Best Management Practices for
Dryland Cropping Systems

Murrumbidgee
CATCHMENT MANAGEMENT AUTHORITY

Murrumbidgee Catchment Management Authority and Harden Murrumburrah Landcare Group

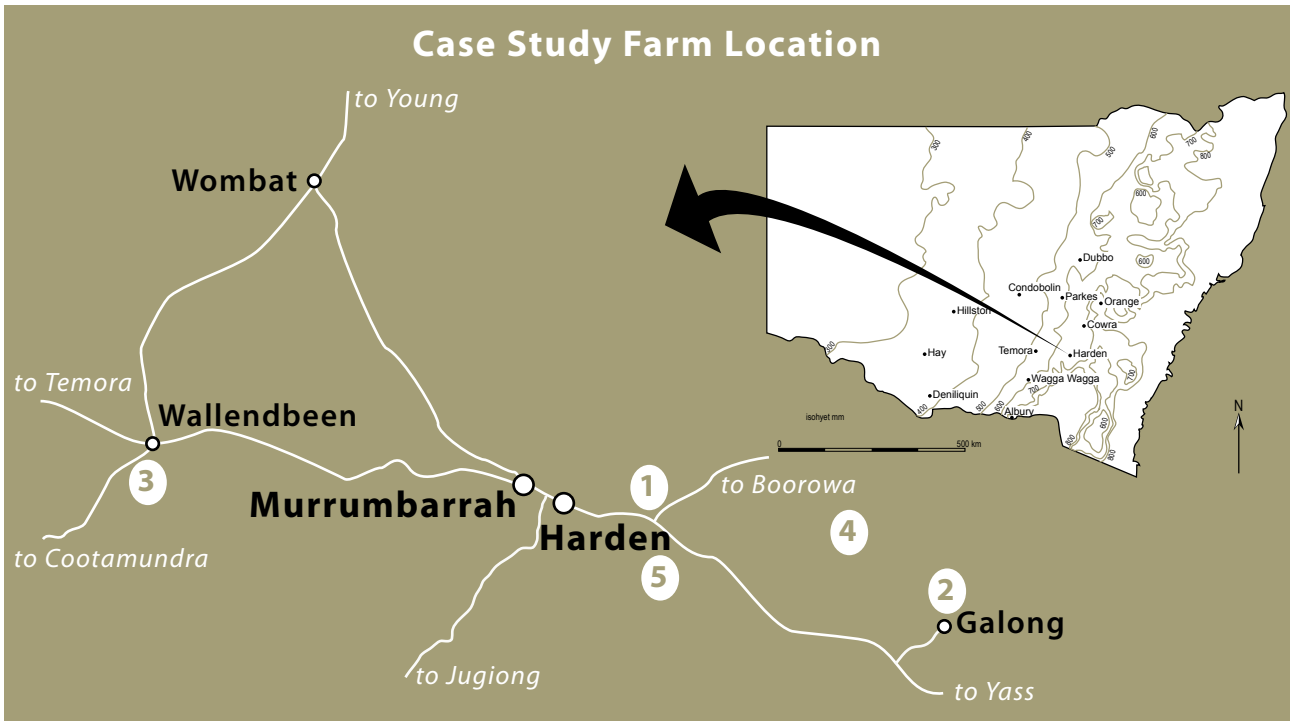
HMLG

Cereal Stubble Management Case Studies

Australian Government

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

DELTA AGRIBUSINESS



Acknowledgement

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Harden-Murrumburrah Landcare Group

The Harden Murrumburrah Landcare Group (HMLG), which encompasses the Jugiong Creek (Harden Shire) Catchment, was formed in 1989 and has a membership of 240. The Group's vision is: *Sustainable and profitable long-term farming and grazing throughout the Jugiong Catchment with a healthy environment for current and future generations.*

Project Background

The HMLG region is a mixed farming area, with most farms cropping between 50 and 60% of total farm area. Of this cropped area, around 60% is cereal, primarily wheat but also small areas of oats and triticale.

The current management of cereal crop stubble in the region is to graze the paddock after harvest then burn the residual prior to sowing the following autumn. While grazing is the most common method of stubble management, some operators are testing a no-livestock system. There are many variations on this general practice and HMLG members were keen to identify management techniques that would allow them to more fully utilise the stubble resource and avoid burning.

Since 2005 a number of methods of stubble management have been investigated including biological products (promoted as assisting with stubble breakdown), mechanical treatments, and other techniques to remove the need to burn stubble. These trials have been conducted in collaboration with NSW Department of Primary Industries and the Murrumbidgee Catchment Management Authority. Stubble loads have been low in all these years. Group members decided to continue with the work in 2008 with the hope of achieving a huge harvest producing enormous stubble loads and allowing more rigorous testing of landholder ideas.

