acres of Chilean cropland—can we learn from their mistake?

At the beginning of our recent WANTFA Annual Conference, Carlos Crovetto began with a dramatic picture of his land. His first picture is now strongly stamped in my mind—see photo left. And his comment "it took 250 years for my forebears to destroy our land as we cultivated and exported wheat all over the world. We also exported our soils—into the sea."

Just what will our Australian land look like in 250 years time? Will we have any topsoil left? Can we really afford any form of cultivation? A drive along dirt roads in the Victorian mallee or the Eyre Peninsula of South Australia shows how much soil has been lost in only 50–100 years of dryland agriculture. It is often hard to see paddocks from a car window due to the sand deposits on the road verges.

continued over…

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Website password
Please note that your username and password for the website are: **wantfa** *and* **no-till**

WANTFA's Scientific Officers are funded by:

GRDC Grains Research & Development Corporation

Agriculture WESTERN AUSTRALIA

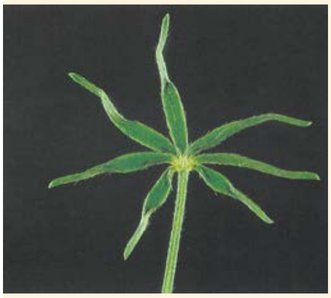
Erosion continues in agriculture in WA in the year 2000.

Carlos challenged us to think that knife point no-tillage is probably still too much tillage. In South America the triple disc seeders are the only form of no-tillage. Carlos has published a book on his no-tillage adventure called *Stubble over the soil* which is available from 'The Rural Store' in Kilmore, Victoria (see www.theruralstore.com.au or call Jim Lowden on (03) 5782 1118).

Calcium nutrient deficiencies

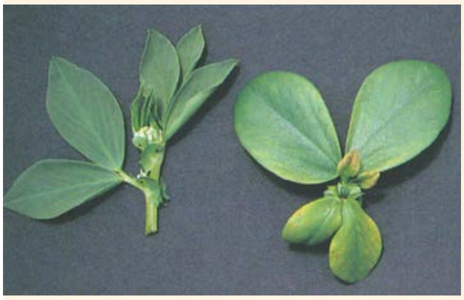
A desire by farmers to know more about classic nutrient deficiencies prompted WANTFA's editorial team to feature some more photos from the series of three books by K. Snowball and A.D. Robson.

The books are called *Symptoms of Nutrient Deficiencies in…* and are available from The University of Western Australia on (08) 9380 2503.



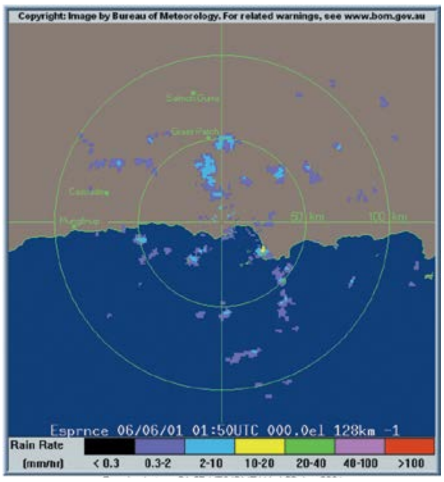
Calcium deficiency. An early symptom of calcium deficiency in narrow-leafed lupin.

Calcium deficiency. Collapsed and withered petioles in calcium-deficient narrow-leafed lupins.



Comparison of symptoms of calcium deficiency (right) and boron deficiency (centre) in new growth of faba beans. Control plant section on the left.

Calcium deficiency. Symptoms of calcium deficiency on the upper-middle leaf (centre) and new leaf (right) of Dinkum peas. Control leaf on the left.



Radars for the south-west

Watching for rain? Then you may find visiting www.bom.gov.au (the web address for the Bureau of Meteorology) very useful. On the home page, under 'Other Weather Services', click on 'Radar images'. There are four radar images that cover most of the whole south-west of Western Australia. These radar images allow you to see where the rain is currently falling and where recent falls occurred. Using the radar loop suggests how soon the rain will arrive, or whether it will miss you. If you keep in mind that it is not predictive but is real time then you should find it useful.

The radar images show where the rain is and where it has come from. The image is updated every 10 minutes.

Large marshmallows can be controlled with Carfentrazone-ethyl.

Finally—marshmallow control!

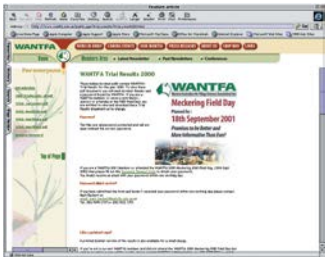
It looks like marshmallow can now be simply controlled with a new herbicide called Carfentrazone-ethyl.

The product is sold by CropCare and is in two forms called Affinity DF or Hammer EC (not yet released). It is from the same family as Goal (Group G)and it is not a scheduled poison.

This seems like an exciting product and will be on show in CropCare trials throughout the state this year. Attendees of the WANTFA Annual Conference were shown that it gives very good results when mixed with MCPA, at an affordable rate of 40 g/ha. Marshmallow has been a problem for no-tillers, as glyphosate alone provides poor control. For more details see Gordon Cummings' article in the Topical Section.

Meckering Trial Results on web

The full text of the Meckering R&D 2000 Trial Results booklet is now available on the WANTFA website at www.wantfa.com.au.



For full access to view the booklet please visit our website and follow the link from 'Trial Results' on the home page.

An email from you

If you attended last year's Meckering Field Day, and you are not a current member, please follow the email instructions on the 'Trial Results' page and we will enable you to access the results.

Meckering Trial Results book is slightly modified

Concern was expressed in March that the Meckering Trial Results 2000 booklet had significant errors in it and it should be withdrawn from sale.

This request was granted immediately, at face value, and after examining the suggested modifications, we are pleased to say that the changes needed were mostly of a typographical and grammatical nature.

So those people who purchased the original book can rest easy as none of the trial conclusions were changed in any significant manner.

Feel free to compare it with the updated version on our website at www.wantfa.com.au.

IBS vs PSPE with no-tillage

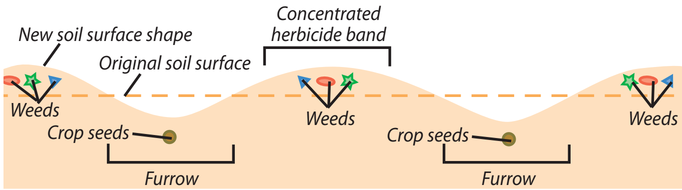
It was very clear, at the WANTFA Meckering R&D site last year, that herbicides applied IBS (immediately before sowing) give much greater crop safety and better herbicide efficacy than when applied PSPE (post seeding pre-emergent). Indeed, this is why many farmers have switched to no-tillage.

The various broadleaf crops and pastures were rated according to biomass reductions on 21st September. An example of the difference between the timings (a few hours difference) and herbicide positioning is clearly seen below with Simazine use. Please note though that this is demonstration work only and was not replicated and some combinations are not on the label. Consult a local agronomist before considering applying any of these treatments.

Atrazine applied at 1111 g/ha (2.2 L/ha) left of centre plot, either IBS (photo above) or PSPE (photo below).

The reason for the stark difference, which also occurred with numerous other herbicides, is the "Clayton's incorporation of the knife points". The IBS-applied herbicides end up being placed on the flat soil surface that is then covered with soil. The action of the knife point also removes the herbicide from the furrow and places it in the inter-row. A reasonable amount of rain is required to move this water-soluble herbicide back into the furrow.

In contrast the herbicide applied on the surface after sowing (PSPE) will easily move into the furrow where crop seeds are located. Such wash can cause undesirable levels of crop damage.



Carbon fines

Many farmers have heard reports from Farmers Carbon International who are promoting the use of fine carbon with some additives and are claiming spectacular results.

This is exciting news—provided independent trial results are consistent with these reports.

Several AGWEST staff have expressed reservations, based on chemistry principles, of the likely benefit from this product. WANTFA is testing the product at the Meckering R&D site this year. So please come along and see for yourself how it performs there.

Burning stubble—a long term challenge!

In autumn, every year, the Avon Valley goes up in smoke! Carbon is quickly lost in the form of the greenhouse gas (CO_2) and the soil is left bare for wind and water erosion to work on.

Fortunately, big winds were not common this autumn and most farmers sensibly burn as late as possible. However, Carlos Crovetto, from Chile would say that "the fire is the most terrible enemy of life and farmers must avoid it".

Stubble burning is as popular as ever in wheatbelt.

Smoke fills the morning autumn air in the valley.

Clearly, farming with weeds and diseases in many WA cropping systems that lack diversity is encouraging farmers to burn regularly. I am sure that we can be more creative and make our cropping systems more sustainable. Indeed, this is WANTFA's challenge!

Perhaps the real wide rows combined with automated tractor driving will make this a reality soon. If stubble blockages are the main problem with knife point seeders then see Mark Siemens article in the *WANTFA Newsletter*, December 2000.

Wide row opportunities

Our thanks to Scott McCalman (NSW farmer) who spoke at the WANTFA Conference and inspired farmers to try wide rows for mainly pulse crops.

Scott's story was presented in the February 2001 *WANTFA Newsletter*. This approach is being tested at WANTFA's Meckering site (on show on 18th September) and by several AGWEST staff.

Scott's daughter standing in lupins grown on 1m row spacing.

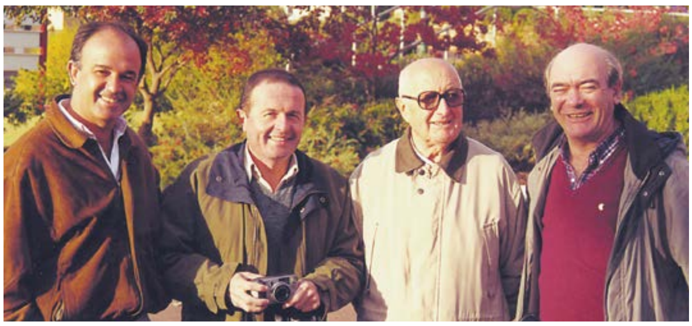
Hooded sprayers allow cost effective and strategic spraying in potentially expensive crops.

Wide rows allow non-selective herbicides to be applied in the inter-row and more expensive herbicides can be applied in discrete bands only on the crop row. This can enable different, and sometimes expensive, new herbicide groups to be used with less selection pressure on the more commonly used herbicides. Likewise, the same process can be used with fungicides for chickpeas or faba beans.

The risk of pulse diseases is also perhaps lower as the canopy is more open. Such a canopy allows air to flow through, reduces humidity and allows light to penetrate to lower leaves which may increase pod set. This may also decrease the risk of frost and decrease the damage or crop loss from spring droughts.

