WANTFA
Western Australian No-Tillage Farmers Association (Inc)

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Newsletter

SUSTAINABLE AND HIGH PRODUCTION AGRICULTURE – NOW!

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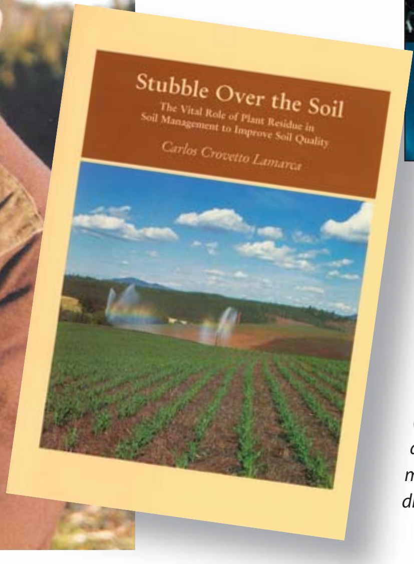
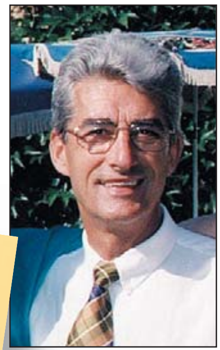
Carlos and Rolf are coming!





Rolf Derpsh from Paraguay.

Carlos Crovetto 's book can be purchased from The Rural Store in Kilmore Victoria on (03) 5782 1118 or fax (03) 57181 0183 for about $80, WANTFA members receive a 10% discount.

WANTFA's 9th Annual Conference will again have exciting, clear thinking and enthusiastic no-till farmers and researchers as speakers.

The dates are: Friday 23rd February at the Esperance Civic Centre, Monday 26th February at Geraldton's Queens Park Theatre and Wednesday 28th February to 1st March at Scarborough's Rendezvous Observation City in Perth. See inside for program details and a special accommodation offer.

Coming from Chile will be Carlos Crovetto, President of Chile's No-Tillage Farmers Association, who helped pioneer no-till in his country and indeed has written an excellent book on what he has learnt. A friend and mentor of Carlos is Rolf Derpsh who has been researching the complexities of no-tillage in Brazil for about 20 years and who now works in Paraguay.

Also speaking, at Perth only, will be dynamic NSW dryland farmer Scott McCalman. Scott spoke at WANTFA's Warm Season Crop Seminars in August. He impressed us with his clear thinking, simple approach to diverse crop rotations and his frugal precision farming system that allows him to manage diseases and herbicide resistant weeds cheaply.

Dry 2000 was a no-till year!

Many farmers have said; "I'm glad I began no-tilling this year".

Many have observed the extra moisture saved from no-till sowing systems. Both the start and the finish to the cropping season were extremely dry in most of WA's wheatbelt. There was no 'break' to the season until mid-June and to add to the problem, many farmers received less than 50 mm of finishing rain (from August to October).

Thanks to the Bureau of Meteorology [© 2000], the table on the next page shows that for many centres it has been the driest May–October growing season rainfall for 20–30 years. For some farmers, particularly those south of the Great Eastern Hwy and east, it has been the driest ever.

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Bill Crabtree, WANTFA's Scientific Officer is funded by:

GRDC
Grains Research & Development Corporation

Agriculture WESTERN AUSTRALIA

Station	Actual Rain (mm)	Avg (mm)	Compared to average (%)	Driest year since	Previous amount (mm)
Grass Patch	116	225	52	ever	120
Ravensthorpe	134	261	51	1940	106
Ongerup	159	260	61	1969	152
Lake Grace	131	242	54	ever	139
Katanning	253	362	70	1982	233
Corrigin	151	273	55	1914	144
Narrogin	277	392	71	1997	266
Merredin	124	228	54	1961	120
Wongan Hills	206	298	69	1994	205
Dalwallinu	183	262	70	1979	144
Morawa	119	240	50	1979	94
Perth Metro	578	748	77	1990	553

Retaining stubble and spraying early weeds (on left) were two of the keys to many farmers' cropping success in 2000.

The crop management package that performed best for most farmers was:

- spraying weeds after January rain
- retaining all stubble
- no pre-seeding cultivation (or tickle)
- creating a furrow that can catch water
- seeding on time and without tillage.

Stubble insulates the soil from moisture loss.These issues are more important than the last five years might suggest. As prior to the 2000 season the wheatbelt has had a series of wetter than average starts to the season. If we return to more average 'breaks' then what we learnt this year could be empowering.

How to control summer weeds?

This year clearly showed the value of summer weed control.

A common strategy many farmers use is to spray weeds early in the morning (from 0400–0800 hours) while weeds are not moisture stressed. David Minkey's Herbirate work, while at AGWEST in Albany, has shown that there can be a 10-fold difference in glyphosate efficacy depending on how moisture stressed the plants are.

WANTFA President Geoffrey Marshall has improved his glyphosate efficacy by spraying high water rates in front of the sprayer's wheels. This settles dust and improves the weed kill in these strips that are otherwise protected by dust. Also, Geoffrey maintains high stubble levels on nearly all paddocks and this ungrazed standing stubble improves overall herbicide efficacy.

The nozzle located in front of the wheel puts out lots of water (has its own reservoir)—but it ensures good weed control in wheel tracks.

Couch grass is spreading

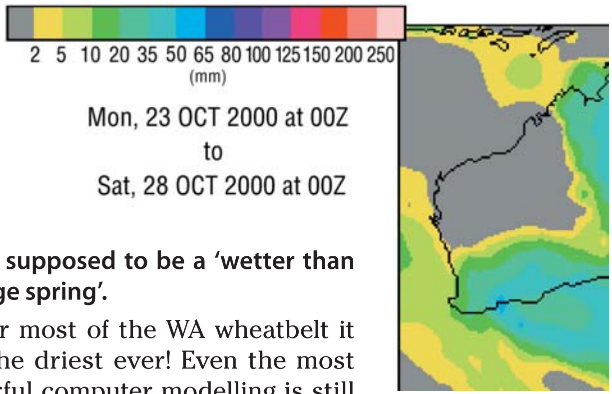
No-tillage helps perennial plants survive the seeding operation.

Knife-point seeding spreads the runners very effectively, while disc seeding does not. If you are using knife-points you may find it worthwhile investing in some plain discs to cut through the runners, as well as through melons and wireweed.

Which subject would you like to discuss?

If you had the opportunity to sit around a table for an hour with 10–30 other farmers from all over the state what would your preferred three subjects be? We hope to introduce this efficient networking technique at the coming Annual Conference. Subjects we could discuss include: specific seeding and harvesting machinery; nitrogen application techniques; specific openers (knifes or discs); herbicide innovations; grain handling and more. Bring your ideas and be ready to participate!

Weather forecasters got it wrong!



Another promising 10-day forecast that yielded only 0.5 mm of rain in Northam. This map was predicted 5 days in advance.

It was supposed to be a 'wetter than average spring'.

Yet for most of the WA wheatbelt it was the driest ever! Even the most powerful computer modelling is still unable to forecast accurately more than a few days in advance. Here is an example of such a prediction—from one of the more accurate web sites.

Kirby modifications

Tom Lewis from Bruce Rock found that increasing the size of the flaps on his Kirby Straw spreader increased its ability to throw stubble further. Tom made the flaps out of sheet

metal.

Bigger metal flaps on the Kirby improved throw with little extra horsepower required.

Hygiene is important!

Laneways, creeks, fencelines and rock heaps are weed opportunities waiting to happen.

If you allow the weeds to grow they will set seed and disperse

Wild oats and other weeds on non-cropped land are a problem waiting to happen for the crop (as weeds) and with herbicide resistance.

into the paddock. If you spray them annually with glyphosate then you risk generating resistance—note Kevin Bligh's warnings in this *Newsletter*.

Perhaps the best option is to grow a crop in these areas and, where possible, harvest it. Remember "weeds are natures way of adding diversity to a system that lacks it!" Perhaps you could lobby your local government to lift the need for firebreaks. Some Council's have done this.

Severe erosion with tillage in South America

Large areas of South America have totally adopted no-tillage. It is easy to see why when you see the amount of water running off this cultivated farm in Paraguay.

Farmer and President of the Paraguay No-Tillage Farmers Association, Erni Schlindwein is excited to see what no-tillage can do for his soil. During a dry season in 1999 Ernie's corn crop went 25–40% more than it would have if he had cultivated.

Left: Erni Schlindwein points to a sticker that shows how severely they view tillage on their erodable soils.

Below: These frequent erosion events were a major incentive to save soils with no-tillage in Paraguay.

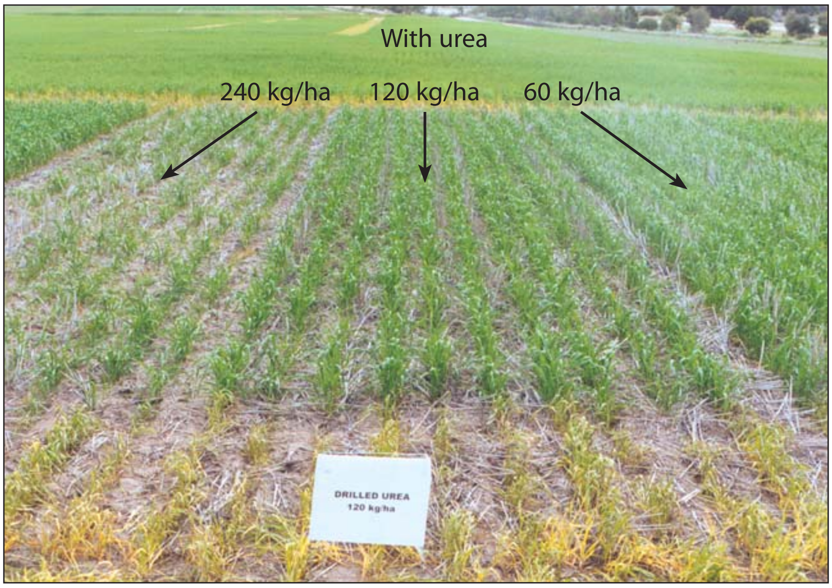
Flexi-N can be toxic—even at low rates!