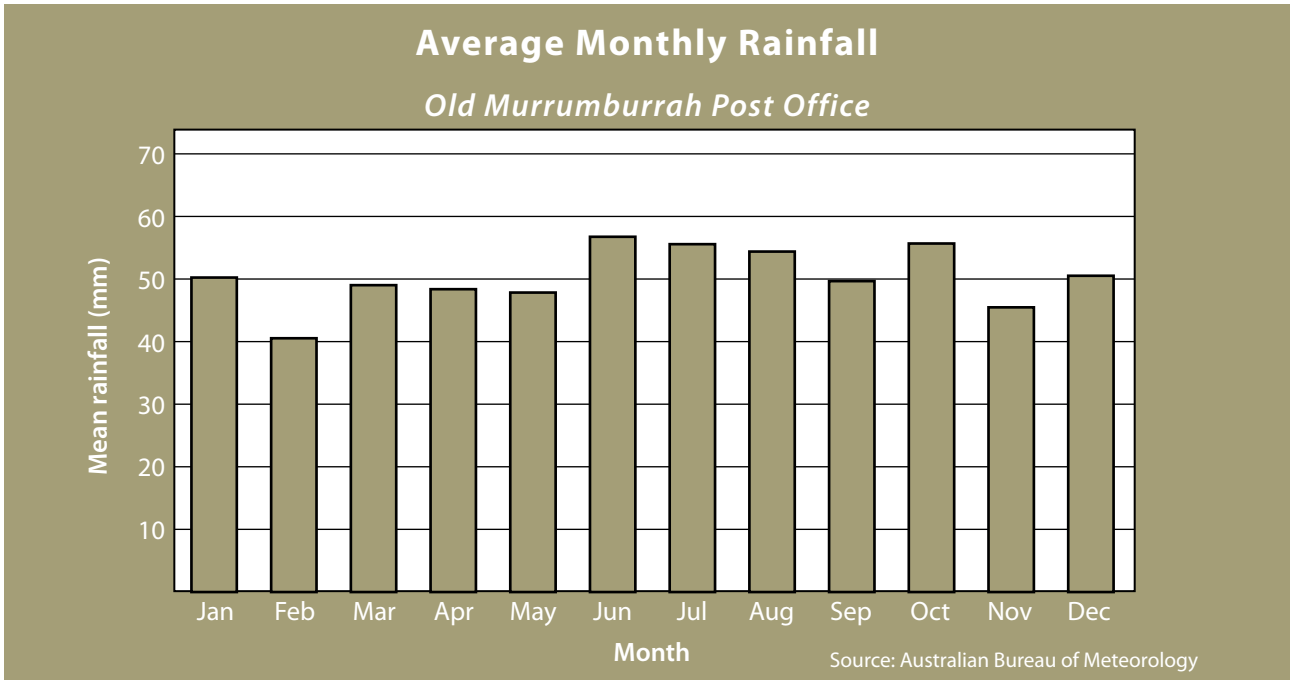
The five Case Studies of HMLG members and the outline of On-Farm Demonstrations described in this document form part of the overall investigations that have been conducted. They demonstrate a range of stubble management methods implemented in the 2007/2008 summer and the impact of these on the 2008 crop.

Previous results can be found on the internet at http://www.murrumbidgee.cma.nsw.gov.au/index.php?id=824

Tillage definitions used in this document	
Reduced-till	one cultivation prior to full–cut sowing
Direct-drill	one pass sowing with a full–cut
No-till	knife or disc sowing, 5–20% soil disturbance

Climate

The climate in Harden is typified by hot summer days with occasional storms. Winter and spring rainfall is more reliable than summer rainfall so the region is dominated by winter crops, with limited summer fodder production. The average annual rainfall is about 600 mm.



On-farm demonstrations

On-farm demonstrations looking at the impact of stubble management strategies on soil moisture, crop establishment and yield were established at each of five case study farms (Table 1). The location of the case study farms is illustrated on the map inside the front cover.

Stubble treatments

The strategies include practical methods that are being tested and adopted on-farm across the region (Table 1):

- Harvesting at a lower height to reduce straw length and improve flow of residue through sowing cultivators
- Mulching with a disc chain or Coolamon harrows soon after harvest to chop and flatten straw, speeding up residue breakdown
- Leaving stubble standing and sowing with a cultivator designed to handle stubble
- Heavy grazing to reduce stubble load.

At all sites stubble load was much lower (<2.2 t/ha post harvest) than normal (at least 5 t/ha). Each grower commented on the low stubble load and the resulting lack of difference between stubble management treatments in these demonstrations.

Stubble load post-sowing 2008. The light stubble loads in recent years has meant that stubble-handling methods have not been effectively tested.