GRDC sponsors South American Study Tour

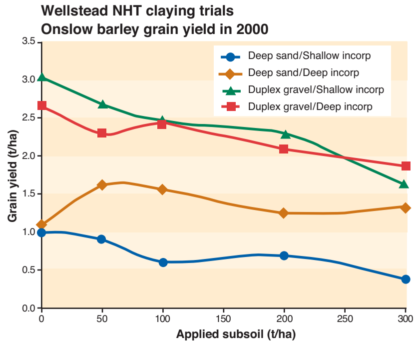
Thanks to GRDC who have contributed $20,000 to the WANTFA Study Tour that leaves on the 31st July for just over three weeks. There are about 35 people going, including four agronomists!



In mid-May, 16 Argentinean farmers and machinery manufacturers visited WA—they would be happy to sell us their machinery. These people will kindly host the WANTFA Study group at the AAPRESID (no-till) Conference.

Wellstead claying result

Last year the Wellstead LCDC conducted a single replicate trial with claying rates and tillage. The trial showed that increasing rates of applied subsoil (~35% clay) decreased barley grain yields. The trial also suggests that deep incorporation was of benefit in the deeper sandy soils. More replicates have now been included. More details are available from Steve Hall (shall@wn.com.au).



Sheep and sustainability

As South Americans Carlos Crovetto and Rolf Derpsch travelled through the wheatbelt in February, they were awestruck with the effect of sheep grazing on sandy paddocks.

Their instant response was "you can't farm sheep on these fragile soils". It was interesting, and perhaps valuable, to hear their instant gut reaction to what they saw.

These two photos taken in the mid-1980's show that paddocks are easily overgrazed in autumn—especially when wool prices are good. Similar photos could have been taken this year.

We know that feedlots do solve this overgrazing issue. Rick Swarbrick, WANTFA committee member from Gairdner, has run a cost-effective feedlot for this reason for many years. It is pleasing to hear that this approach is catching on for the south coast in an attempt to protect our fragile soils.

Even grazing pulse crop stubbles on fertile red loams of the Avon Valley invites soil movement on windy days this year.

The big problem with sheep is that, in good years, we don't have enough and, in bad years, we have too many. Sure, for herbicide resistance and nitrogen production it makes sense to have sheep (or pastures) but if these are not managed carefully over the next 2–5 decades—especially with improved wool prices—what will the WA dryland farming soils look like?

Resistance is single gene

In two brief articles in the *WANTFA Newsletter* we have reported the possibility of the genetics of ryegrass resistance to glyphosate could be due to multiple genes (based on modelling work by Prof Jonny Gressel). However, recently published work by Australian researchers (Lorraine-Colwill, Powles, Hawkes and Preston, 2001) in the Journal Theoretical and Applied Genetics has shown that in one population the inheritance is due to a single semi-dominant gene.

President's Report

Neil Young, Kojonup
(08) 9821 0026

Thank you to those members who attended our AGM in March, at which time I was elected President of WANTFA. I know this will be a big job, and I look forward to giving it my best shot. The outgoing committee have done a tremendous job in encouraging WANTFA's continued growth both in membership and influence.

Committee changes

I am pleased to have Ric Swarbrick as Vice President, Richard McKenna as secretary and Tony White to be continuing on as Treasurer. Tony has overseen considerable change in the budgeting procedures over the last year, so his knowledge will continue to be put to good use.

Two men retired from the committee—Colin Steddy, whose enthusiastic approach to issues will be missed, and Graeme Malcolm who brought long-term experience. Our two new committee members are Paul O'Meehan of Borden and Tim Braslin of Katanning. I look forward to working with these men, and thank them for offering their time to the association.

Each member of the committee has adopted specific responsibilities, and in that way we hope to combine the talents of all for WANTFA's benefit.

No-till for tough seasons

WANTFA has become a powerful force in Agriculture since its formation in 1992, and I hope our influence can continue to grow. I know the use of no-till sowing contributed at least an extra 2 (some say 3) million tonnes of grain to WA farmers last year in what was a shocking season for many. This association can take much of the credit for the widespread adoption of this technique. It has been members wanting to "do it better" that has driven this process, combined with the enthusiasm of our Scientific Officer Bill Crabtree for both finding answers to the hard questions and passing that information on to the farming community of WA.

The use of no-till farming systems in WA is at a critical stage, and if we get it wrong no-till will get undeserved criticism. As farmers we seem to get a "honeymoon" period of two or three years for weed control, after which the weed numbers blow out if they haven't been well handled. This is the point where many farmers adopt a pasture phase to lower the weed pressure, even though it is less profitable than remaining in crop. Thick, even stubble cover and lack of soil surface disturbance are two key factors in minimising weed infestation, and it is very important that WANTFA direct its efforts toward developing a cropping system that includes these two key factors.

Stubble has value

WANTFA has been instrumental in the majority of the state's farmers now having access to some form of low-disturbance sowing, either knife points or discs. This is a tremendous foundation to work from as we chase the next major task—working out what crop sequence or machinery design is compatible with full stubble retention.

Farmers elsewhere in the world have found great benefits from retaining stubble, and researchers world-wide agree that no-till sowing combined with full stubble retention is the only way to sustainably farm, yet here stubble is still so often removed from many paddocks prior to sowing. It is done for many reasons, yet we know that with stubble removal the cropping system is not sustainable.

Our best gardeners use organic mulch of varying forms, yet we see our paddocks have that same mulch removed by grazing, baling or burning. This does not make sense! I am sure that eventually we will end up with a different agriculture to that which we have today, one that uses a wider variety of crops and therefore a wider variety of planting and harvesting times. These crops and techniques will allow us to keep our stubbles and hence really improve our soils.

Changing cropping systems

The future direction for our farming practice has been spelt out very clearly by world leading researchers. Jill Clapperton spoke 15 months ago at our Conference about the work being done at Lethbridge, Canada, on low input but high yield agriculture. Dwayne Beck's observation about his ability to farm using only very strategic applications of herbicides was intriguing.

Rolf Derpsch, at this year's Conference, told us the South Americans are able to lower costs by using cover crops and the resultant high biomass to their advantage. I can see we must head in the same direction if we are to remain competitive on the world markets.

Glyphosate resistance

An immediate concern is the threat of weeds becoming resistant to glyphosate, as has already happened in NSW and Victoria. No-till cropping systems used in WA are dependant on this single chemical working every time it is used, and to be without it would make farming as we know it very difficult—if not impossible. Please be careful with its use, and prolong its useful life. Your committee have followed on from the discussion at the AGM on this subject, and have decided to make every effort to raise community awareness of this major threat.

WANTFA Administration

This association is now budgeting for a turnover of nearly $1 million dollars when we include our GRDC and NHT projects, Annual Conference and this year's South American tour. All of this goes back into members' benefits, and as part of responsible management of such a sum, we have contracts with John Duff and Associates to provide administrative services and management services which are being reviewed at present to ensure we are getting the service we need.

This service has taken a great load off the individual members of the committee. It has also given us confidence in our budget management, allowing us to obtain greater involvement by commercial partners who are willing to sponsor specific activities of the association.

WANTFA's future lies in assisting the invention of a new agricultural system, based on no-till, that combines the knowledge accumulated to date about the vital role of residue management, soil disturbance and crop rotations, together with the knowledge yet to be obtained about crops that are different and new in our farming systems. If we concentrate on this goal, we can make an even bigger difference to farming in WA than has been made over the last ten years with the widespread adoption of low disturbance sowing. I look forward to being in WANTFA as this happens.

Affinity DF—new option for in-crop marshmallows

Gordon Cumming, Technical Officer,
Crop Care Australasia, 0407 483 941

Affinity DF (400 g/kg carfentrazone-ethyl) is a new in-crop herbicide with a new mode of action (Group G) that provides an additional option for broad-spectrum broad-leaved weed control. It can also be used as a rotational tool in broad-leaved weed resistance management.

When used as recommended (Affinity DF in a tank mix with MCPA amine), it provides two modes of action (Group G and I). Carfentrazone-ethyl has significant implications for the control of weeds that have resistance to SU's, diflufenican, and triazine resistant populations of wild radish as well as other weeds like double gee.

Efficacy

Affinity 400 DF is labelled for post-emergent control of five broadleaf weeds with bedstraw being the most sensitive. The addition of 500 mL/ha of MCPA (500 g/L as amine) increases the weed spectrum to include 20 weeds over a wider range of growth stages. Of these, the most significant weeds for WA are: wild radish, turnip, Indian hedge mustard, spiny emex (Doublegee), wireweed, white ironweed, prickly lettuce and volunteer lupins and canola.

Affinity 400 DF has demonstrated robust and reliable control of SU-resistant wild radish when used at the recommended label rates of 40–60 g/ha.

Affinity 400 DF provides farmers with a useful alterative to SU (Group B) products. It can be used in a properly planned rotation to alleviate some of the selection pressure being placed on diflufenican (Group F) based products such as Tigrex and Brodal.

Affinity is not suitable for application with crop oil concentrates or blended oil/surfactant adjuvants, due to unacceptable levels of crop phytotoxicity. For this reason, Affinity is not suitable for mixing with Grass Selective Herbicides.

Mallow trials in 2000

With the commercial release of Affinity DF at the beginning of the 2000 winter season, the field trial program in WA concentrated on additional weeds that were not on the label—in particular on Small-flowered Mallow *(Malva parviflora)*. This annual weed is becoming of increasing importance in the wheat belt, particularly with growers that have adopted no-till.

Two trials were established at Pingrup and Borden to test Affinity DF plus MCPA amine on two different sizes of Small-flowered Mallow.

Above: Mallows before spraying at Borden in Schooner barley.
Below: Mallows 10? days after spraying 50 g/ha of Affinity and 500 mL/ha of MCPA in barley at Borden in 2000.

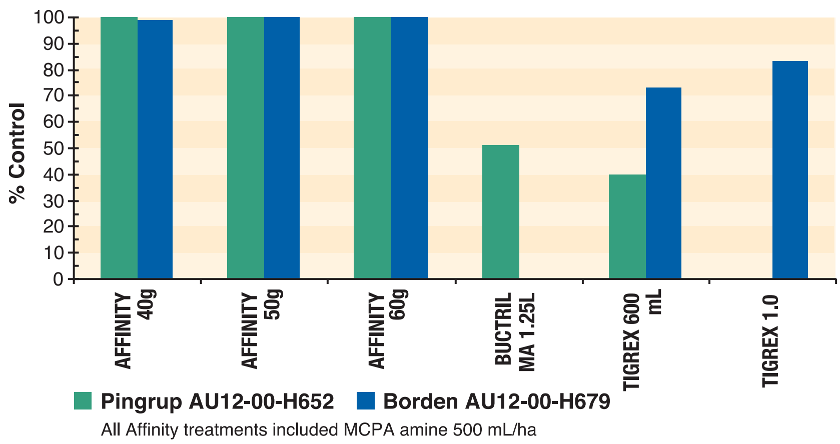
Pingrup: This was a timely application when most mallow plants were between 6 leaf (15 plants/m^2) and 14 leaf (3 plants/m^2) or 5–15 cm in height and 21 plants/m^2. Herbicides were applied to Carnamah wheat at the 2–3 tiller (Z22, Z23) stage with 83 plants/m^2.