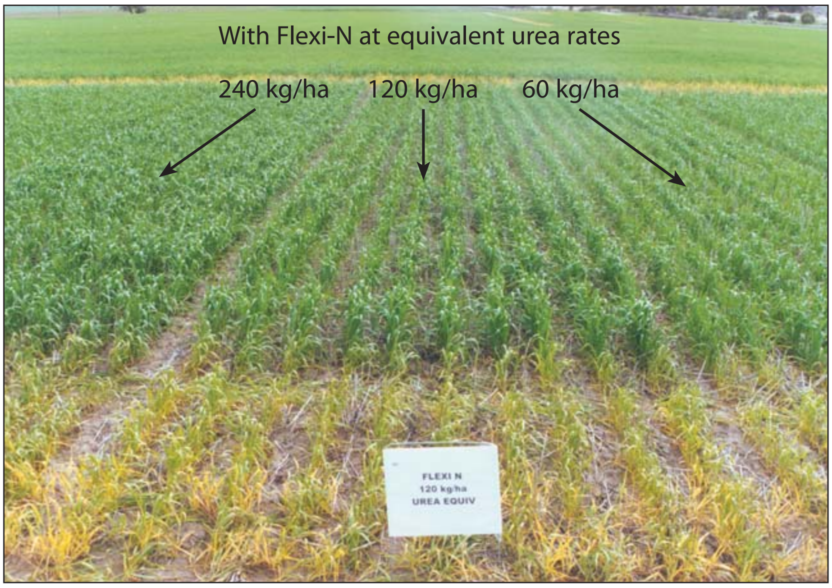
Tom Lewis from Bruce Rock discovered that even 20 units of N could be toxic to wheat in dry conditions if the Flexi-N is placed with the seed.

Tom set up Flexi-N in this year's wheat crop using simple plastic garden equipment. He discovered that row #14 (see photo on next page) gave consistent emergence damage and reduced the grain yield on all paddocks tested. Tom's wheat was planted on 4th June into soil that was dry to about 70 mm depth with some moisture down deeper. The farm received 8 mm in May and 24 mm in June.

In contrast to this, the wheat sown at WANTFA's Meckering R&D trial showed much greater crop safety. The Meckering site had 6 mm of rain the day before seeding and 50 mm in five rainfall events in the subsequent two weeks. The photo on the next page shows how lucky you can be—if regular rain does fall after seeding.

Pick the row No.14 where Tom had 20 units of N placed with the seed.

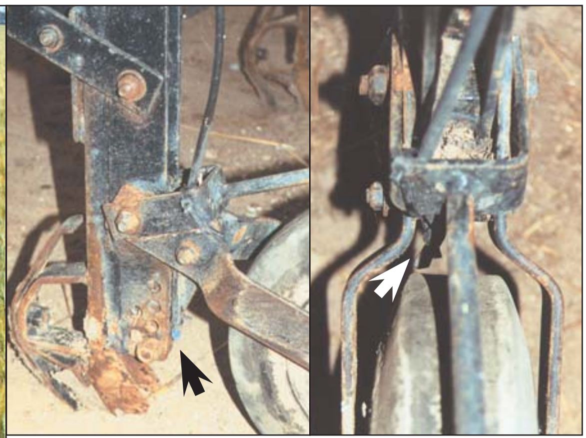




The Meckering trial shows no damage from Flexi-N being dribbled into the furrow, behind the press wheels.

New website passwords

Please note that your WANTFA username and password for the website from 10th December will be: **wantfa** and **no-till**



Tom's DBS had Flexi-N placed to the side of the seed (right), and this was safe compared to the Flexi-N placed (dribbled) with the seed (left).

Dry years and wide rows

Wide rows and no-tillage gives drought resistance —this comment is common among farmers in dry areas.

The photo below, taken near Ongerup in early November, shows that the canola crop grown on the edge of the crop is much healthier than the whole crop. Who knows how much extra crop yield could be gained in droughts by using 0.5 to 1.0 metre wide rows with canola and lupins in dry seasons?

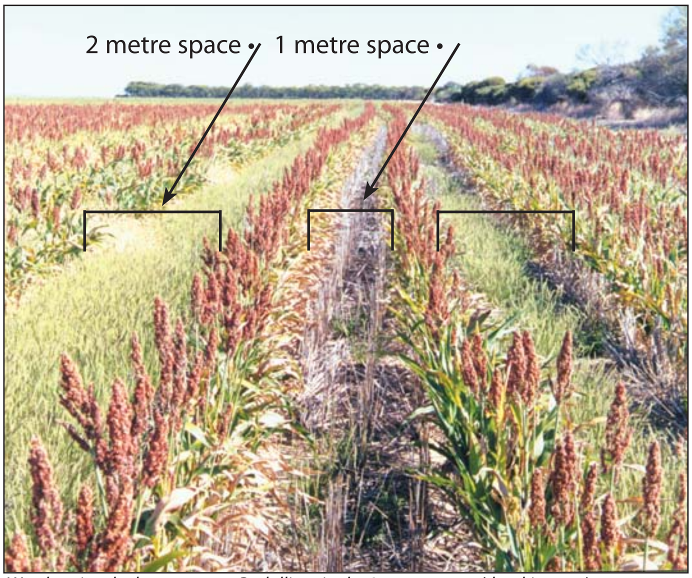
The outside row extracts moisture from the adjacent bare ground to produce a healthy row.

Some might say, 'the space allows weeds to flourish in the wide gap, particularly in wet years'. NSW farmer Scott McCalman's approach to these weeds is to spray them with glyphosate or SpraySeed. Scott will speak on this and other innovative ideas at the coming WANTFA Annual Conference in Perth. You can also read some of his thoughts in his article in this *Newsletter*. Scott has also observed that lupins get less disease in wide rows and they pod up better. AGWEST's Mike Collins and Paul Blackwell are also researching this approach.

Skip rows and weeds

The large January rains this year showed the weakness of wide rows in warm season crops (skip rows) to control or compete with germinating weeds.

Where there were 1m gaps between sorghum rows on Toll Temby's farm at Bodallin, there were few weeds. However, when the gap was widened to 2 m, the weeds grew vigorously. This highlights the need for spraying up these rows with an affordable non-selective herbicide.



Weeds enjoy the large gaps at Bodallin—in the 2m space gap (the skip rows).

Reducing canola harvest losses

Doug Harrington's article in the January 2000 *WANTFA Newsletter* talked of canola seed loss at harvest.

Doug talked of ways to reduce the amount being thrown out the back of his "Coke Can"**—**phone 9881 1496 for details. With further refinement, Doug and other farmers have greatly reduced these losses.

Above: Lots of canola seed germinating after January rains at Narembeen—demonstrating the harvest loss.

Below: Farmer designed plate (right) sits above the concave (left) and reduces canola seed loss.

Ants at Gairdner

Farmers who have been no tilling for several years often notice increased ant activity in their paddocks.

Ants enjoy the abundant food source that is left on the soils surface, particularly weed seeds. Here below, is an anthill observed at canola swathing time.

Ric Swarbrick regularly shaves the tops off his ant nests at harvest time.

Updated WANTFA web site

Matt Beckett, WANTFA Scientific Officer, Northam

Have you visited WANTFA's website recently-or at all? The site has been operating for over a year, but has recently had a face-lift.

The site has four main purposes; as a resource for current WANTFA members, to advertise and promote the benefits of WANTFA membership to non-members, to promote no-till agricultural practices in general, and to create an international presence and link.

The site has had many international visitors with some people browsing it for periods of an hour or so. For more information on the web site and 'who it reaches' see our webmaster Graham Langley's article in the *Topical* Section.

We are constantly looking to find ways to improve and expand our website, particularly as a resource to members. Please email Matt Beckett with any suggestions you have to matt.beckett@wantfa.com.au. Constructive comments would be most appreciated!

WANTFA's website gets around

Graham & Valda Langley, Stylus Design
(08) 9279 4847, stylus@p085.aone.net.au

October saw a new look for WANTFA's website, with a new home page and navigation bar and a larger screen viewing area to accommodate newer, larger computer screens. Over 123 individual pages were changed to the new format.

If you haven't visited the website recently, you may also notice some changes to the way it is organised. More pages are now available to the public, including links to other websites. Only *Newsletter*, *Conferences* and *Ask Dr Dirt* remain in the password-protected member's area.

Your member's area is accessed by typing a password and username into the dialogue box which appears when you click on any member's button. As of December 10, the new passwords will be: Username: **wantfa** and Password: **no-till**. Remember, don't use capital letters.

Something for everyone

A "Crop Info" button has been added for research information. At present, Crop Information contains a series of Crop Management Summaries thanks to Angie Roe of FarmFocus Consultants. You can download these and view them in Adobe Acrobat format. We will expand this area to include research results from Meckering.