Weed growth

Summer weeds established soon after harvest in late 2007 following significant rainfall events in November and December 2007. Herbicide was applied in mid-February 2008 on the ungrazed treatments stopping seed-set, while grazing effectively controlled seed-set of the weeds on grazed treatments.

Weed growth on all treatments would have used soil moisture and nutrients. It is likely that early application of herbicide (e.g. early January) to stop summer weed growth would have conserved more soil moisture than the delayed application or grazing.

Table 1 Stubble management treatments, stubble load at sowing, summer rainfall and comments on summer weed growth for each of the five demonstration sites.

Note: this information is from demonstration plots, not from a replicated trial.

Site	Stubble treatment	Stubble at sowing 2008 (t/ha)	Rainfall (Dec-Apr) (mm)	Comment on summer weed growth
1	nil–standing	1.0	261	moderate density of weeds sprayed out mid-Feb
	mulched–Coolamon harrows	1.0		moderate density of weeds sprayed out mid-Feb
	grazed	0.2		weeds heavily grazed
2	nil–standing	2.2	335	minimal weed growth
	mulched–disc chain	1.2		moderate weed growth
3	normal harvest height	1.8	200	no summer weed issue
	low harvest height	0.8		no summer weed issue
4	normal harvest height	2.0	270	black grass growth late summer
	low harvest height	1.9		black grass growth late summer
	grazed	0.9		minimal weed growth, lightly grazed
5	mulched–disc chain	2.0	268	low to medium density, controlled with herbicide

Explanation of results

Soil water

Soil water was measured pre-sowing to 60 cm and an estimate of plant available water is given in Table 2.

At Bobbara Station (Site 2), Rob McColl noticed there was more water movement over the soil surface in the mulched (disc-chained) area than in the standing stubble. This was reflected in the estimated plant available water at sowing—mulched with 38 mm and the standing stubble 45 mm in the top 60 cm.

Sowing

The demonstration blocks were sown by the farmer with their normal equipment (Table 3). At Bobbara Station (Site 2), the disc-chained treatment required an additional pass to prepare it for sowing, even with the relatively low stubble loads. The standing stubble was difficult to sow through, leaving lumps of straw and dirt after sowing.

The Baldry's (Site 3) had to harrow and burn the stubble just prior to sowing as they knew they wouldn't be able to sow through the standing stubble.

Crop Establishment

Crop establishment was assessed and there was little effect of stubble treatment. Plant density on each treatment and site was within the target population for the specific crop and variety sown (Table 3).

Table 2 Estimate of soil water (0-60 cm) at sowing for each stubble management treatment at the five demonstration sites.

Note: this information is from demonstration plots, not from a replicated trial.

Site	Stubble treatment	Soil water (0-60 cm) at sowing (mm)
1	nil (standing)	45
	mulched–Coolamon harrows	38
	grazed	34
2	nil (standing)	45
	mulched–disc chain	38
3	normal harvest height	75
	low harvest height	71
4	normal harvest height	49
	low harvest height	39
	grazed	33
5	mulched–disc chain	46

Table 3 Stubble management treatments, 2008 crop and variety, sowing details and crop establishment at each of the five demonstration sites.

Note: this information is from demonstration plots, not from a replicated trial.

Site	Stubble treatment	Crop, variety date sown	Sowing cultivator, row space, cover device	Crop establishment (plants/m^2)
1	nil–standing	wheat,	Tine, modified Shearer	136
	mulched–Cool. harrows	28 April	combine,	138
	grazed		20 cm, press wheels	144
2	nil–standing	wheat, Wedgetail$^{\Phi}$	Tine, ConservaPak,	137
	mulched–disc chain	25 April	30 cm, press wheels	140
3	normal harvest height	wheat, Ventura$^{\Phi}$ undersown	Tine, AusPlow DBS,	87
	low harvest height	17 June	26 cm, press wheels	90
4	normal harvest height	wheat, Marombi$^{\Phi}$	Disc, Excell,	96
	low harvest height	15 March	23 cm, press wheel	110
	grazed			113
5	mulched–disc chain	canola,	Tine, Flexicoil,	41
		1 June	23 cm, press wheels	

CASE STUDY 1

Peter Holding, Harden

Property details: 600 ha; 400 ha crop; 200 ha improved pasture; 2100 sheep.

Soil type: sandy clay loam.

Farming system: mixed, pasture phase important; livestock used to reduce stubble load and manage weeds over summer.

Crop rotation: continuous winter cropping (canola-wheat-lupin or faba bean-wheat-canola undersown); approximately six years crop, then four or five years pasture.

Tillage: direct-drill.

Stubble management: mulched with Coolamon harrows immediately after harvest then grazed at high stocking rates on a rotational basis.