Borden: This crop was sprayed later than the ideal timing, to give maximum herbicide challenge. The Small-flowered Mallow plants were well developed and were 20–30 cm high with a population of 49 plants/m^2. The crop was Schooner barley at 3–5 tillers (Z23, Z25) with 103 plants/m^2.

Results and discussion

At both sites the action of Affinity DF was extremely fast with 85% or greater brown-out within 7 days of application, compared with the standards which produced only 20% or less brown-out in the same time.

The final level of Small-flowered Mallow control at 30 days after treatment was excellent (see graph below). Affinity DF (plus 500 mL/ha of MCPA amine) gave 99–100% control at both sites. The other herbicides gave only 40–85% control.



The Tigrex applied at 600 mL/ha at Pingrup gave only 40% control of mallow compared to 73% control at Borden. The Pingrup site was suffering from moisture stress at the time of application and the wheat crop was thin and competed poorly with the mallows. Conversely, the barley crop at Borden was growing vigorously in moist soil and competed well with the mallows after spraying.

While Affinity DF (plus MCPA) at Borden gave excellent control there was the odd surviving weed in the plots. Typically these plants had a single new shoot from the crown, growing up to 10 cm in length with a single flower. These plants were rare and were not captured in the assessment—except at the lowest rate (Affinity DF 40 g/ha) with 3 shoots/m^2, compared to the untreated plants with 322 shoots/m^2. These re-shoots were small and infrequent and posed virtually no crop competition and returned little seed to the seedbank.

Conclusion

Affinity DF gave robust and reliable in-crop control of Small-flowered Mallow when used at 40–50 g/ha plus MCPA amine at 500 mL/ha. The speed of action and the final level of control were much greater than the herbicide standards currently being used.

A registration claim for this use is being submitted to the National Registration Authority (NRA) and is expected to be approved for the 2002 winter season.

19 May 2001
The Editor
WANTFA Newsletter

Dear Sir,

No Glyphosate on Firebreaks

What are the chances of continuing to sow without tillage, if glyphosate-resistant ryegrass becomes widespread?

There are now said to be about a dozen cases of glyphosate-resistant annual ryegrass world-wide. (See the November 1997, May 1998, May 2000 and December 2000 *WANTFA Newsletters*.)

Herbicide resistance is forever. And only no-till reduces erosion to about soil formation rates. Therefore, sustainable grain-growing will go out the window too, if no-till does!

No-till sowing was extremely difficult before glyphosate became available. Only one out of about 30 no-tillers survived then. (Mike Brown of Yillimining, via Narrogin, has now taken off 25 successive no-till crops.)

The WA Herbicide Resistance Initiative states that resistant ryegrass can develop after about fifteen applications of glyphosate, if a second knock to eliminate survivors is not applied (like SpraySeed applied 1–10 days after the glyphosate).

Some firebreaks are approaching the dangerous level of 15 glyphosate sprays. Therefore, sustainable grain-growing may be threatened, for the mere convenience of sprayed firebreaks.

Firebreaks, where needed, can be graded, ploughed or scarified. But turn off on the downhill side frequently, to divert surface runoff onto no-tilled soil and minimise water erosion.

Research showed 35 times more water erosion from tilled than from no-tilled cropland. A little rilling on graded or tilled firebreaks is small, compared to water erosion after tillage.

It is also important to alert other farmers, hobby farmers and agencies like Main Roads and Westrail to the risk to sustainable grain-growing, from continually spraying glyphosate without a second knock.

Kevin Bligh
Honorary Life Member and Committee Member

Glyphosate and paraquat resistance in WA weeds

Paul Neve and Mechelle Owen,
WA Herbicide Resistance Initiative,
UWA (08) 9380 7872

During the 2001 growing season the WA Herbicide Resistance Initiative (WAHRI) and Agriculture Western Australia (AGWEST) will once again conduct a survey to establish if, and to what extent resistance to the knockdown herbicides is present in the WA wheatbelt.

Clearly, emerging resistance to these herbicides will place major constraints on current weed management strategies.

Early detection will enable management to be put into place which may eradicate or prevent the spread of resistant populations and better enable researchers to understand the processes which result in glyphosate and paraquat resistance. This will be particularly important with the imminent introduction of Roundup Ready crops.

As yet, no resistance to glyphosate or paraquat has been reported in WA. This is not a reason to dismiss the problem, but rather an opportunity to put in place strategies which will ensure the continued efficacy of these herbicides into the future.

If you have weed populations where control with knockdown herbicides is incomplete, WAHRI and AGWEST will test these and inform growers and agronomists of results.

For this purpose, a number of resistance testing kits have been sent to district AGWEST offices and district agronomists.

Suspected resistant plants can be sent to WAHRI (Faculty of Agriculture, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009) or to AGWEST in overnight express post bags and will be tested for resistance.

If you would like further details or would like us to send you a testing kit, please contact Paul Neve or Mechelle Owen at WAHRI. Results will be treated with the strictest confidence.

2001 WANTFA Conference

Carl Perralla, WANTFA Admin, (08) 9277 9922

About 500 people attended the BEELINE WANTFA Annual Conference and associated one-day seminars in late February and early March 2001. Three hundred people attended the main conference in Perth, with the Esperance and Geraldton seminars each attracting about 100 people.

People enjoyed the presentations by international guests Carlos Crovetto and Rolf Derpsch with many delegates commenting on their enthusiasm and passion for making agriculture sustainable. Scott McCalman from Warren NSW was also impressive, with his clear thinking practical innovations appreciated by all. Local farmer speakers and specialists were well received with attendees enjoying input from people with similar attitudes and views on no-till farming.

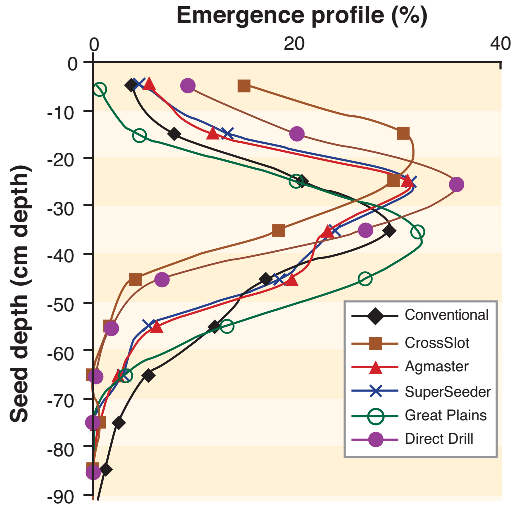
Hotel Rendezvous proved to be an excellent venue, providing a very comfortable and relaxing environment. At this stage it is planned to hold the conference at Hotel Rendezvous again in 2002. The feedback received for the main event was very positive. Minor suggestions will be used for the 2002 event.

The events brought significant publicity for WANTFA and No-Till in general and will greatly assist in ensuring the success of this Conference in years to come. The Conference was reported extensively in the Farm Weekly.

Thanks go to the major sponsors Agystems BEELINE, Elders Rural Bank, Crop Care, CSBP futurefarm, GRDC, Hotel Rendezvous Observation City and Farm Weekly, Snap Printing (Midland and St Georges Tce) without whom such events with international speakers would not be possible.

We look forward to another exciting Annual Conference in 2002—we'll keep you posted.

Left: Wheat germinating on marginal soil moisture. Right row is excavated.



When is precise seed depth important?

Mike Collins (& Peter Dale), AGWEST Northam (08) 9690 2114

During three years of no-till seeder experiments (1995–97) and thousands of seed depth measurements, some useful insights were gained into seeding depth. Contrasting soil types of deep and shallow sands and heavier soil types were used at Cunderdin in 1996, and marginal soil moisture seeding options were tried at Merredin in 1997.

With a crusting heavy soil, precise shallow seeding, plus surface residue, is helpful

A wheat trial was sown in late June into faba bean stubble, with 60 kg/ha of Tammin wheat and 150 kg/ha of Super CuZnMo, followed by topdressed nitrogen. Loxton light rotary harrows were used on all plots at seeding—except for the CrossSlot treatment. There were significant differences in emergence, dry matter production and head count, but not with grain yield (see table below) at this site. This illustrates a feature of many no-till trials where differences between treatments decline over the season to insignificant yield differences, particularly where reduced emergence still results in 100 or more plants/m² and weed control is good.

Seeder	Seed depth (mm)	Plant counts (pl/m²)	August dry matter	Head count (h/m²)	Grain yield (t/ha)
CrossSlot	23	120	64	315	4.11
SuperSeeder	32	108	62	290	4.00
AgMaster	33	107	58	296	3.96
Great Plains	39	101	55	279	3.95
Direct drill	39	98	49	265	3.95
Significance (LSD at 5%)		7.3	5.8	21	NS

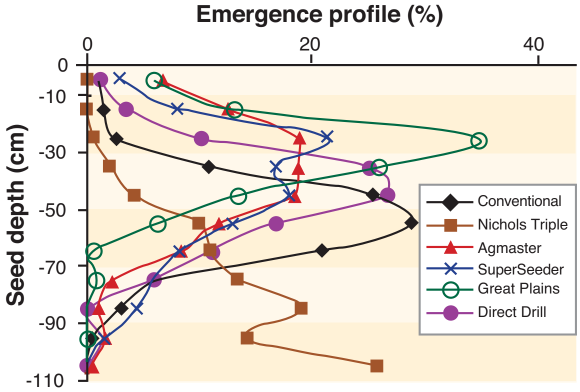
The Faba residue improved soil moisture (14 vs 12% in top 50mm) immediately before sowing. The CrossSlot maintained a high level of residue over the seed row—keeping the soil moist for longer after seeding—with less crusting (evident in all treatments). The CrossSlot gave superior seed depth control, with prompt emergence from the shallowly placed seed. However, the CrossSlot plots, unlike all other plots, were not lightly harrowed after topdressing Agran, the harrowing probably accelerated surface drying. Emergence data showed a significant negative correlation between seed depth and emergence.

Other trials (in light soil) have shown that opener differences in drying soil have been greater than the moisture conservation due to the residue, although this needs qualifying. In this particular case the residue was 10 t/ha of stalky lupin material. Fine material, derived from lupin leaf, is much more effective than stalks.

Ripping response on light soil overcame poor seed depth control

The treatments on the second trial on light soil were the same as for the heavy soil trial—except the CrossSlot was replaced with the Nichol's 'Triple-Action-NoTill' and the wheat was Stiletto. The Nichols machine was sown too deep (86 mm), due to it's upward thrust on a typical narrow row spacing (18 cm) while achieving a working depth of 30 cm. The rear tines also buried the front seed rows. The plots were also harrowed level, to prevent topdressed nitrogen from running into the furrows. This further reduced the emergence of the Nichols sown crop. Despite this, the Nichols gave the best grain yield and highest plant nutrient levels (N, K, Mg, Mn, S, NO_3).