For those wishing to become members, an application form can now be filled out online and clicking on any WANTFA logo will show users how to contact WANTFA.

Following each *Newsletter*, we continue to publish the current issue on the web. The short front page articles, known as *News in Brief*, are made available to the public to show what an active association WANTFA is—and to encourage more people to become members. The complete *Newsletter* is available in the Member's area along with recent issues.

Above: The new navigation bar.

Potential *Newsletter* advertisers can now view all of the information they need about placing ads—making the website useful to a wider group of people.

Who visits www.wantfa.com.au?

We can gather a fair amount of information about how the website is being used. For example, there were 1,431 visitors to the website between 19 July and 31 October. Referrals from search engines came most often from Yahoo (50%), Lycos (33%) and Altavista (16%).

In October, the website had 613 visitors—people who stayed to look at several pages—not 'web surfers' or random 'hits' (there were 15,184 of those). The most popular pages were *News in Brief* and *Press Releases*. Some 30% of visitors looked at 5 or more pages. Some stayed for minutes, some for up to an hour. Most people went back to the Home page before they left the site and, interestingly, many of these also tried to access the member's area. Maybe some of them will join up as a result!

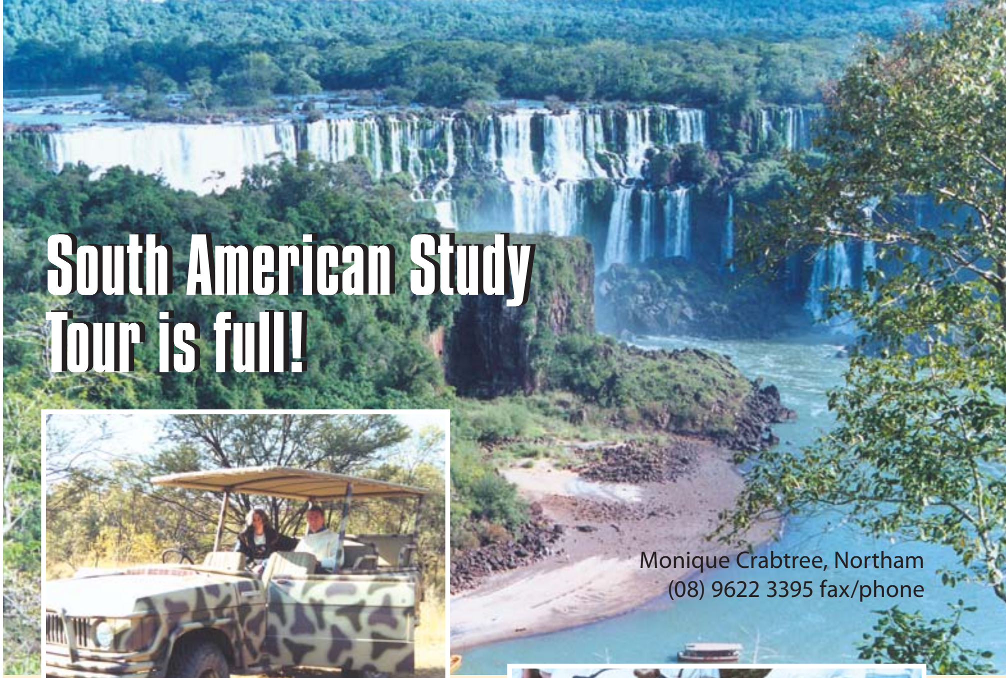
In one month, the site had 124 visits from Georgia in the USA, 21 from Massachusetts, 19 from California 13 from Virginia, 14 from the UK and 14 from Japan, which seems to indicate that No-Till is a popular international topic. Nearly 30% of October's traffic came from North America.

Geographic Network Location	Total for Period
Australia	340
Georgia, USA	130
Massachusetts, USA	85
California, USA	55
South Carolina, USA	45
Japan	27
Virginia, USA	22
Netherlands	18
Czech Rep.	17
Hong Kong	16
United Kingdom	16
China	4
New Zealand	2
South Africa	2
Saskatchewan, Can.	2
Viet Nam	1
Taiwan	1
Pennsylvania, USA	1

This list shows some of the many visitors from various geographic locations recorded between July 19th and October 20th.

In one week, 26 people visited from universities in Perth and Adelaide. This supports the idea that the website is being used for research—one of its original aims.

So, as you can see, the website is being used and is getting increasingly popular as it gets more widely known. Perhaps it's time you had another look?



South American Study Tour is full!

Monique Crabtree, Northam
(08) 9622 3395 fax/phone

We have had nearly 50 expressions of interest in the August 2001 Study Tour.

However, you are welcome to add your name to the waiting list. Those who are registered should have received more detailed information during mid-November. Others are welcome to request this further information—just fax me on (08) 9622 3395.

Glyphosate-resistant ryegrass

Kevin Bligh (Committee-member) Ph. 97557589

Annual ryegrass is reported to have developed resistance to glyphosate at "about" six sites, by Professor Stephen Powles, Director of the WA Herbicide Resistance Initiative (in "Australian Grain" April–May 2000, Pages 10–11).

One was discovered in 1995 and one in 1997, (see the April '98 *WANTFA Newsletter*, page 171). So far, none have been reported in WA.

One question that may be asked is: "Can Western Australia be far behind?" Another question more relevant to sustainable grain-growing is: "What is the future of no-till sowing with glyphosate-resistant ryegrass?"

Professor Powles states simulation modelling suggests that ryegrass may mutate to tolerate glyphosate after about fifteen applications without a second knock to eliminate survivors. And that the double knock of SpraySeed following glyphosate, reduces the chance of glyphosate resistance developing to near zero.

When everything is going well with herbicidal weed control, get your back-up strategy ready, because you'll probably need it!

Many Western Australian landholders have sprayed glyphosate on firebreaks, fence-lines, banks and other spare areas as well as cropped land since the 1980s. Therefore it is possible that the recent rapid increase in glyphosate resistant-ryegrass occurrences in the Eastern States, may also occur in here.

Agriculture Canada weed agronomist Dr Doug Derksen (who spoke at WANTFA's 1999 Annual Conference and Seminars) has said for many years: "When everything is going well with herbicidal weed control, get your back-up strategy ready, because you'll probably need it!"

Is there a back-up strategy for glyphosate resistance with no-till?

What can we do about It?

Perhaps the most important thing we can do about it now, is to minimise chances of glyphosate resistance developing in the first place. If Professor Powles is right, a double knock may need to be considered practically every time glyphosate is applied.

It may not always be easy to apply a double knock, particularly when a poison as personally hazardous as SpraySeed is the second knock.

For example, because fence-lines and rock-heaps are frequently sprayed using four-wheel motor bikes, a trailed rather than on-board boom may be required, in order to reduce the amount of spray drift to the operator.

Alternatively, the Immediate Past President of the World Weed Science Society, Israeli Professor Jonny Gressel suggests buying time, by applying high rates of glyphosate after about every two years of low rates. Such a strategy requires that a more permanent solution be found in the long term.

In any event, **all** landholders must take preventative measures, in order to avoid glyphosate-resistance occurring in a district. Many hobby farmers and road and rail authorities, etc. regularly apply glyphosate alone. Some may be blissfully unaware of the threat resistance poses to commercial cropping.

Clearly **all** landholders must be made aware of the threat, if they are to have an immediate incentive to modify any relaxed glyphosate spraying behaviour.

What would the loss of No-Till mean?

One effect of having to return to direct-drilling (that is, a second tillage knock at sowing) would be to make the soil much more vulnerable to wind and water erosion, structural degradation and reduced soil microorganism activity and numbers.

As the Chairman of the Western Australian Soil and Land Conservation Council, Rex Edmondson of Jerramungup said in 1992: "You can minimise wind erosion with direct-drilling, but it's so easy with no-till!"

Water erosion under no-till is considered to approximate estimated soil formation rates. Not even closely-spaced contour banks sufficiently reduce direct-drill erosion.

For example, direct-drilling reduced rainfall infiltration from 96% under no-till, to less than 86% near Beverley in 1983. And soil loss was thirty-five times greater following the first tillage operations for eight years, between contour grade banks spaced only 50m apart near Geraldton!

If earthworms are considered an indication of soil health, both numbers and size of earthworms decrease with direct-drilling—

and are reduced to near survival levels with multiple tillage.

If the use of SpraySeed alone, or other herbicides with knock-down effects, increases with glyphosate resistance, how long will it be until resistance to those herbicides also sets in? SpraySeed-resistant barley grass, silver grass and cape weed have so far been reported in the Eastern States.

If direct-drilling also becomes impossible, delayed sowing with multiple tillage would reduce both yields and profitability in many areas. Can grain-growing today afford to forego the economic and ecological benefits of no-till?

And what of the future?

Wider rotations including warm-season crops allow a greater range of herbicides to be used, diluting chances of resistance developing to any one. WANTFA is currently endeavouring to obtain data on wider rotations.

It will surely be harder to get into wider rotations if glyphosate can't be used as a knock-down, because of resistant ryegrass. Therefore it is well worth preserving glyphosate as an effective herbicide for as long as possible.

Wouldn't it be nice to get down to only having to apply glyphosate about every second year, as Jill Clapperton of Agriculture Canada reported some Canadian farmers are doing, at the time of WANTFA's last Annual Conference?

To do nothing on the reasoning that glyphosate resistance is inevitable, would be like an armchair Cold War warrior I once heard saying, before the break-down of the Soviet Union: "We know the world's going to end sometime anyway! So, what the hell! Let's nuke 'em and be nuked!"

Classic nutrient deficiency

Bill Crabtree, WANTFA Scientific Officer, Northam (08) 9622 3395

With many fertiliser reps making claims about the expression of classic nutrient deficiencies in crops, it seems prudent to publish some work from 1983, 1986 and 1991 that shows the effects of various nutrient deficiencies.

This excellent and recently re-published series is by Kevin Snowball and Alan Robson and has clear photos of nutrient deficient plants. The plants were grown hydroponically (in water) with all nutrients except the one in question.

The series is titled "Symptoms of nutrient deficiencies in..." a) wheat and sub-clover, b) lupins and c) faba beans and field peas". Each book has almost every nutrient tested and has clear coloured photos taken with a black background. The books also contains diagrams, critical nutrient levels and tables, they are about 80–100 pages long and average a large colour photo per page.

The books can be purchased for $16.50 each from the Department of Soil Science, Faculty of Agriculture, University of Western Australia, Nedlands, phone (08) 9380 2503 or 04. With the permission of the Department, WANTFA will reproduce some of their photos in following *Newsletters* in response to requests from farmers.

When looking at these photos, remember that if two nutrient deficiencies occur together then a different expression symptom may occur. Or if some other constraint also occurs, like frost or herbicide damage, the symptoms may be a bit different. Therefore, remember that these photos are showing 'classic' nutrient deficiencies and experience in the field may be somewhat different.

To confuse matters more, plant age also influences the deficiency symptom. Below is magnesium deficiency in faba beans at different ages.

1. *Early symptoms of magnesium deficiency in young leaf and very new leaf (right) of faba beans.*
2. *Magnesium deficient (right) and magnesium adequate middle faba bean leaf.*
3. *Magnesium deficient (right) and magnesium adequate old leaf of faba bean.*
4. *Typical red colouration of the necrosis in magnesium deficient leaves– including new leaves.*

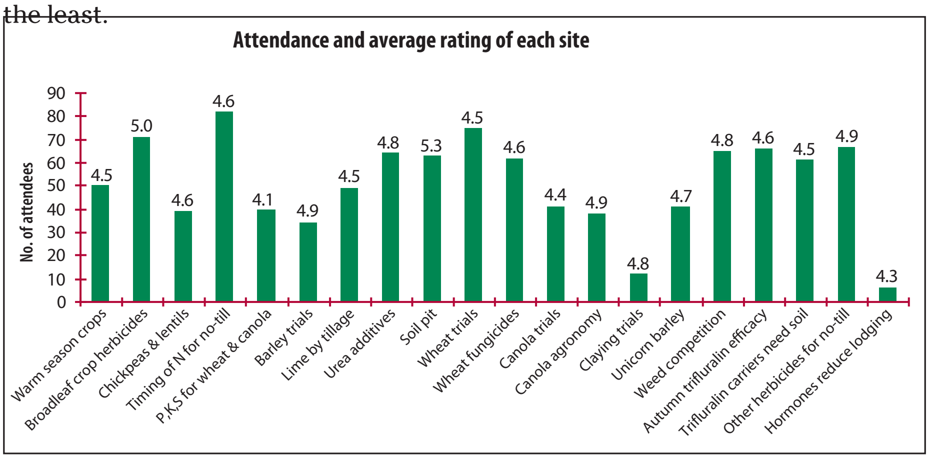
Applause for Meckering Field Day

Matt Beckett, WANTFA Scientific Officer, Northam (08) 9622 3395

350 people attended the inaugural WANTFA Meckering R&D 2000 Field Day on the 26th September and we are pleased to say that those who attended agreed that it was a success.

According to the 120 people that completed their response forms, we had an average rating of 5.2 out of 6 (with 6 being excellent). The response form asked attendees to rate many aspects of the day, including which sites they visited. The following graph shows the average rating of each site as well as the number of people who visited it. The overall average rating was 4.7.

The soil pit clearly rated the highest where Prof. Bob Gilkes showed farmers which soil and root depth characteristics to consider when cropping. The broadleaf herbicide trial also rated well (see above) . It demonstrated the impact of various herbicides and the timing of their application across a range of broadleaf pastures and crops. The site "Timing of applied N for no-tilled wheat" had the greatest number of people attend, whilst the site "Hormones reduce lodging in Barley" had the least.



According to the survey, aspects of the field day that could be improved were:

- more details in the "booklet" with more space to make comments, and
- more time spent at some sites.

Increasing the time spent at some sites could be difficult to do without lengthening the day, or reducing the total number of sites.

People considered that the most successful form of advertising was the *WANTFA Newsletter* and mail-out, followed by word-of-mouth and then the *Farm Weekly*. We also advertised the day on ABC Radio and had signs and flags at the site. Several people suggested that we do earlier widescale advertising. There were also many suggestions for possible future trials. These will be considered for inclusion in next year's Field Day.

Please note that the responses received cannot be directly linked to the performance of the speakers, but reflect the value to the respondant of the information presented, including aspects of the trials themselves (such as their visual impact).

WANTFA would like to thank all the speakers, organisers and the Diamond Sponsors, being: GRDC, CSBP futurefarm, Commonwealth Bank and Agriculture WA. Thanks also to our other sponsors (4 Farmers, Nufarm, Aventis, Aglime, Hollett brothers, the Meckering Crop Research Group, FarmFocus Consultants and Valaw Clay Spreading Contractors) for their help in making the day a great success.

New residue manager has good promise!

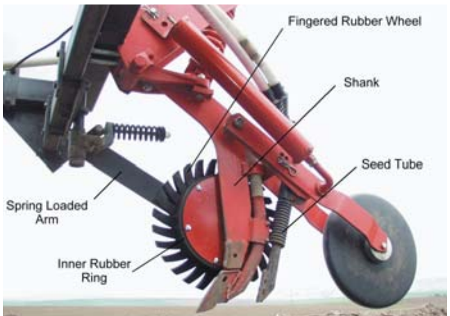
Mark Siemens, MarkC.Siemens@orst.edu
and Bill Crabtree

(Editor: While in Oregon earlier this year, Geoffrey Marshall and I saw this potentially exciting new residue manager for tined seeders.)

The Pacific Northwest (four States in the northwest of USA) lags the rest of the United States in no-till adoption.

One reason for this is the lack of trouble-free, reliable seeding equipment for planting into the heavy stubble residue. To overcome this problem, Mark Siemens, Robert Correa and Dale Wilkins (USDA-ARS, Pendleton, Oregon) invented an attachment that would allow a hoe-type (tined) no-till drill to handle more residue and improve seeder performance.

The residue manager wheel works by effectively pinning the straw to the soil surface at about 1 cm distance from the opener, while the opener cuts through the stubble and soil. If the stubble does build up the mechanism will trip-out, letting go of the bunch. A useful analogy for the fingered rubber wheel is that it is like a 'flat tyre', that when subjected to a vertical load, provides a larger surface area to pin down and help 'walk through' residue. The unit also reduces soil throw and cost about $US300 each.



The soft rubber wheel on the manager squashes the stubble down while the opener continues through the held straw.

The residue manager was tested in late 1999 and early 2000 at several locations. A ConservaPak seeder unit, with a residue manager attached, was used to sow canola, wheat, flax, barley and lupins into differing amounts and types of residue. The previous crop had been harvested with either chaff spreaders, straw choppers or neither, or was just stripped. In some trials, the standing residue was then flail or rotary mowed.

Residue ranged from 2–9 t/ha and the residue managers increased seedling counts by 44–53% in canola, 41% in mustard, 24% in spring barley, 9% with lupins and 15-20% with wheat. These responses were greatest where residue had been spread over the soil's surface and least when stubble was left standing. Grain yield increases also occurred in these studies, with canola up 5–22%, mustard 5%, lupin 0–15%, winter wheat by 0–16%, and spring barley by 3%.

The relevance of soil cation exchange capacity

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(Editor: Earlier this year, I discovered that South African agronomists are taught at University that it is important to consider the ratios of soil cations. For many years Hans Schoof and other visiting American agronomists have been suggesting similarly. I recently met HF [the author of this article] in Northam, where he is now based, and have enjoyed many conversations with him on this topic. He has a Masters in Science on nutrition and he can clearly explain why it is important to consider Cation Exchange Capacity and Percent Base Saturation as a basis for fertilising and liming soils.)

According to Mengel (1999) soils can be thought of as warehouses for plant nutrients. Many nutrients, such as calcium (Ca) and magnesium (Mg), may be supplied to plants solely from reserves held in the soil.

Both are macronutrients and are required in significant levels by all plants. Due to cultivation, continuous cropping, higher yields and making use of high concentration fertilisers, that might contain marginally Ca or Mg, the time arrived to look at the availability of these nutrients and their influence on soil structure and other elements. Elements like N, P and K are regularly added to soils as fertiliser. The relative ability of soils to store one particular group of nutrients, the cations (positively charged elements), is referred to as cation exchange capacity (CEC).

Soils are composed of a mixture of sand, silt, clay and organic matter. Both the clay and organic matter particles have a net negative charge. Thus, these negatively charged soil particles would attract and hold positively charged particles, much like the opposite poles of a magnet attract each other. By the same token, they will repel other negatively charged particles, as like poles of a magnet repel each other. Any element with a positive charge is called a cation and in this case, it refers to the basic cations, calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^{+}) and sodium (Na^{+}) and the acidic cations, hydrogen (H^{+}) and aluminium (Al^{+++}). Notice that some cations have more than one positive charge (Mengel and Kirkby, 1987).