Seeder	Seed depth (mm)	Plant counts (pl/m²)	August dry matter	Sept dry matter	Head count (h/m²)	Grain yield (t/ha)
Nichols	86	115	0.49	286	231	2.75
AgMaster	38	134	0.43	241	206	2.57
Great Plains	31	136	0.41	223	-218	2.55
Direct Drill	54	132	0.44	226	199	2.51
SuperSeeder	44	135	0.43	219	208	2.51
LSD at 5%		10.2*	0.044**	25.7**	14.8**	0.153*



Is such a response to deep tillage sustainable, and how much better could this response have been with good seed placement? Additional nitrogen, up to 30 units per hectare, did not eliminate these opener differences. Work by Hamblin, Tennant, Jarvis and Crabtree in the 1980's suggests that deep cultivation improves early root growth, enabling the wheat to 'catch' more nitrogen and explore more topsoil and capture more nutrients. The additional available K would help N utilisation.

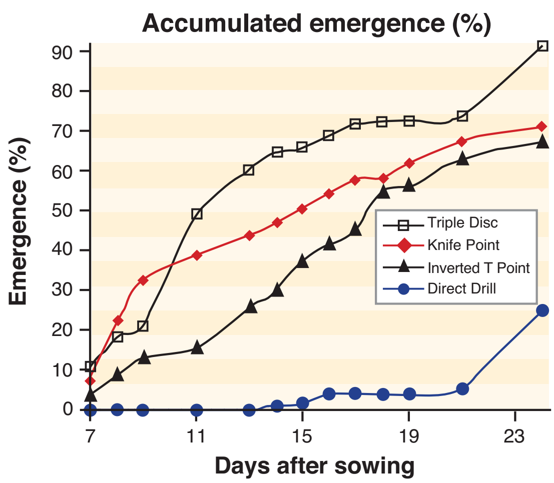
In this trial, more topsoil moved down into the tine slot, enriching soil colour in a vertical strand to a depth of 23 cm. This topsoil, relocated at depth, contained fertile topsoil and this may have given some of the response and may have residual benefits for subsequent crops (although the following lupin showed no visible response).

Is seeding depth important?

Yes, it is, but so too is stubble retention—particularly in dry situations, on heavier soil types. Shallow seed placement, in moist soil, ensures that plants have good early vigour, aided by the reduced soil strength of moist soil. Surface stubble can improve crop emergence by reducing surface crusting evaporation and by restricting the impact damage to soil structure of rainfall. However, creating better soil conditions for crop growth can overcome problems with deep seed placement in sandy soils.

Zero-till shines in marginal soil moisture

Good soil moisture from a rain in late March (1997) enabled seeding on 8th April into warm-moist soil (5.3–9.5% in top 40 mm before seeding). Emergence was prompt from all depths—complete emergence in nine days. A second sowing, two weeks later, with soil moisture at 1.5–3.5%, showed slower emergence and gave some clear treatment differences. Seedlings from each plot were tagged at emergence, and later the plants were pulled up to measure seed depth.



The triple disc gave the most consistent relationship between seed depth and emergence time—probably due to less soil mixing and drying, which was evident with direct drilling. Seeds sown in dry soil, nearer the surface, took much longer to emerge than those from greater depth, in fact, those sown into 'visible moist' soil, at greater than 60 mm were the quickest to emerge. Where there was some lupin leaf residue, there was good early emergence with the triple disc seeder compared to no emergence without residue (see table following and photo).

Depth (mm)	Soil moisture (%)	
	No cover	Residue
0–40	3.4	4.1
40–80	4.5	7.2

Wheat germinates better when stubble is left on the soil surface, as seen in this lupin header row going across the triple disc sown plot.

The hard dry soil prevented full opener penetration, and the seeds were sown in the top 40 mm. Where the soil was moist, sowing depth was greater—into the moist soil. Germination and emergence was 100% under the residue and nothing (0%) in the bare soil.

The addition of press wheels generally reduces the variability of seed depth. Many trials were conducted in a range of soil moisture levels. Where conditions were good (moisture, seeder penetration, seed coverage, weed control, crop nutrition) we usually got no significant yield differences to press wheel addition. However, where there are some of these problems, then press wheels provide a clear advantage. Where weed control is not good, then quick crop establishment is vital. Likewise where surface crusting exists precise seed placement is invaluable.

In none of these series of trials did 'full-cut tillage' treatments, either one pass or two, out-yield no-till. Also of interest is that 'average' no-till seeding equipment, as used in these trials performed adequately. But all equipment must be correctly set and operated. Very shallow depth (under 12 mm, as we found with an inadequate old triple-disc machine) always lead to poor results. Ray Harrington's list of three critical factors (disturb 4–6 cm under the seed placement depth; place seed at optimum depth; cover seed) is adequate for most situations.

This is encouraging for farmers who do not have the money to spend on more expensive equipment, for once the above setting and operating procedures are followed, much greater gains in profitability are possible by improving crop agronomy than by investing in expensive no-till seeding equipment.

Deep ripping and gypsum can improve soil structure and crop yields

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A package of deep ripping soils with massive structure, and application of gypsum in the presence of non-limiting nutrition and incorporating plant residues, can improve soil physical and chemical fertility and crop grain yields. An earlier study by AGWEST showed one main reason for low wheat yield in low rainfall areas was degraded soil physical properties as indicated by poor water infiltration and compacted soils.

Four years of research on three different soil types in low rainfall areas of WA has shown that wheat yields can be greatly improved by deep ripping and applying gypsum. Plant nutrients were applied on the basis of soil tests. Likewise, pulse crop grain yield improvements have also occurred using these amelioration techniques except for lupin, which is known for its sensitivity to lime and gypsum. Wheat grain yields increased by 20–49% in the first year (1997) and by 40–63% in the second wheat year (1999).

General trial management and rainfall

The soils chosen were compacted, contained low organic matter, had a low soil pH and had poor water permeability. Eight different treatments (including control) were imposed on sites that had degraded topsoil and four replicates were used. Soil amelioration treatments involved deep ripping to 400 mm, application of 2.5 t/ha of gypsum and application of complete nutrient mixture of macro and trace elements as shown by soil test. The treatments consisted of all combinations of these factors. The cost of ripping and applying gypsum is estimated at about $50/ha.

The plots were rotated each year between wheat and pulse crops (either field peas, chickpeas or lupins—depending on soil suitability). Plant residues, from the previous year, were scarified into the soil to 5 cm depth for all treatments—usually after harvest, or in the autumn. There was no grazing of any crop residues. Soil compaction for all plots was avoided by having wide buffer areas between every plot (see the photo).

The basal nutrients for the control treatment at each site have been 10 units of both P and N each alternative year. Calcite lime was applied at 1 t/ha to all treatments at the Nungarin site only, in April 1997.

The growing season rainfall for 1997–1999 has been close to average for the three sites. However, last years rainfall (year 2000) was well below average.

Location	Soil type	Bulk density (mg/m^3)	Growing season rainfall (mm)			
			1997	1998	1999	2000
Merredin Topsoil Subsoil	sandy clay loam clay loam	1.7	186	199	236	89
Nungarin Topsoil Subsoil	sandy loam clay loam	1.3	167	185	165	87
Tammin Topsoil Subsoil	sandy loamy sand	1.5	195	241	199	117

Wheat yield responses

Wheat grain yields increased at all sites for all treatments in the first year but in the second wheat year (1999) yield increased at all sites except on the deep ripped treatments. Deep ripping alone decreased grain yields by 25% at Nungarin and by 10% at Tammin while it increased grain yields by 14% at Merredin. The highest yields on average were obtained from applying all amelioration treatments (Deep ripping + gypsum + nutrients). Gypsum plays an important role in reforming the structure of compacted soil after it has been deep ripped.

Treatment	Wheat grain yield (t/ha)					
	Merredin		Nungarin		Tammin	
	*1997	1999	*1997	1999	*1997	1999
Control	2.32	2.42	1.87	2.43	3.25	2.93
Deep ripping	2.71	2.76	2.72	1.83	3.60	2.63
Gypsum	2.43	3.25	1.92	3.12	3.39	3.42
Nutrients	2.98	3.15	2.10	3.28	3.28	3.40
Gypsum and nutrients	3.07	3.69	2.14	3.71	3.50	3.93
Deep rip and nutrients	3.26	3.01	2.79	2.65	3.90	3.52
Deep rip and gypsum	2.85	3.41	2.75	3.48	3.54	3.53
Deep rip, gypsum and nutrients	3.22	3.95	2.66	3.87	3.72	4.10
LSD at 5%	0.34	0.43	0.22	0.42	0.34	0.39

**In the first year (1997) the gypsum applied had a high salt content at Tammin (EC = 400–500 ms/m).*

The decrease, or relatively minor response in grain yield due to the deep ripping treatments, suggests that the soil structure is still poor even after three years—in the absence of a flocculating agent such as calcium from gypsum. In the long-term, deep ripping alone might even produce a negative effect on the soil.

Complete nutrient treatments increased wheat yield at all sites but the lower increase at the Tammin site was associated with a lower cation exchange capacity (see below) which reflected the sandy nature of the site. This result suggests the importance of increasing cation exchange capacity through returning plant residues to the soil *(Editor: As Rolf Derpsch would say "would the result be similar if the organic matter was left on the soil surface". Work by Fran Hoyle comparing the two approaches should give an answer.)*

The effect of nutrient addition was about the same as the gypsum on grain yield, but the negative effect of deep ripping on grain yield was absent when all ameliorants were used.

Plots of wheat grown at the Merredin site.

Pulse crop responses

Similar to the wheat, but to a smaller degree, there were often main responses to all ameliorants. However, lupin yield in gypsum treated plots at the Nungarin site in 1998 showed a large decrease. The negative response of lupins to gypsum and lime is common but the reason is not yet clear.

Treatment	Pulse grain yield (t/ha)					
	Merredin		Nungarin		Tammin	
	Field peas 1998	Field peas 2000	Lupin 1998	Field peas 2000	Chick peas 1998	Field peas 2000
Control	1.26	0.78	1.04	0.22	0.91	0.72
Deep ripping	1.52	0.65	0.97	0.17	1.05	0.67
Gypsum	1.66	0.92	0.61	0.19	1.09	0.80
Nutrient	1.43	0.93	1.21	0.31	0.97	0.77
Gypsum and nutrients	1.70	0.97	0.75	0.35	1.19	0.84
Deep rip and nutrients	1.69	0.78	1.07	0.24	1.09	0.70
Deep rip and gypsum	1.79	1.01	0.31	0.33	1.18	0.81
Deep rip, gypsum and nutrients	1.85	1.07	0.40	0.40	1.26	0.95
LSD at 5%	0.29	0.28	NA	0.17	0.32	0.21

Physical and chemical changes to the soils

Water infiltration rates, soil strength, bulk density, water stable aggregates, cation exchange capacity and soil organic matter all improved with the addition of soil ameliorants. The greatest increase, for both infiltration and cation exchange capacity, occurred after all ameliorants were used.