Base saturation

The percent base saturation tells what percent of the exchange sites are occupied by the basic cations. If calcium has a base saturation value of 65% then 65% of the negative charges on the soil particle are occupied by calcium. If all the exchangeable bases (Ca, Mg, K and Na) total 100% of the CEC, then there is no exchangeable acidity. The acidity on a soil analysis report is the amount of negative charges on the soil particle occupied by the acidic cations (H and Al).

The concept of base saturation is important in more than one way:

- The relative proportion of acids and bases on the exchange sites determines a soil's pH. As the number of Ca and Mg ions decrease and the number of H and Al ions increase, the pH drops. Adding lime, limestone or dolomite, replaces the acidic H and Al cations with basic Ca and Mg cations in the soils exchange sites, which increases pH. Beukes discovered a significant increase in yield of wheat where calcitic lime was added to a sandy soil with an acid saturation of 23% and a Ca and Mg base saturation of 62%. The addition of lime increased the Ca and Mg base saturation to 75 % and reduced the acid saturation to 12% resulting in a pH change from 4.2 to 5.3 (KCl). *(Editor: The change in pH alone could have been the reason for the improved yield.)*
- The values and/or ratio between Ca and Mg determine the type of lime to use. Low Mg values and/or ratios—Dolomite. Using the wrong type of lime can be the reason for adequate amounts of nutrients becoming inadequate. Eckert and Mclean (1981) found that this is the case when Ca/Mg ratios were widely out of balance. A Ca deficiency was found from treatments where soil Mg was too high (16%) relative to soil Ca (22%), or in the case of some pH 7 treatments where soil Ca was high (75%) relative to soil Mg (4.4%).
- Soil structure is influenced by base saturation, due to the flocculation ability of Ca. It is important that Ca occupies an adequate amount of negative charges on the soil particle. A low percent Ca will cause an excess of Mg and/or Na on the exchange site and this could result in soil dispersion, poor water infiltration and crust forming. This leads to a lack of aeration in the soil and the decline of biological activities. If the Mg percentage and value is too high the soil become sticky.
- Antagonistic and synergistic relationships among nutrients (Bear and Toth, 1945).

Causes of nutrient element deficiency or excess

The causes of nutrient element deficiency or excess are many and varied, for instance:

a) An inadequate supply of one or more nutrients.

b) Continuous nutrient withdrawals without corresponding replacement.

c) Leaching or retention of nutrient elements.

d) Unbalanced fertiliser application.

e) Applying the wrong type of lime (Ca and Mg value and/or ratio in soil)

f) Applying gypsum in the wrong situation.

The interactions between these factors can be complex. Elements can interfere with the absorption of other elements and have a negative influence on the soil structure/condition that lead to a loss in yield.

Therefore, before taking the economical step of buying fertiliser and soil ameliorates it is important to look more thoroughly at the chemical status of your top and sub soils. The more information you have the better you can make decisions and the easier you can solve problems. All the chemical decisions you make concerning the soil, fertilising and liming, is build around the cation exchange capacity.

(Editor: If the readership is keen, I will request a second article that substantiates the suggestion that Ca and Mg need to be in a certain ratio. This is also is being tested at the Meckering R&D site—this 2000 year being a set-up year.)

Information sources:

Bear, F.E. and S.J. Toth. 1945. *Influence of Calcium on availability of other soil cations.* N.J. Agr. Exp. Sta., Rugters Univ., Dept. of Soils.

Beukes, D.J. 1995. *Benefits from identifying and correcting Soil Acidity in Agriculture.*

Eckert, D.J. and E.O. McLean. 1981. *Basic Cation Saturation Ratios as a Basis for Fertilising and Liming Agronomic Crops.* J. Art. 89–80 of the Ohio Agric. Res.

Liebhardt, W.C. 1981. *The basic cation saturation concept and lime and potassium recommendations on Delaware's Coastal Plain Soils.* Delaware Agric. Exp. Stn. As Misc. Paper no. 936

McLean, E.O. and M.D. Carbonell. 1972. *Calcium, Magnesium and Potassium saturation ratios in two soils and their effects upon yields and nutrient contents of German Millet and Alfalfa.* J. Art. 62–71 Soil Sci. Soc. Amer.

Mengel, D.B. 1999. *Fundamentals of Soil Cation Exchange Capacity (CEC).*

Mengel, E.A. and E.A. Kirkby. 1987. *Principles of plant nutrition.*

Schack-Kirchner, H. and E.E. Hildebrand. 1996. *Changes in soil structure and aeration due to liming and acid irrigation.* Inst. for Soil Sci. and Forest Nut., Albert-Ludwigs Univ. D-79085

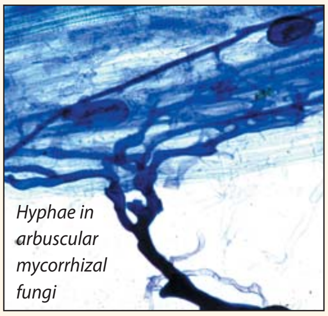
Soils are alive!

A/Prof Lyn Abbott,
Soil Science and Plant Nutrition, UWA (08) 9380 2503

Our regular Soil Biology segment continues…

AMs & VAMs – unseen plant helpers

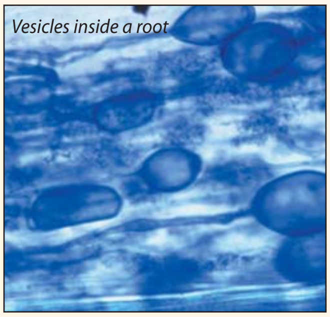
What are arbuscular mycorrhizas?



Hyphae in arbuscular mycorrhizal fungi

Arbuscular mycorrhizas are specific types of fungi that attach themselves to roots and explore the surrounding soil. These fungi have thin threadlike structures, called hyphae (pronounced 'high-fee'), which are 1–10 µm in width. The hyphae form networks between neighbouring soil particles, between roots and soil particles, between roots on the same plant, between roots of different plants (even different types of plants) and inside the roots. Arbuscular mycorrhizal (AM) fungi occur in all soils and are an integral component of a healthy soil.

There are about 4–8 different types of AM fungi in soils in south-western Australia, but the number in one soil can be greater in other parts of the world. These fungi have often been referred to as vesicular arbuscular mycorrhizal (VAM) fungi but we use AM because not all of the fungi form vesicles.



Vesicles inside a root

The name of AM fungi refers to the specific structure called an "arbuscule" inside a cell of the root. Arbuscules are finely branched hyphae. Some of these fungi also form structures called 'vesicles' within the roots. Vesicles store energy for the fungus as lipid. Although some soil fungi can be associated with plant and animal disease, the fungi that form arbuscular mycorrhizas belong to a group of soil fungi that can be very beneficial.

The name "mycorrhiza" means "fungus root" and this is derived from the close association of the fungi with plant roots. In fact, AM fungi cannot complete their life cycle unless they are connected to a plant root. Therefore, it is not possible to grow these fungi to any great extent without the support of the plant. The reasons for this are still largely unknown.

Mycorrhizal fungi get their carbohydrate (energy) from the plant root they are connected to and they usually transfer phosphorus from the soil into the root. Most types of plants form mycorrhizas of one kind or another, and indeed, most agricultural plants form arbuscular mycorrhizas. However, there are important agricultural plants that do not form arbuscular mycorrhizas such as canola and lupin.

What do mycorrhizas do in farming systems?

Arbuscular mycorrhizas are most important in soils that are not fertilised excessively with phosphorus. The association is particularly important for phosphate uptake because phosphorus does not move through soil towards plant roots easily. Some nutrients (like nitrogen) are carried towards roots in water in soil but phosphorus is not like this. Therefore, it is necessary for roots to intercept the phosphorus in the soil before it can be taken up into the plant. The result is that the fungi extend the volume of soil that can be explored by the plant for phosphorus. Thus, plants that have well-developed mycorrhizas on their root systems can take up more phosphorus than plants with none or only small amounts of mycorrhizas in soils that are not oversupplied with phosphorus.

It is often stated that mycorrhizas only have a benefit in soils that are very deficient in phosphorus, but this is not so. Mycorrhizas have a benefit even when the quantity of phosphorus available in the soil is close to the level that is required for maximum plant growth. However, under such conditions, the observable benefit is less noticeable because phosphorus would be already in plentiful supply. When soil is extremely deficient in phosphorus for plant growth, the benefit of mycorrhizas is also less obvious because there is little phosphorus available. More obvious effects of arbuscular mycorrhizas on the plant are therefore usually observed in between these two extremes of phosphorus supply.

How are arbuscular mycorrhizas affected by farming practices?

The proportion of roots of a wheat plant that are colonised by AM fungi is usually less than for legumes (such as subterranean clover or other clover species). However, the actual length of roots of wheat that are mycorrhizal can be a lot greater than that of legumes because wheat has a longer root system. Furthermore, the roots that form arbuscular mycorrhizas are generally the shallower roots. When phosphorus is added to soil, the proportion of the whole root system colonised by mycorrhizal fungi can be reduced but the actual length of root colonised may not be affected to such an extent (see Table 1).

In this study, supported by GRDC, the addition of phosphorus had a greater effect on mycorrhizas in the Wongan Hills soil than in the Katanning soil. The Katanning soil was less P-deficient for these plants than the Wongan Hills soil.

know that not all of the fungi function in an effective manner under controlled glasshouse conditions, we have little knowledge of how particular fungi are distributed in agricultural soils. It is therefore extremely difficult to work out whether mycorrhizal fungi are beneficial

Table 1

Arbuscular mycorrhizas formed on wheat and subterranean clover in two agricultural soils with addition of three levels of phosphorus (P0 to P3) in a glasshouse bioassay. The length of root colonised by mycorrhizal fungi (m/3 kg soil) and the percentage of the root system colonised (%) were estimated.

	Katanning*			Wongan Hills*		
	P0	P1	P2	P0	P1	P2
Mycorrhizas in wheat						
Length of root with mycorrhizas (m/3 kg soil)	73	65	72	47	61	56
Percentage of root system colonised by mycorrhizal fungi (%)	36	34	24	46	22	17
Mycorrhizas in subterranean clover						
Length of root with mycorrhizas (m/3 kg soil)	36	33	57	17	35	32
Percentage of root system colonised by mycorrhizal fungi (%)	39	42	45	61	54	13

In Western Australia, the common cropping rotations that include wheat, lupin and canola all discourage the formation of arbuscular mycorrhizas to various degrees. The effect of wheat is probably not directly related to the wheat itself, but rather to the high level of application of phosphate fertiliser that is commonly used. In other studies in Western Australia, wheat grown after lupin and canola (both of which are non-mycorrhizal plants) had much less mycorrhiza development than wheat grown after pasture.

Use of herbicides do not generally have a major effect on mycorrhiza formation, although, mycorrhiza formation can be reduced in soils if residual herbicides affect root growth. The specific effects of herbicides used in Western Australia on AM fungi are not well studied. Unfortunately, it has been difficult to identify effects of agricultural practices (including herbicides and tillage treatments) on mycorrhizas because agricultural soils have often received levels of application of phosphate fertiliser that are detrimental to these fungi.

Are we making the most of them?

The network of hyphae of AM fungi in soil contributes to soil aggregation. Therefore, the fungi are valuable in improving the physical characteristics of the soil as well as increasing the efficiency in the way that phosphorus is used. Some of these fungi produce much more hyphae in soil than do others, thereby influencing the extent to which they contribute to soil aggregation or to the exploration of soil for phosphorus uptake.

Even if arbuscular mycorrhizas are present in roots, we cannot be sure that they are functioning in a beneficial way. Although we

or not in a particular paddock. Recent studies in south-western Australia by Professor Jim Graham from Florida, funded by GRDC, demonstrated that some AM fungi have the potential to reduce wheat growth even when there is a high level of available phosphorus in the soil. In this glasshouse study, the reason for this effect was not identified. It is not yet known whether this occurs in the field.

Generally, it is expected that arbuscular mycorrhizas are likely to be less effective in soils that have received consistently high levels of application of phosphorus, although soil type also has an effect. Their contribution to phosphate uptake of wheat under field conditions cannot be estimated simply be recording their occurrence and abundance in roots. In addition, AM fungi may be more active at particular times during the year. In order to estimate the contribution AM fungi make to phosphorus uptake, it is necessary to compare phosphorus uptake in the presence and absence of mycorrhizas. However, this is almost impossible to do in the field because the fungi cannot be removed from the soil without changing the soil in other ways. Sophisticated experimental methods for estimating the activity of hyphae are available, but they are very time consuming.

As AM fungi occur naturally in all ecosystems, it is essential to understand how to make the most of them. Generally, the inclusion of pastures in crop rotations has the greatest chance of retaining these fungi as an integral living component of the soil. However, as they do not all function effectively, there remains a lot to learn about the contributions they make to soil biological fertility. It is expected that if phosphate fertiliser is managed appropriately, arbuscular mycorrhizas will play a more beneficial role in both the physical and chemical fertility of soil.

Green manuring in Victoria

Rob Norton, Kate McCormick and Mark Jasper, Longerenong College, The University of Melbourne.

Rob Norton and Kate McCormick

Green manure crops are becoming more common in the Wimmera region of Victoria.

This involves growing a crop—usually a legume—and then killing it by ploughing or spraying. Such crops can provide N to subsequent crops, improve soil organic matter levels, give a disease break and provide an alternative method of weed control. We have been investigating the impact of these crops for some years now.

In 1996 a paddock was sown with replicated strips of vetch (Blanchefleur), medic (mogul), fenugreek, peas (Dun) in late May. Additional treatments of mechanical and chemical fallows were initiated in mid-August to give a total of six basic treatments. These crop treatments were killed with an off set disc, or with glyphosate and ester, or allowed to grow through to harvest. The area was then sown to wheat in 1997 and barley in 1998.

We measured the yield of the crops in 1996, soil water and nitrate at the sowing of the wheat crop, and the yield and grain quality of the subsequent wheat crop. Some growth measurements were taken on the 1998 barley crop—but severe frosts in October restricted data usefulness. Vetch produced the highest biomass in 1996, but fenugreek produced the highest seed yield. There were no significant differences in soil mineral N at sowing between termination treatments or crops. Mean soil mineral N at sowing averaged 50 kgN/ha in the top 0.5 m.

In 1997, wheat yields were highest where the legume was ploughed compared to either sprayed or harvested. The yields where the crop was sprayed out were intermediate, probably due to a slower and less complete crop death compared to the ploughed treatment. The wheat yield in 1997 is thought to largely reflect the differences in soil moisture at sowing where the ploughed had 575 mm, the sprayed 540 mm and the harvested crops 504 mm. Averaged across all legume crops, green manuring conserved an extra 70 mm of soil water, compared to leaving the crop until harvest. This extra water produced an additional 0.90 t/ha (WUE of 13 kg/ha/mm) in the subsequent wheat crop.

Fenugreek and other treatments in the Victorian trials.

The crop selected

In terms of the crop selected for green manuring, vetch was similar to fenugreek, while peas produced the best yield, and medic gave the lowest. Although available N at sowing was similar, it is proposed that the green manure crops released N at different rates. It would appear that peas are the most quickly broken down, followed by vetch and then medic and fenugreek.

The magnitude of the remaining N pool would be a consequence of the initial N fixed as well as the rate at which it is mineralised, and this experiment is unable to remove this confounding effect. However, the effect on subsequent barley growth is inversely related to the yield of the prior wheat crop, which indicates only a small pool of mineralisable N from the green manure treatments.

Conclusions

Based on the first cropping year, growing a GM crop is less profitable than leaving the crop (or pasture) and harvesting it. The yields were low due to a dry spring and hail damage. However, the extra water saved (70 mm) added about 1 t/ha, and this extra grain was at the expense at harvesting a crop (1.4 to 2.0 t/ha) in the prior year. For this to be a viable option, yields in the subsequent barley crop would have to be an additional 1.5 t/ha on the green manured treatments. We could not determine if that was the case due to the frosts during 1998, however, it was not likely (in that year) to make up that many dollars in the barley.

Subsequent work we have done has included a range of crops including mustards and various legume mixtures. We are also hoping to generate sufficient data to model the effect of green manuring to make an assessment of the relative profitability of this practice over a large range of climatic conditions.

Frosted lupins in Lake Grace were green manured in 1998.

Gene technology: Opportunities and threats

Jim Peacock, Chief, CSIRO Plant Industry,

Dr Jim Peacock from CSIRO Canberra is excited about the scope of GM crops for the malnourished, the farmers and the general consumers.

The most common understanding of gene technology is that it is the insertion of a new gene into a plant or an animal—the development of a genetically modified plant.

While this is certainly a big part of it, the technology is much broader than that. Gene technology is giving scientists an unprecedented understanding of plant development and function. It truly is revolutionising modern biology.

Biologists are using this knowledge to improve traditional plant breeding, using advanced tools such as DNA markers, carbon isotope discrimination and new biochemical and physiological assays.

CSIRO has used DNA markers that 'flag' a particular characteristic to develop dwarf wheats with higher yields, by producing wheats with longer coleoptiles (first shoots) and better emergence and early vigour.

A gene is made up of many separate components—sections that tell the gene when, where and how much protein to produce, what type of protein to produce and when to stop. All of these parts are needed to make the gene work.

Genes can be introduced into plants in two ways—using a gene gun, 'shooting' the DNA into the cell with very high air pressure; or using a gene 'taxi'—a tamed version of the bacteria which naturally introduces DNA into plant cells.

Gene technology offers plant breeders enormous possibilities for the improvement of agricultural plants. Genes can be inserted into most crops, including grapes, lettuce, cotton, canola, wheat, potatoes and many more.

Progress

Gene technology appears to be moving in three phases, or waves.

The first wave provides benefits primarily for growers—agronomic characteristics such as herbicide tolerance and insect resistance. The second wave will give benefits directly to consumers—healthier, safer, and tastier foods. The third wave will provide plants producing entirely new products—pharmaceuticals and industrial chemicals.

First wave

A good example of a 'first wave' genetically modified crop is insect resistant cotton. CSIRO's genetically modified a cotton to a gene called INGARD® that gives it natural protection against cotton's most important pest, heliothis. Farmers growing INGARD® cotton have been able to cut pesticide use by up to 70% in some areas.

Another example is potatoes with immunity against potato leaf roll virus. Again, it is expected that growers will be able to reduce pesticide use on these plants once commercialised.

Other first wave crops will include plants with the ability to access previously unavailable phosphorus in the soil. This could give farmers access to $9 billion worth of phosphorus which is currently unavailable to them.