The water infiltration rate increased by 100% to almost 200% at the Merredin and Nungarin sites but by lower amounts at the Tammin site. The changes in water infiltration rate and the cation exchange capacity (CEC) improve soil physical characteristics for storage and supply of water and nutrients.

Treatment	Merredin	Nungarin	Tammin
	Infiltration rate mm/hr in 2000		
Nutrients	8	10	12
Gypsum and nutrients	21	25	20
Deep ripping and nutrients	16	21	19
Deep ripping, gypsum and nutrients	24	27	26
	Cation exchange capacity cmol/kg in 2000		
Nutrient	9.7	10.6	8.4
Gypsum and nutrients	13.6	13.8	10.6
Deep ripping and nutrients	11.2	9.4	9.7
Deep ripping, gypsum and nutrients	14.2	14.0	10.9

The cation exchange capacity (CEC) increased substantially at all sites due to soil mixing (deep ripping) and stubble retention. Deep ripping increases soil CEC by mixing the topsoil, which has low CEC (low clay content) with subsoil, which has high CEC (higher clay content). Stubble retention increases CEC through increasing soil organic matter.

The higher percentage increase in cation exchange capacity at the Tammin site was associated with higher yields. This meant increased amounts of plant residue were returned to the soil during the previous three years.

Poor soil structure exacerbates waterlogging risk.

The highest grain protein contents occurred in the deep ripping–gypsum–nutrients treatment at the Merredin and Nungarin sites and in the deep ripping–nutrients treatment at the Tammin site (data not shown).

Residual effects

Data collected in 2000 showed that the yield and soil physical properties maintained their improvement in response to the residual effects of the package, which was applied in 1997.

The residual effect of deep ripping decreased wheat yield in two sites and increased yield in the third site—indicating the negative long-term effect of deep ripping on soil and yield, when used without gypsum.

The high cation exchange capacity of the soils under the highest yielding treatments was most likely due to the soil mixing and increased amounts of crop residues produced and retained in those treatments. Increased fertiliser efficiency and reduced chances of environmental pollution can be expected from these treatments.

Soils are alive!

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Our regular Soil Biology segment continues…

Nitrogen-fixing root nodule bacteria (rhizobia)

Nitrogen is a major constituent of air but plants cannot use this form or nitrogen until it is converted to ammonium—through nitrogen fixation—thus reducing our reliance on fertiliser nitrogen. Bacteria that form nodules on legumes (rhizobia) for symbiotic associations is used by the legume and stored in seeds and other plant tissues. When the legume dies, the plant tissue is broken down by other soil microorganisms and the nitrogen is released for use by the following crop.

The nitrogen fixed by rhizobia does not leak out into the soil while the legume is alive. The amount of nitrogen fertiliser that needs to be added to a wheat crop grown after a legume depends on legume retained, environmental conditions, soil type and soil management history. Recently, with less pastures and more crops being grown more nitrogen fertiliser has been used in Australia.

Rhizobia bacteria in soil and in legume nodules

Rhizobia are one of the best known groups of soil bacteria. They are extremely small (about one micron long) and rod-shaped. Rhizobia live in soil with other soil bacteria amongst organic matter and soil particles and roots. They survive better in soils that have more clay than in what sandy soils contain. The number of rhizobia present in soil depends on whether they were introduced (inoculated) at the time of seeding the legumes, how long ago they were introduced and whether or not legumes have been grown in the soil recently.

Rhizobia only fix nitrogen when they are inside the root. Most rhizobia are outside of the plant and are not involved in the process of nitrogen fixation. The shape of nodules is different on different legumes. Nodules occur on native legumes such as acacia, but the rhizobia that form them cannot form nodules on agricultural legumes. Specific inoculum is required for each group of legumes.

Rhizobia make N available to legumes from N gas in air

The relationship between legumes and rhizobia is called a symbiosis because the plant and rhizobia live in a close association that is beneficial to both partners. Rhizobia gain their nutrients from the plant cells. It has been estimated that more than 90% of nitrogen fixed by rhizobia is rapidly made available to the legume plant. Nodules are formed as the result of chemical signals exchanged between legume roots and rhizobia in the soil. These signals allow the rhizobia to recognise and enter the appropriate root.

Efficient nitrogen fixation occurs in nodules richly supplied with a red pigment called leghaemoglobin. This pigment, like the haemoglobin in our blood, supplies the rhizobia with oxygen they need to fix nitrogen. This makes it easy to identify nodules containing active rhizobia by their red colour when a nodule is cut open (see below left).

Genetic diversity of root nodule bacteria in south-western Australia

In trying to understand the performance of the legume–rhizobium symbiosis on our farming systems, we have focussed on understanding how many different forms of this group of bacteria are present in soil. Although the bacteria appear very similar, they can differ greatly in their efficiency at converting nitrogen gas to a form of nitrogen that can be used by plants. Our studies have looked at genetic diversity in populations of rhizobia found in clover, serradella and lupins in south-western Australia. These rhizobia belong to two distinct bacterial groups, *Rhizobium* (the group that nodulates clover) and *Bradyrhizobium* (the group that nodulates serradella and lupins).

Nitrogen-fixing ability of rhizobia

We tested isolates that had different DNA fingerprints to see how effective they were at fixing nitrogen on their host legume. The results for the two groups of rhizobia that nodulate clover *(Rhizobium)* and lupin/serradella *(Bradyrhizobium)* were very different.

Rhizobia in the *Rhizobium* group included both effective and ineffective nitrogen fixing bacteria. Some of the most common bacteria inside a clover nodule were more effective than the commercial inoculant while others were less effective. The most effective type of rhizobia was very common in clover nodules at a site near Denmark. This was an undisturbed pasture in a high rainfall region. The least effective rhizobia were found in a sandy soil site that had many different types of clover rhizobia in nodules, all varying in their effectiveness at fixing nitrogen. In contrast, the situation for rhizobia in the group *Bradyrhizobium* was different to that for *Rhizobium*. These rhizobia form nodules on serradella and lupin and were stable and consistently effective at fixing nitrogen.

In order to maximise nitrogen fixation in clover pastures, we need to know which management practices encourage the most effective rhizobia to occupy nodules. However this is difficult to determine because plants do not necessarily select effective rhizobia during the nodule formation. In contrast, the diversity of rhizobia associated with lupin and serradella does not affect their nitrogen-fixing performance, which is consistently high.

Acknowledgements

The research on clover and lupin rhizobia was carried out by Krys Haq and Margaret Collins with support from GRDC and CLIMA. Alison McInnes conducted the research on the diversity of serradella bacteria with support of Australian Wool Innovation Limited.

WANTFA and Aglime Trials

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In response to many farmers' concerns that no-tillage might delay the onset of yield increases from liming, Aglime of Australia, WANTFA and Agriculture WA set up 3 long-term lime by tillage trials at WANTFA's Meckering R&D site.

Soil pH increases when soil acids dissolve lime particles. Each lime particle only affects the soil within approximately 2 mm of the particle. Therefore, more particles (through a finer lime) and better distribution through the soil increases the rate of reaction of the lime.

No-till does not involve physical mixing of the lime particles through the soil. These trials measure the effect this has on the rate of soil pH increase and yield increase.

Treatments include the application of 0, 1, 2 and 4t/ha of Aglime's limesand topdressed in April 1999,compared with four seeding techniques. The seeding techniques are:

- triple disc openers (TD),
- knifepoint openers (KP),
- full cut direct drilling (DD) or full cut cultivation, in the first year, followed by knifepoint only in subsequent years (CT).

The three trials are located on Colin Pearse's farm on the Meckering faultline on a paddock that had 1t/ha of Aglime limesand applied in 1994.

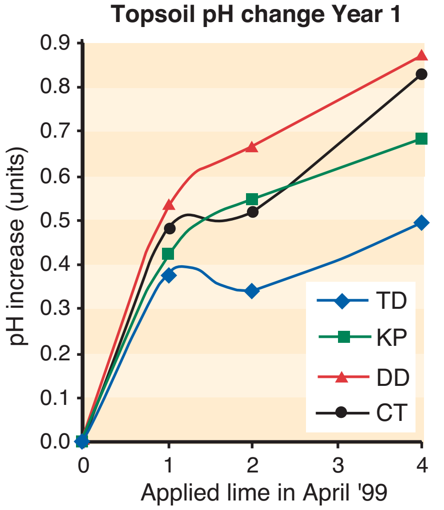
1999 yield results

In 1999, the first year of the trial, all trials were sown to wheat with no yield differences from any lime or seeding treatments. The soil without lime was moderately acid (topsoil pH 4.8 and mid-soil pH 4.5), and therefore, a yield response was unlikely in the first year.

In late May 1999, a month after the lime was applied, about 100 mm of rain fell on the site (over about 4 days), then again 8 months later (in January 2000) a similar amount of rain fell on the site over 2 days.

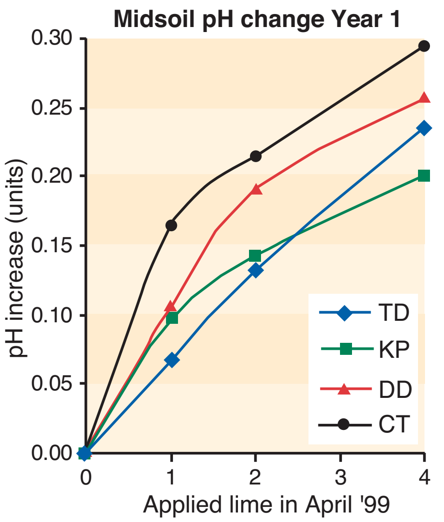
1999/2000 pH change

Soil pH was measured in April 2000 and the results of all trials were similar and are combined together for this analysis. Aglime limesand did increase topsoil pH in all tillage treatments.



However, midsoil pH increased significantly with only knifepoints and a full surface tillage. There was too much variability in the triple disc treatment for the pH increases to be statistically significant.

At the 1 t/ha Aglime rate, the 3 tillage treatments did not change the topsoil pH. However, at the 2 and 4t/ha rates, the pH change was less with the triple disc machine.



As expected the topsoil and midsoil pH increased more with the higher rates of Aglime. Further pH increases are expected over the next year or so.

It is evident from these trials that the no-till systems, especially the knifepoints, can allow a significant amount of Aglime limesand to dissolve in the surface and leach deeper into the soil.