Second wave

Second wave benefits will be more directly advantageous to consumers than first wave crops. For instance, we are looking at dough quality, identifying the genes that are critical for high quality products. Using gene technology, we will soon be able to tailor wheat varieties for specific markets, depending on their quality preferences.

Third wave

In the third wave of applications, we will see new applications for plants—industrial or pharmaceutical 'factories'.

Safety and Regulation

Many consumers are concerned about genetically modified foods, particularly their safety.

To make up their minds about the technology, the general public needs information about the technology and how it is regulated.

Testing

Products of gene technology are tested extensively before release. Far from being an overnight revolution, it can take up to 15 years for a product to make it from a scientist's ideas notebook into commercial production.

When we develop a plant with a new gene, we start testing in the lab. Once we are satisfied with the results of these tests, we then run glasshouse trials.

Again, once we are satisfied that everything is proceeding as it should, we move to small field trials (about the size of a suburban backyard) to larger field trials.

Aside from the precautions we take within our own organisation—and there are many—there are a number of groups involved in the regulation of genetically modified organisms.

Regulation

The Genetic Manipulation Advisory Committee (GMAC) regulates genetically modified organisms. The Australia New Zealand Food Authority (ANZFA) regulates food safety in Australia, and is responsible for labelling. The Interim Office of the Gene Technology Regulator brings all the organisations involved in regulation together is responsible for overall regulation.

For instance, with CSIRO's genetically modified cotton, before we could trial the genetically modified plants, we had to show that the genetically modified cotton would not breed with native cotton species, and that the insect resistance gene could not 'escape'.

Labelling

The labelling regulations are under review by the Federal and State Health Ministers. ANZFA have recommended that:

- New genetically modified foods undergo a rigorous risk-based safety assessment.
- Labelling be required for GM foods which contain new or altered genetic material.
- Labelling not be required for GM foods which are substantially equivalent to their existing conventional counterparts.

Food safety

Genetically modified food goes through many safety assessments before reaching supermarket shelves. A good case study of the process is genetically modified soybeans. These soybeans contain a gene that produces a new protein, which provides tolerance to the herbicide glyphosate, or RoundUp. To test that these soybeans are safe, ANZFA investigated a number of factors—would the new protein break down in people's digestive systems? Could it cause an allergic response in some people? They also tested the soybeans to see if there was any change in the nutritional value of the soybean. They found there was no difference between these soybeans and conventional soybeans.

Agribusiness revolution

Gene technology is not just fascinating science, but is fast becoming a complex business.

There is increasing vertical integration along the business chain—many giant corporations are now involved in every aspect of food production, from paddock to plate. Chemical companies are buying seed companies and food distribution companies.

To develop a genetically modified crop, many different pieces of Intellectual Property (IP) are required, including each of the different sections that make up the gene and the technology to insert the gene into a particular plant.

Each of these IP rights may be owned by a different organisation. Researchers can only gain access to the bits they need by dealing with the different companies involved, and trading their own IP.

Australian success

Given the scope of the massive changes in food production and agricultural business systems, how can the little players like Australia survive?

Australia must develop valuable IP of our own that we can trade with others.

Although Australia only provides two per cent of the world's scientific effort, we are world leaders in many core areas, such as fungal resistance and flowering control.

> *Gene technology is giving scientists an unprecedented understanding of plant development and function.*
>
> *It truly is revolutionising modern biology.*

It is critical that we form alliances and partnerships with other research organisations, funding bodies and corporations, so that we have the strength to deal with giant corporations to get the best benefits for Australia.

Graingene is an alliance between CSIRO, the Grains Research and Development Corporation and AWB Ltd that will ensure that the benefits promised by gene technology are captured for Australian industry.

Graingene is set up so that it is flexible—associates can join us for small projects, or larger efforts, small Australian companies and research groups, and big multinationals. It means that we can get the best deal for Australia.

Current projects

Sulphur-rich pastures

It has been known for some time that adding sulphur amino acids to sheep diets improves wool production. CSIRO Plant Industry researchers have added a sulphur-rich gene from sunflower to feed lupins, boosting wool and meat development in sheep, and meat production in pigs and poultry. Field trials have shown the success of the work.

Golden rice

Vitamin A deficiency is an enormous health problem in developing nations. Researchers have identified a way of introducing a gene which increases vitamin A content into rice. This vitamin A rich rice will benefit millions of people throughout the world.

Iron rich rice

Over three-quarters of a billion people suffer from iron deficiency, with most depending on rice as a staple food. To increase iron content, researchers raised the level of a protein called haemoglobin in rice. The rice is still in development, but could be less than five years away.

Rust resistance

Rust is one of the most devastating diseases of cereal crops. Plant breeders are constantly struggling to develop new cereal varieties with resistance against the latest rust strains.

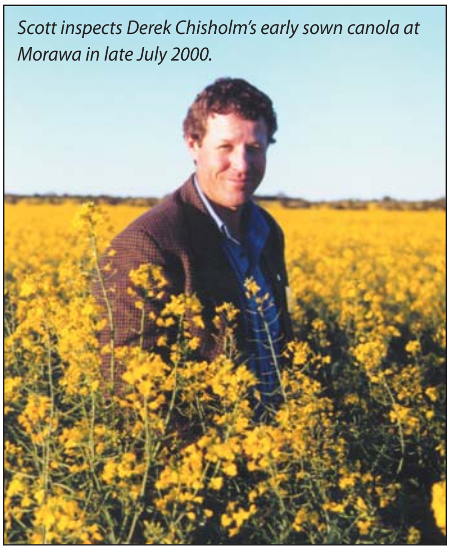
CSIRO researchers studying rust resistance genes are learning to recognise the parts of the proteins produced that are responsible for the specificity of resistance to particular rust strains. In future, this will enable scientists to provide resistance against strains of rust as they evolve.

Weevil free peas

Field peas genetically modified to resist pea weevil attack contain a gene from beans, which are naturally resistant to pea weevils. CSIRO introduced the resistance gene into field peas, producing peas with 99% resistance against their biggest insect pest, the pea weevil.

Using water when you have it—in NSW!

Scott & Jo McCalman, 'Jedburgh' Warren, NSW (02) 6847 4819.



Scott inspects Derek Chisholm's early sown canola at Morawa in late July 2000.

My wife Jo and I are dedicated no-till farmers. We dryland crop 11,500 acres and irrigate a further 1,000 acres on Jedburgh, west of Warren, in the dry regions of central NSW. The soil types on our property comprise about 70% self-mulching grey clays, 20% brown earths and 10% red clay loam.

In the early 80's we ran a conventional wheat/sheep cattle operation in a family partnership. In the mid-80's we started growing irrigated cotton as a major enterprise. With more capital tied up in machinery for cotton production we started increasing our dryland cropping area. We began reducing as machinery technology improved and chemical costs fell, we progressed to a full no-till operation by 1990. This allowed our cropping flexibility and cropping frequency to increase and our input costs to decrease.

We quit the sheep for the soil

When I started to no-till, the plan was to have four years of crops followed by four years of lucerne pasture. But I haven't strictly adhered to this for a couple of reasons. Firstly, when I started out, we ran sheep as a major enterprise. We soon realised that the compaction and the loss of stubble cover from grazing caused by the sheep was limiting the success of no-tillage. It was a big step but we got rid of them—as they just weren't compatible with our system. We still run some cattle on heavily timbered non-cropping country.

With no sheep, the need for lucerne diminished. Secondly, our no-till system improved soil structure much faster than expected, also reducing the need for a pasture phase. Our main crops are wheat, faba beans, canola, chick peas, fenugreek and broadleaf lupins in winter. In summer we grow irrigated cotton and opportunity dryland cotton, sorghum, and mung beans.

Use the water when it's there

We are flexible and take opportunities to plant other crops to suit the calendar date—like opportunity winter or summer crops—as soil moisture dictates. We try and rotate our country so that in any one season, a third is sown to cereals, a third to oilseeds, and a third to pulses.

It is really a matter of using the moisture when it is there. If the season breaks late and we fill our profiles late, then we go and plant a later crop or keep a fallow for a summer crop. There is no need to long fallow if you have the moisture there and nitrogen is available in other forms rather than relying on mineralisation. Getting maximum use of moisture in these drier areas means that you are using the country to the best of its ability.

No-till led to tramlines

With such good results from no-tillage, it was a natural progression to tramlining. I started setting up tramlines in a couple of paddocks in 1994. I completed putting the tramlines over the whole farm in the next year. We have seen many benefits to tramlines, especially in the dry years.

Tramlining gives higher crop yields (from the precision), improves accuracy, improves soil health, decreases soil compaction (except on wheel-tracks), decreases wheel slip, requires less horsepower, uses less fuel, and allows less inputs. The fewer inputs—of about 10%—come from no over-sowing, spraying or fertilising. There is no need for foam markers and we can easily spray at night. Tramlining also ensures better rainfall infiltration and reduces moisture evaporation from the better soil structure. Finally, the accuracy allows for in-crop shielded spraying and this provides other exciting benefits—particularly to manage resistant weeds and precise placement of expensive pesticides.

No-till machinery

We have two seeders—both are 12.2 m wide and are on three point linkage—to ensure precision. The first seeder is 12.2 m wide, has 305 mm (12") row spacings and uses a modified DBS parallelogram. We use 660 mm wide tram-tracks with 2 m wheel-centres. It is our own design on a custom built frame and we pull this with a Cat Challenger 85C.

Our second seeder has hydraulic lift assist wheels with optional spacings of 500 and 1000 mm. It has ground hound parallelograms and is on a home-made frame and is pulled by a John Deere 8400.