2000 yield results

Trial 1: Canola

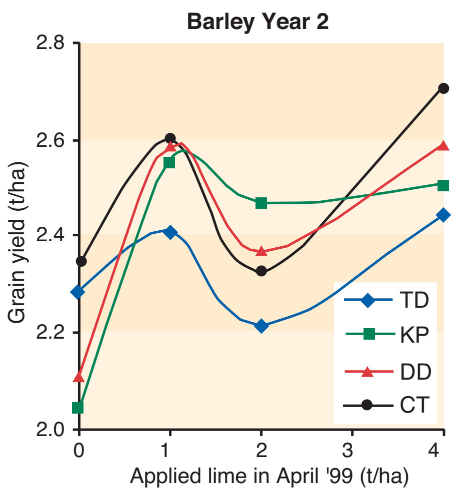
Canola yields averaged 1.3 t/ha with a large amount of variation throughout the trial. There was no yield increase from liming in any cultivation treatment. The no lime treatments have a topsoil pH of 4.7 and a midsoil pH of 4.5. This is a borderline measurement for canola and with the high variability in the trial, small yield responses were unlikely to be measured. Larger differences may show up in future years.

Trial 2: Barley

There was a significant increase in barley yield from liming but no difference between tillage treatments. The no lime treatments averaged 2.20t/ha while average yields were 2.54, 2.34 and 2.56t/ha for 1, 2 and 4t/ha of Aglime respectively.

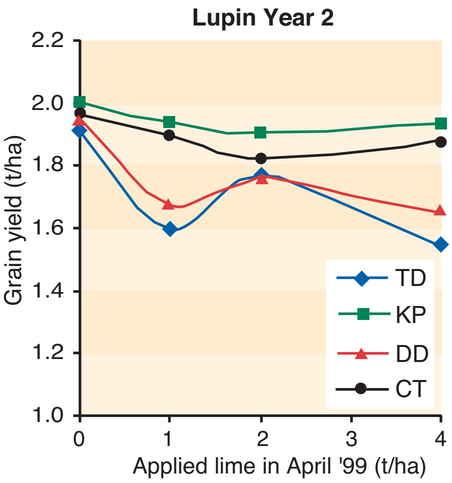
The increase of 0.34t/ha (around $45/ha) with 1t/ha of Aglime limesand applied the previous year is a highly profitable investment and was achieved with all types of tillage. Yields at 2t/ha of lime were lower than 1t/ha but had increased again at the 4t/ha rate. The reason for this result is unclear but may be due to the numerous interactions between toxicity and nutrient availability affected by pH.

The no lime treatment had an average topsoil pH of 4.4 and midsoil pH of 4.2 (around 0.3 units lower than the canola trial). The barley trial would have been under more stress from acidity than the canola trial and may explain the high yield increases shown to liming by barley.



Trial 3: Lupins

The lupin trial averaged 1.8 t/ha yield with no effect of liming with the two knifepoint treatments. However, there was a negative effect of liming on lupin yield with direct drilling at 1 t/ha and with the triple discs at 4 t/ha of lime rates. This effect was particularly evident in yields of only 1 replicate.



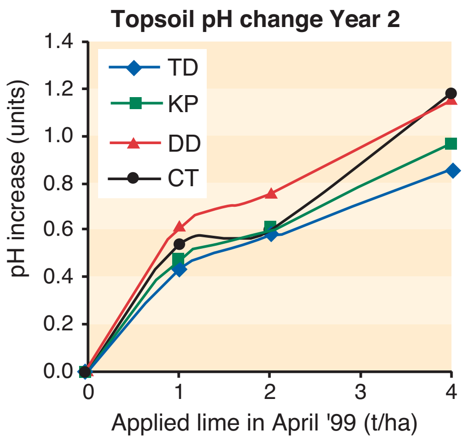
Tissue analyses showed no Mn deficiencies, although a slightly lower uptake of Mn was measured with liming. The yield depression with the triple disc and direct drill openers may be related to increased brown spot incidence. The knifepoint do move surface soil and trash away from the emerging seedling, which does not happen with full tillage and the disc openers. Such soil movement may reduce the incidence of brown spot. These trials will continue for several more years and the effect of tillage on lupin responses to lime will continue to be studied.

The pH of the no lime treatments averaged 4.5 in the topsoil and 4.2 in the midsoil in the lupin trial.

2000/2001 pH change

Similar to the first year after liming, the pH results of all trials are combined for this report. Soil pH of each plot was measured in April 2001, 2 years after liming. Over the 12 month period since April 2000, the topsoil and midsoil pH had decreased on average by around 0.2 units in the nil lime treatment. This may be due to soil acidification or to slight variation from year to year often measured with soil pH. All liming treatments under all seeding treatments significantly increased topsoil pH in year 2.

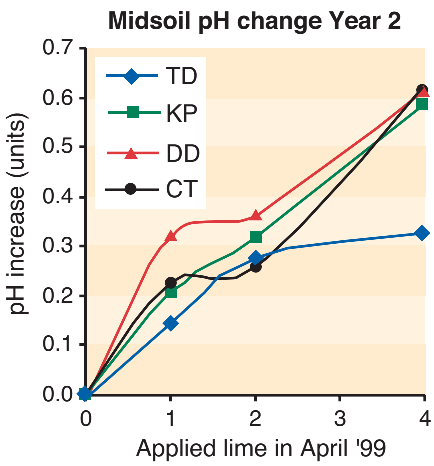
Between the first and second years after liming, the topsoil pH of all the limed treatments increased, but the variability of the results was high, and these differences were not significant with 1 and 2 t/ha rates of lime. At the 4t/ha lime rate, the full cultivation in year 1 followed by knifepoint in year 2 and the direct drill did increase pH over year 1 by 0.3 units.



If an abnormal outlying result is removed from the disc treatment, it also showed a significant pH increase of around 0.3 units at the 4 t/ha lime rate. The pH increase with knifepoints was 0.2 units but wasn't statistically significant.

There were similar increases in average midsoil pH of limed treatments in the 2nd year after liming. In the midsoils, the 4 t/ha lime treatment pH increased by 0.3 to 0.4 unit since year 1 and this was significant with all treatments except the disc openers. The midsoil pH was significantly lower under the disc openers at the 4 t/ha lime rate than all other tillage treatments.

The increase in midsoil pH with the 1 t/ha lime rate, knifepoints and disc openers was not significant in the 2nd year while the full tillage in year 1 and both years were significantly higher with this rate. However, the midsoil pH was significantly higher with all tillage treatments with 2 and 4 t/ha lime rates.



CONCLUSIONS

- Canola was not affected by tillage or lime treatments in year, 2 possibly due to large soil pH variation. No effect of openers or tillage was measured.
- Barley yield increased with liming in year 2 possibly due to the lower pH of the topsoil and midsoil of the no lime treatments. No effect of tillage was measured.
- Lupins showed a tillage effect with the two knifepoint treatments giving no yield responses to lime. The direct drill and disc openers showed negative effects with the 1 and 4 t/ha lime rates respectively although this was largely confined to one replicate.
- In the 1st year after liming, the topsoil pH with triple discs were significantly lower than the other treatments with 2 and 4 t/ha lime rates. Midsoil pH was not affected with triple discs but was increased under the other tillage treatments with all lime rates.
- In the 2nd year after liming,
  - Soil pH increased with the 4 t/ha lime rates in topsoil and midsoil in most treatments. There is a significantly lower midsoil pH with the 4 t/ha lime rate under the disc openers.
  - Topsoil pH had increased above the no lime treatment for all lime treatments under all seeding treatments. Midsoil pH increased for the 2 and 4 t/ha of applied lime with knifepoints and triple discs. Likewise, midsoil pH increased with all lime rates under full cultivation in year 1 followed by knifepoints in year 2 and also direct drilling in both years.

Liquid phosphorus fertilisers

Simon and Andrew Longmire (Salmon Gums farmers) and Jeremy Lemon, AGWEST Esperance (08) 9083 1111

Innovative research by Dr Bob Holloway, at Minnipa Research Station in South Australia, has encouraged us to experiment with liquid phosphorus on alkaline soils at Salmon Gums.

Both Minnipa and Salmon Gums soils have a very high Phosphate Retention Index. The local results suggest that such fertilisers are likely to be beneficial in the alkaline soils of WA. The WA farmer trial was not replicated but did have several control treatments between the P treatments, which were used as control references.

Trial details

The trial was on our (Longmire's) farm at Kumarl, 30 km north from Salmon Gums, and was on a grey calcareous loam. We drilled Mundah barley at 45 kg/ha on 2 June 2000 with super seeder points on a combine. Weeds were controlled after several summer rains with knockdown and tillage and a final knockdown (SpraySeed) was applied on 19th May, mixed with the trifluralin.

The previous paddock history was pasture, 1.2 t/ha of wheat, 2.0 t/ha of barley and a spray topped pasture from 1996-99. Rainfall during May to October in 2000 was 81 mm, while estimated stored soil moisture was 80 mm giving a potential yield of 1.0 t/ha using 110 mm evaporation, or 2.7 t/ha using 27 mm (1/3 growing season rainfall) evaporation factor.

A topsoil (0–10 cm) analysis taken at sowing gave the following results.

NO_3	NH_4	P	K	S	OC%	dS/m	pH H_2O	pH $CaCl_2$	PRI
22	1	12	534	6.1	1.39	0.172	9.00	8.2	27.7

All P fertiliser was banded with the seed at sowing and extra N fertiliser was topdressed immediately before sowing. The P fertilisers were applied at a rate of 0, 10 and 20 kg/ha as either phosphoric acid, MAP granules or technical grade MAP (crystals dissolved in water).

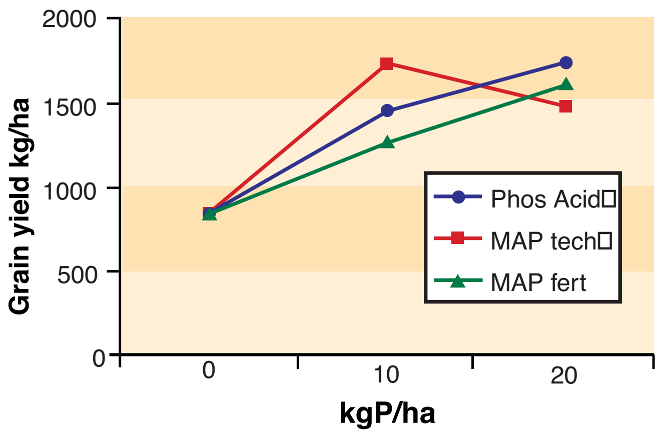
The N fertiliser was topped up to total 37 kg N/ha for each treatment and was topdressed as CAN. The liquid fertilisers were applied behind each boot on a combine in the seed row and the granules were banded with the seed.

Results

Whole top plant analyses taken on 20th August showed a two-fold increase in dry matter responses to applied P at 10 kg/ha. Also, the liquid fertilisers increased dry matter by 20–25% over the granular P.

The tissue tests indicate an increasing P and decreasing boron concentration with effectiveness of P source (as indicated by grain yield). Grain yield increased with the rate of P applied (except the high rate of MAP tech dissolved—see observations below). Screenings were highest on the nil P plots and reduced by P fertiliser. Grain P concentration and total content were increased by the rate and effectiveness of P applied (as indicated by the grain yield.)