We have two home made spray rigs which are 24 m self-propelled units that are built on 9940 cotton picker chassis with 4,000 L capacity tanks. One sprayer converts to a windrower for canola.

Cropping rotation

We have optimum sowing date windows for all crops and this diversity spreads the workload through the year. We use a probe and shovel to monitor soil moisture, this allows for better decisions in opportunity cropping options.

Although Dwayne Beck (above centre) and Scott have never met, they speak a very similar language of diverse crop rotations, retaining stubble, no-tillage and the resulting improved crop yields. Here Dwayne discusses corn agronomy at Kirkwood's farm at Kendenup.

Wayne Smith inspects Lindsey White's 1.6 t/ha sorghum crop at Goomalling this year.

Mark Adams from South Stirlings grew some excellent grain sorghum which yielded up to 4 t/ha in places earlier this year. Mark's single skip row shows the benefit of the system.

We often dry sow or moisture-seek. Pulses and canola suit dry sowing—but we need to be ready for post-emergent weed control. Moisture-seeking is appropriate for pulses, wheat, barley, cotton, sorghum and sunflowers. Deep or side banding of N is critical in a dry season and ensures we can apply all nutrients in the one pass. Good seed quality and appropriate variety selection is important.

Opportunity cropping

Reducing the area of crop in dry starts minimises crop failure. In contrast, when the soil is full of moisture it becomes vulnerable to erosion. Therefore, when the soil profile is almost full, a double crop may be as reliable and as profitable as a long fallow. Increased crop frequency is often needed to take advantage of the faster moisture storage by no-till.

We also use the opportunity long chemical fallow when it is too dry (such as drought). Other factors which affect the decision to double crop are; rainfall outlook (SOI works for us), weeds, disease, erosion risk, and legume crop opportunities.

Retaining stubble

Stubble acts as an insulation layer and reduces evaporation and raindrop impact. Stubble helps prevent diseases in legume crops by reducing raindrop splash. Stubble is food for soil microflora and macroflora which help improve soil structure and fertility. To ensure soil cracks remain open and the profile is filled from the bottom up. Non-grazed stubble is essential to ensure moisture conservation. Stock reduce cover, create surface dispersion and their hoof compaction inhibits water infiltration. Be aware of allopathic problems—in dry summers canola stubble is slow to break down.

Weed control

Spray timing is critical and each paddock is different. Tank mixes are needed to kill a range of weeds. Dust can be a problem in dry years but retained stubble reduces this and clean water is essential. We use small nozzles—#015 rather than 110 02—as they give more droplets and better coverage. We use less than 50 L/ha of water as it increases the chemical concentration—especially with glyphosate. Spraying has much less effect on soil microbes than ploughing and is much quicker.

Spraying is cost effective and we use pre- and post-weed control. We rotate herbicide groups with crop rotations and this is for resistance management. Both warm season and cool season crops give lots of diversity.

Row spacings

We use 305 mm wheat, 350–500 mm for canola and fenugreek and 1 m for chickpeas, faba beans, lupins, cotton and sorghum. With opportunity, dryland summer crops we use 1 m plant rows and have a 2 m skip row and in predicted dry conditions we use a 3 m skip row. The wide rows allow a cheap in-crop weed control with glyphosate and over the top banded spraying of expensive pesticides. These rows reduce chocolate spot in faba beans, ascochyta in chickpeas and CMV in lupins.

Marketing

Successful yielding crops in a dry season can be very profitable by generating cash flow. We grow pulse crops for human consumption. We have forward contracts with GMP and cotton is forward sold—three years out NY futures. We use Pools and include on farm storage and blending to get the best prices. We also grow seed crops. ■

"The second mouse gets the cheese"

John Stone, (committee member) Borden (08) 9828 1027, fax 42

My family and I farm 5,000 ha (12,000 acres) and we crop 70% of this land each year. The following quote by Pita Alexander sums up our early work with no-tillage. "I have learnt that being early and being first is not the whole answer—it is true that the early bird may catch a worm, but a smart bird can catch a worm anytime! Even more importantly, it is usually the second mouse that gets the cheese."

Being an early no-tiller is being like the first mouse, and every trap seems to catch you. In 1991 we purchased a no-till combine and the learning began. We stopped raking and burning and sowed our stubble back into lupins or wheat into barley. We experienced many mechanical problems and our chemical program was not ready for the system.

Above: John Stone explains his crop rotation thoughts to a 1998 WANTFA Field Day group.

Right: John Ryan from Ausplow explainsthe merits of his Ausplow DBS seeder at the WANTFA Field Day.

Adopting higher rates of glyphosate and learning to wait for brown-out of weeds helped with weed management. However, many weeds would then emerge after seeding due to our history of full-cut cultivation, poor crop rotations and poor weed control. We increased stubble retention with the wheat:lupin and pasture:wheat rotations and observed the burning and erosion happening around us.

In 1995, we purchased a DBS seeder to replace the full cut scarifier seeder and another learning curve began. In the first year, we deep banded the fertiliser and found the crops very slow to get going. Also, we began post spraying of our crops. The next year we split our fertiliser 50:50 (with the seed and banded) and the crops got away much better.

The herbicide mix!

We also followed a pre-sowing chemical plan for wheat of 2 L/ha of Treflan (400) plus 500 mL/ha of Diuron and 10 g/ha of Glean. This is now the benchmark in weed control with no-tilled wheat. However, we continued making mistakes like wearing points down too much and not getting enough soil coverage for our chemicals. We had to redesign the points and replace them more quickly. In all of this we still found our weed banks were too high.

Then the biggest break-through (for rotation cropping) arrived with TT Canola. We planted 400 ha of Karoo canola in 1997, then in 1998 and 1999 we planted 800 ha of Pinnacle canola and we have seen our weed banks reduce along with 100% no-till practices.

Herbicide resistance is a serious issue that will make us change what we do. Crop topping lupins and field peas is a valuable tool against weeds. Despite glyphosate being cheap, SpraySeed - as a tool, has a big role to play with cropping.

Nutrition

After many years of no-tilling and wanting to climb the next yield step, nutrition had to be addressed. Zinc was applied to wheat seed for two seasons before Summit introduced a No-Till fertiliser with higher copper and zinc levels (at 1% each and less N). Potash has been applied mostly in lupins and canola with yields increasing. Lime is now a part of our program.

Getting through straw and melons

No till seeding is set up at harvest. Straw needs to be chopped up and evenly spread. We have found that with 25 cm (10") row spacings, the straw needs to be cut at 25 cm height or less. This has the added advantage of helping the herbicide hit the target weeds when spraying.

Weed control in the current autumn is vital for tine machines because vines and roots affect seeding depth, fertiliser placement and chemical coverage. All this leads to poor weed control and crop establishment.

Discs have important role

The Agri-Systems disc machine plants 30% of our canola, all the lupins and peas and sows 50% of the barley. It leaves the paddock smooth and leaves the rocks in the ground. We can seed into straw with little or no preparation. This seeder can also work deep under the seed, it separates the seed and fertiliser, it effectively rolls the country after seeding and it provides precise seed placement at anywhere from 15-50 mm depth.

The Cross-Slot seeder has been greatly modified by the Stone's during the 8 years of ownership.

The Agri-Systems and DBS work well together. The DBS is very effective at incorporating Treflan and consequently sows 90% of the wheat program. However, with us growing lots of straw—and not necessarily more grain, and a wet harvest in 1998, we had to use a stubble rake in 1999 to be able to seed with the DBS. Also, the contract harvesting was done without a Kirby straw spreader.

Frost frustrations

We are not sure if there is a relationship between better crops and more frost or not. For this year, our number one concern is frost. For the last three seasons we have been losing large areas of good crops on mainly non-wetting soils, grown in the lupin:wheat rotation. We wonder if the thick canopy from the high seeding rates has increased our frost risk. Therefore, we will experiment with lower seeding rates on our non-wetting soils. This may decrease our yield potentials, but it is more important to grow some grain and not just straw (from frost).

Need to be sustainable

We are pleased with our progress toward more sustainable cropping systems. Our land does not blow like it used to and the structure of our soil has greatly improved. Our yields are also increasing and our water use efficiency is up. However, so too are costs and there are other risks that we need to manage.

The dry 2000 season

This season has been very difficult. With frosted crops from 1998 and 1999 in the front of our mind, we made a conscious decision not to plant wheat too early. So we waited and waited. Apart from the time of sowing bit, we had got the basics mostly right. We sprayed the melons and re-growth in January and February and we even harvested our last 100 ha of frosted wheat for only 7 tonnes of grain.

With thick, frost-affected wheat stubble remaining on the soil surface, and with intentions of seeding 70% of this stubble to canola and no moisture in the top 5 cm, it meant that the disc machine (Cross-Slot) was not an option. Then, with no coulters on the Ausplow DBS, we felt we had no option but to rake the straw. This left the soil too bare to risk sowing into. In desperation, 6 days before a rain, we sowed dry on the 6th June—so our window of opportunity closed.

We did use the disc machine to sow lupins at 5 cm seeding depth and they came up poorly, as a very thin stand. Many areas have now recovered to 50 pods per plant and they look good. In future I have resolved to:

- Buy coulters for the DBS seeder.
- Sell the stubble rake.
- Not take too much from the year 2000 and hope it was a 1 in 40 year event.
- Use knife points and discs for full stubble retention.

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At Rendezvous Observation City Hotel, Perth.

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