Phosphorus fertiliser form	P applied (kg/ha)	Grain yield (kg/ha)	Grain protein (%)	Screenings (%)	Grain P conc. (ug/g)	Seed P levels (ugP)
Control	0	0.75	13.5	16.5	1410	65
Phosphoric acid	20	1.76	11.6	7.0	1830	84
MAP tech grade	10	1.74	11.7	8.0	1610	77
Control	0	0.92	13.1	13.2	1310	62
MAP fertiliser	20	1.63	11.8	9.7	1850	83
Phosphoric acid	10	1.46	12.1	10.0	1650	76
Control	0	0.84	12.8	12.5	1510	65
MAP fertiliser	10	1.28	12.3	10.3	1650	74
MAP tech grade	20	1.50	11.8	11.7	1730	107
Control	0	0.88	12.8	13.1	1450	63



Conclusions

The site was very responsive to phosphorus. The MAP technical grade was the most effective source of P on this site, followed by the phosphoric acid. Both were better than the standard MAP granular fertiliser.

There is potential to further investigate liquid fertilisers and combinations of nutrients on calcareous soils. It will be interesting to follow the developments in South Australia in the next few years.

Other observations

There was a visual response to rates of P with the dissolved MAP appearing the best fertiliser treatment. There was a response to phosphorus with the liquid fertilisers giving more growth than the granular fertiliser MAP.

Maturity was delayed markedly on the nil P plots during October. The high rate of MAP technical grade did not dissolve properly and may have blocked the delivery system leading to an unexpectedly poor result for this treatment.

The high rate of MAP technical grade had much smaller grain than other plots leading to a high seed P content.

Cadiz and repellent sands up north

Rohan Ford, Balla (08) 9933 1045, fax 60

I farm 2,460 ha with my wife Carol and two children at Balla, north east of Geraldton. The soil types are 95% yellow sand and 5% red loam. The average annual rainfall is 310 mm.

Lupins and water repellence

My major farming challenge is non-wetting soils, which has increased in area from 10% of the farm area in 1990 to nearly 80%. Lupins have been grown here for about 25 years and since 1986 the lupins have remained as 50% of the cropping program—and in some years more. All crops were sown with culti-trashes until 1985 when two John Shearer trash culti-drills were used for wheat. Two years later we upgraded to an airseeder and Flexi-coil bar with rotary harrows.

In 1994, we sold all our sheep and continually cropped all the arable acres, as we had to help pay a family member out of the business. Although I had more time to watch the cricket we knew this was not going to be good for two reasons. The tine machine could not handle the stubble in the hollows of the paddocks and the stubble was persisting for 2–3 years causing poor soil seed contact and poor chemical incorporation.

Not wanting to burn stubble, we sold the tine machine and went to a two-way plough. However, it was hard not to promote erosion on the hills. The other problem was to control in-crop weeds on water repellent sands where weeds kept germinating until September.

In 1994, we sold the two-way plough and went back to tines to try the no-till but we had trouble stopping soil disturbance at any speed because the soil had no strength and the tine would just pull the stubble out of the ground, disturbing the soil between the rows. We have carried on using this machine with press wheels for the last five years and had fairly good lupins and wheat emergence. One problem that emerged was the grass weeds getting a head start on the wheat as the seeds lodged in the furrows and germinated with the first rains. We felt that changing machinery again would not solve the problem. Perhaps it would be more profitable to start repairing the soil.

I met Ken Bailey, from Creative Land Management, five years ago. He suggested our soils were dead and needed microbial activity and life injected back into them. He also said we needed to get our nutrients back in balance and we could do this with some low cost inputs. I mentioned this to my fertiliser rep and his response was that he didn't believe that the "Myth and Magic, Mumbo-Jumbo" approach I was going to take would work.

We had been spreading limesand before I met Ken and with the words "myth and magic" still in my mind I thought I would give it a go. We picked a paddock that had failed the previous season. The previous crop was canola with barley, white lupins, blue lupins, bromegrass, radish and any other weed you could think of. After grading it, the canola yielded 200 kg/ha.

In 1999, we spread 400 kg/ha of limesand, 100 kg/ha of dolomite and 100 kg/ha of gypsum and sowed it to Cadiz because of the easy germination factor in the non-wetting soil. We had no sheep to control weeds and we were unsure how well it would grow with the weed competition so we sprayed out the broadleaf weeds and the grass early.

The Cadiz experiment

The paddock size is only 40 ha but big enough to get good results. We had 5 mm of rain in September and ploughed 20 ha of the knee-high Cadiz in as a fallow with a 30-disc hydraulic Shearer one-way plough as we were worried that a two-way plough might bury too much Cadiz and cause the soil to blow. We ploughed deep enough to incorporate 25–50 mm of the yellow soil below that has about 6–8% clay content. I believe with the continuous use of narrow points the clay has been worked out of the topsoil and we have to get it back.

I would like to think that we could retrieve the clay and also the nutrients that are in it. Claying would be a last resort because of the cost, the associated compaction and holes that would have to be filled in. Bill Crabtree visited us in November and was surprised to see that the yellow clay was only 100 mm below the surface. He agreed that, to bring this to the surface and mix it in with the water repellent soil, ploughing was a good option.

In October, we brown manured the other 20 ha with glyphosate and 2,4–D amine. The Cadiz lay flat on the ground and acted like a insulating blanket, only an odd melon grew. On the fallow, weeds that could get the sun germinated well, giving us some hope that that we would get some result with the non-wetting soil. We had over 100 mm of rain in a summer storm in March and still very few weeds germinated under the blanket of Cadiz. It was wet to soil surface six weeks after the storm.

Culti-trash dried wet soil under Cadiz

We realised that the next problem was seeding through a blanket of trash 20–50 mm thick on the brown-manured section. Even the shovel had trouble cutting it. So we cultivated the brown-manured block with a disc three weeks before seeding to be sure the crop seeds would be buried when we sowed it with the Walker cultitrash. It was a bad mistake. As soon as we disturbed the Cadiz the soil dried out more than the fallow right along side. The yields were disappointing—but given the conditions, they were still good.

A thick matt of Cadiz may provide a healthy soil blanket.

Both the brown and green-manured blocks had two fertiliser rates and only one seed rate of 75 kg/ha of Brookton wheat sown on the 25th June. One knockdown and one post-emergent spray, and no other fertiliser. Our overall wheat yield was 1.25 t/ha, with the green manuring yielding slightly better than the brown manured blocks.

Treatment	DAPSC applied (kg/ha)	Grain yield (kg/ha)
Brown manured	50	880
Brown manured	70	950
Green manured	50	960
Green manured	70	1,240

In future, we will try to green-manure the Cadiz because we have had a better result on the non-wetting soil in the 2000 season. I have purchased a single disc opener to sow into the fallow to conserve moisture but will still have problems sowing into the brown manured paddocks if the rain has not allowed us to green manure. We will be running a few cattle to help pay for the Cadiz program.

We are hopeful that the cattle will graze the radish and grass without stopping the growth of the Cadiz too much, allowing us to remove them and to get enough green growth to fallow.

With only 103 mm of rain between April and October, we still had green Cadiz on the 5/12/2000. That meant nutrients and moisture were still coming to the surface, feeding the soil biology for a longer period. It all helps the system.

Wide and deep furrows has failed us

Our current no-tillage package of 23 cm row spacings, working 15 cm deep to create large furrows has failed us. In our water repellent soils, rainfall and with continuous cropping we are finding the weeds are beating us and the herbicides are not effective. This approach has helped the crop emerge—but we need a more robust system.

Brown manuring needs discs

We purchased a Germinator bar last year and this year we have sown our whole program with it. The Cadiz cover has been excellent at retaining moisture and suppressing weeds. My neighbour and I have been surprised at how clean the crop is looking so far. The crop is sown on 19cm row spacings which will also help it compete better with the weeds. The crop is not growing as vigorously as the deep knife point system but I am hopeful that it will finish stronger with the Cadiz releasing N through the year and holding more moisture.

Cadiz is still partially green and just growing at Rohan's farm on 1st December after a very dry spring in 2000.

No-till soil improvements for dry winters

Luke Sprigg, Bonnie Rock (08) 9047 0041

The Sprigg family farm operates a mostly continuous crop program with no-tillage in the north eastern wheatbelt. Since 1994 we've been on a fast learning curve on rotations, weeds, soil fertility and overall no- till management. We have all of the local varieties of soil types—all of which benefit greatly from reduced and no-tillage.

We are continually challenged by the adversity that comes with summer floods and dry winters - which seems to be almost an annual pattern lately. Summer rains have enforced decisive management decisions, requiring good paddock preparation, staff organisation and productivity of machinery. The 200 mm of rain during January and February this year has again shown the benefits of retained summer moisture (as observed on 12th June).

Prompt summer weed control is critical

We began spraying this year in January with a Rogator fitted with GPS Guidance and we sprayed every hectare twice during summer. All the spraying is done at night and on cool mornings. Sulphate of ammonia is used without any extra adjuvants or oils. Summer grasses, like Burr grass and helicopter grass were both killed with only 600 mL/ha of glyphosate when these grasses were seedlings, or flowering. At any other growth stage they were difficult to control, although, we did have some kill success after heavy rains or very heavy dews.

With our good past experiences of dry sowings, and the moisture seeking ability of no-tillage, we were able to sow 2,500 ha in mostly dry soil during April. It is amazing how moisture remains in most of our soils if paddocks have been kept weed free and have some soil structure created by a history of no-tillage. Using this system, much of our crop emerged without any rain since mid-February. In past years, with a tillage-based system we struggled to get crops up on 6 mm of rain.

Seeder choice

No-till seems suitable for all of our soil types and it is also well suited to broadacre management if the correct method and machinery are used. We operate two Flexicoil bars. One is fitted with ConservaPak openers on 12" spacings and the other with DBS openers on 7" spacings followed by a prickle chain. These seeders complement each other well.

The harrowed machine, on the narrow row spacings, is used for any summer cultivation that might be needed on tight, heavily grazed pastured country. It is also used for sowing field peas and hay crops. The ConservaPak seeder seeds through any heavy stubble and is best suited for any dry sowing or moisture seeking that is needed. When the narrow spaced seeder

Left: Luke Spriggs and family.

Right: The ConservaPak on 12" row spacings creates a much better wheat germinating environment (on left) than the 7" row spacing with harrows following.

is fitted with long DBS openers, it can also moisture seek—nearly as well as the ConservaPak openers.

Some farmers feel that press wheels are the magic solution to crop establishment in all moisture years. This has not been my experience for average years, while it has been when the soil is partially dry. In moist soils the harrowed machine establishes crops well, because it almost always ensures good soil coverage.

Soil health and management

No-till taught us to think more about our soils. This lead to a better understanding of soil physics, soil biology and general soil health.

We have experienced crop failures from poor management decisions and have tried several farming compromises. Some of these are from mixing ambitions beyond our capabilities. Like delayed weed control, full stubble retention without coulters and trying to work deeper than the machine is designed for.

The 7" spaced machine has allowed us to bury some stubble—which we thought might be a good thing. However, it also gives uneven germination, lower plant densities, yellow spot, more insect attack and some damage from trifluralin which can be dragged back into the furrow.

Early crop vigour has been excellent this year with the cultivation below the seed. Moisture is brought to the surface by capillary action around the seed.

In this photo, summer weed control was poor. Note also where one point was worn (centre), the crop vigour is decreased compared to the adjacent rows.

The dry year—2000!

In 2000, we had 125 mm of rain during April–October. But with large summer rainfall and minor rain events through May–June it allowed those paddocks, whether sown early or not, to establish okay and grow well—but only if they had suitable preparation.

There are several factors that we believe were important for the success of our crops in 2000. These were, six years of no-till cropping, prompt summer weed control, suitable stubble retention, a reasonable sized furrow (from the ConservaPak) and long moisture seeking openers.

Some observations from the year 2000 include:

- more cultivation equals more radish
- light land still has a severe hard pan
- creating big furrows with the ConservaPak on Wodgil soils was a problem.

On our Wodgil soils, the crop residue is of great help and these soils urgently need lime and potash. Where we did not have choppers on one header we should have removed some stubble before seeding or added coulters to the seeder. It would have been better to have sold our sheep and sprayed the pastures than let pasture grow during autumn and consume good soil moisture.

Conclusion

We are continually encouraged by the benefits of no-till on our soil and its suitability to broadacre management.

A positive result to come from 2000 was that complete no-till management reduced risk and created profit. With soft soil and precise machinery we only need limited rain events for good crop germination opportunities.

Farm profitability and rotation

Gerard O'Brien, Jennacubbine (08) 9623 2228

I farm in the Northam district and have spent 20 years as an agricultural consultant. I have been asked to share my experiences of farm profitability and rotations. I farm in a 425-mm rainfall area on red loams of the Avon Valley with many rocky outcrop areas that cannot be cropped. I also farm some duplex soils and I have been no tilling for several years.

(Editor: Gerard's success of wheat following wheat (or hay) will not hold for farmers on lighter soils or in regions where 'take-all' is more predominant.)

After a difficult year (2000) many might think that returns from farming might not be worth pursuing. However, if you were cashed up, would you now go and buy a farm—and would your accountant suggest you visit a psychiatrist? There is ample evidence from farmers who have a "passion for farming" and are getting good crop yields, to show that farming is a viable and a profitable business activity.

Most businesses are rated by their internal rates of return (IRR). This is the net cash return derived from each season, plus the capital appreciation. On both accounts, farms that are managed in the top 25% of farm business are recording good profits, despite depressed world grain prices. Figures from the BankWest survey from 1999–2000 of 540 individual farm businesses and the Valuer General's Land Value Watch show that land values for all dryland regions in WA are increasing.

BankWest survey of wheatbelt farmers	1998/99	1999/00	Our return 2000/01
Cash return for top 25% of farms	6.1	8.7	9.4
Capital growth during 1987–2000	10.6	10.6	10.6
Average IRR for top 25%	16.7	19.3	20.0
Cash for all WA farm business (%)	0.8	1.6	
Capital growth during 1987–2000	10.6	10.6	
Average IRR for all farm businesses	11.4	12.2	

Would owning a Deli be better?

Accordingly, those farmers that are producing in the top 25% of business are deriving returns that are far better than most other businesses. If farmers were to sell their farms their option would be to purchase a retail business such as a newsagency, fruit and vegetable, deli or video store.

With increased deregulated trading hours and more competition from the supermarkets, these businesses are often struggling to get anything like a 15% return on capital invested and the value of the goodwill is declining rapidly. I have not yet come across a farmer who has sold out and, could if he wished to, and still been financially able to repurchase his farm 5 years later.

Those farmers who are prepared to learn and have the enthusiasm to farm will have profitable businesses. Even after a very tight year, I believe farming is worthwhile.

Five key factors

So, what distinguishes the top 25% of farm businesses from the rest? The answer is well known and can be linked, almost entirely, to crop and sheep yields. The top 25% of farmers are not necessarily working harder, but they are generally more organised and pay attention to 4 or 5 key factors. The critical factors to achieving higher crop yields are timing, nutrition, disease management, grass control and crop rotation.

1. Timing

It is essential that the crop be sown as early as possible—to maximise yield potential. The cost of this is primarily just being organised and having the seeding equipment to penetrate dry soil. This was highlighted in the year 2000, which was dry.

2. Nutrition

The top yielding farmers are applying larger quantities of fertiliser and rates of 80 kg/ha or more of N is now common (equivalent to 100 kg/ha of Microrich plus 140 kg/ha of urea). It is also essential to ensure all other elements are applied at a ratio equal to or above the amount removed by the previous crop. The addition of lime and gypsum are also giving economic results where needed and soil, nutritional balance and pH is critical.

3. Disease

A broad spectrum foliar spray such as Folicur can be worthwhile, however the results are variable and need to be monitored depending on disease levels and varieties.

4. Grass Control

In the legume phase—whether it be lupin, field pea or clover, it is essential that the phase is grass-free. The real benefit from growing canola is the use of 4 litres of Atrazine which guarantees, in most instances, a grass-free crop. The real cost of a pasture is that it is nearly impossible to get it completely grass-free without starving the stock. Therefore most paddocks, on heavy soil types, should be either permanently pasture or permanently cropped.

5. Rotation

The largest single cost of the high yield packages is the opportunity cost foregone of putting a low profit legume into the system. For instance, a normal gross margin from lupin is around $80/ha or less and this year we lost $65/ha from growing peas.

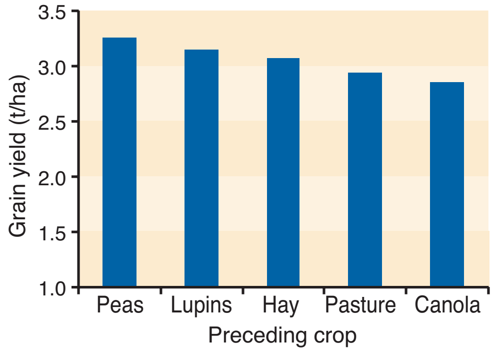
Accordingly, we need to grow an additional 1.8 t/ha from next year's wheat to cover the loss by growing peas and the lost opportunity of growing wheat in 2000. This means that next year's wheat crop will need to average 3.0 t/ha plus 1.8 t/ha of lost income, which is 4.8 t/ha needed to justify growing the peas. With any rotation we must consider the financial returns for each enterprise and not be swept away with just the agronomic benefits.


Gerard's team spraying trifluralin immediately before seeding with a DBS seeder.

Defining benefits and cost of legumes

While each of these above factors are well understood, the most difficult one to assess is the financial benefit of the "Rotation". Therefore, I will focus on our own experience in the following graph.

Adjusted wheat grain yield after which crop



Our experience shows that, over 4 years and across 39 paddock per year (which equates to 156 broad acre trials), that there is only a small wheat yield benefit due to rotations with legumes. However, between seasons the variations are larger. The benefits of rotation vary depending on seasons. In a dry year, a crop like canola that reduces root diseases in the previous year is very beneficial to the next wheat crop. In 2000 the wheat following canola increased wheat grain yield by 12% compared to the 4-year average of a yield loss of 7.1% for wheat following wheat.

To properly understand the reliability of this information we need to collect data from various soil types and over several more years. However, in essence, the results show a large economic benefit from pulses and canola when the paddock is burdened with a high level of weeds and root diseases.

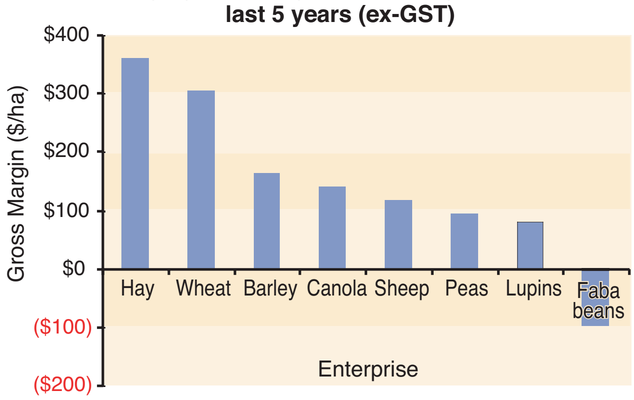
Once weeds and diseases are under control in a rotation, the most profitable option—with current prices—is to grow as much wheat and hay as possible, although, hay also has a large risk potential. Then only use legumes in the rotation when a specific weed or disease problem arises. As farmers, we are rightly advised by agronomists, however, we must review what financial impact such agronomic advice has. The challenge is—to stop and review your program for sustainable profits, not just for rotation reasons.

Hay and wheat can be very profitable

To focus more on the most profitable crops I will use our average of the last 5 years of gross margins. This highlights that wheat and hay remain the most profitable crops and that we should only use oilseed or pulse crops where there is a specific need and we should not just blindly accept that the agronomic benefits of a so-called optimum rotation corresponds with the financial returns.

It is essential we question this practice of rotation, as the cost of some of the legumes cannot be recovered. While we must maintain a sustainable system, we must also not lock ourselves into declining farm profits.

Average gross margin for farming enterprises over last 5 years (ex-GST)



					Return over 4 years	Average annual return ($/ha/year)	Average dollar return over 3,100 ha
Rotation #1	Wheat	Noodles	Hay	Wheat			
Return ($/ha)	305	305	361	305	$1,276	$319	$988,900
Rotation #2	Wheat	Barley	Hay	Wheat			
Return ($/ha)	305	164	361	305	$1,135	$284	$880,000
Rotation #3	Wheat	Lupin	Wheat	Canola			
Return ($/ha)	305	81	325	141	$852	$213	$666,000
Rotation #4	Wheat	Lupin	Wheat	Peas			
Return ($/ha)	305	81	325	95	$806	$201	$624,000

Accordingly, the insertion of a pulse phase reduces the net profits by up to $360,000/yr over a 3,100 ha cropping program. So while pulses and canola crops are necessary, they must be considered in the rotation from both an agronomic and profitability basis.

Take home messages

My experience suggests that you can encourage your children to return to the farm business as there are very good rewards in managing a farm business well. In fact, good farmers can achieve better profits than many other small business operations. Capital appreciation from land values has averaged over 10% since the 1960's thus providing farmers with a good capital return.

Knowledge and motivation will secure farm business success. Don't blindly accept that the best agronomic rotation is also the most profitable. You can dramatically increase your farm profit by understanding the rotational Gross Margins and using them to maximise profitability on your soil type with your specific weed spectrum.

DATES FOR YOUR DIARY

WANTFA
Western Australian No-Tillage Farmers Association (Inc)

Meckering Field Day
Tuesday 18th September 2001

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Tuesday 24th July 2001

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