Background

Peter Holding has been heavily involved with Landcare activities since 1989 and with his family, operates a mixed farm east of Harden. Direct-drill annual cropping and sheep are the key components of the whole farm system.

Cropping system

For over 20 years, the cropping program has been a direct-drill system based on wheat and canola with some pulse crops. During the past five years Peter has not sown a pulse crop due to the drought, late seasonal breaks, poor yield and uncertain price. He plans to reintroduce lupins or faba beans into the crop cycle. The aim is to start the crop phase after a good weed-free pasture. The past few seasons have made this a challenge and more recently some weedy paddocks have been put back into crop to *tidy them up*.

Peter Holding with his modified John Shearer Trash Culti Drill

After the 1982 drought through to 1985 Peter experimented with reduced-till and no-till cropping because soil erosion was a large problem on the sloping country with heavy summer storms. Wind erosion was also an issue after the ´82 drought and with declining soil structure. Peter had just completed an agricultural degree at Charles Sturt University and he had become interested in research into direct-drilling being done at the Wagga Wagga Agricultural Research Institute. Peter decided to see if he could make it work.

The implementation of direct-drill has helped reduce soil erosion and improve soil characteristics such as:

- Water holding capacity
- Organic carbon levels
- Soil structure.

It is a continually evolving process–always developing–requiring further research. Changes to the system require a few years to show the true benefits, and as the system changes, so do the issues faced. There are many options and directions to take e.g. controlled traffic farming and inter-row sowing; baling stubble and developing uses

and markets for the straw; to graze or not to graze. The system needs to be adaptable and will vary from farm to farm, year to year and paddock to paddock.

Peter modified his John Shearer Trash Culti Drill (19 rows, 20 cm row space). The key changes he made were:

- Removing cultivating tines
- Raising the seed and fertiliser boxes to improve stubble flow
- Replacing the tines with stronger coil tines
- Adding press wheels to replace the Flexicoil roller used to improve seed-soil contact and germination.

The Shearer combine was easily and cheaply converted to a direct-drill planting unit with good stubble handling capability.

In addition, an anhydrous ammonia gas applicator was added and small seed box mounted on the frame.

The disadvantages of the machine are the width limitation and the relatively slow sowing speed required to achieve good seed and fertiliser placement (as the machine doesn't have good the ground following ability of some other seeding units). It is also difficult to prevent soil throw, even at slow speeds.

Stubble management

Grazing, in conjunction with the use of the Coolamon harrows (as soon as practical after harvest), is the preferred method of managing stubble to enable subsequent crops to be sown. Cereal stubble paddocks are ranked according to their position in the rotation and following crop, and are grazed accordingly. For example, stubble paddocks to be sown with early grazing wheat are kept clean by grazing and herbicide application, as opposed to those to be late sown, which may be left with slightly more green growth. Canola stubble is much less of a problem and crops are easily sown in these paddocks.

Peter is interested in exploring other options of stubble management practices such as baling straw. 'This may fit with livestock grazing on winter cereals by providing the required roughage'. Peter has plans to only have breeding sheep on paddocks, growing out prime lambs in a feedlot, utilising the baled straw, another piece in the stubble management puzzle.

Weed management

Peter has a keen focus on managing weeds and reducing the weed seed-bank The main winter weeds include wild radish and annual ryegrass, and occasionally black oats and skeleton weed. A combination of herbicides and grazing is used to manage these weeds. Peter attributes the success of his weed management program to the:

- Crop rotation with the inclusion of a pasture phase
- Use of strategic grazing
- Well planned use of herbicides
- Use of detailed and appropriate consultancy advice, keeping up to date with herbicides and weed management research.

Weed control over summer in stubble is critical to successfully sowing through stubble.

Livestock management

The sheep are heavily integrated into the cropping with the use of grazing wheat (and potentially grazing canola). The sheep are only on the pasture area from crop lockup in mid-spring through to harvest, and again in late autumn. Sheep are grazed on crop stubble from harvest until these paddocks are sown. Supplementary feeding includes silage cut from the pasture paddocks, minerals, and lick feeders with grain when required.

Future opportunities and challenges

Soil throw is a problem but doesn't appear to be critical. Peter is going to try a slightly different tine pattern which may give a better result. The challenge is optimising stubble flow while minimising uneven soil throw and sideways movement by the sowing plant. Part of the problem is caused by the build up of soil around the tines caused by the anhydrous ammonia applicator in close proximity to the sowing tine. This may be solved by better insulation or changing the fertilizer delivery.

CASE STUDY 2

Bobbara Station, Galong

Property details: 4500 ha; 1700 ha crop; 500 Angus/Wagu cows; 7000 ewes joined to X-bred composite rams; and opportunity cattle trading.

Soil type: sandy clay loam.

Farming system: mixed no-till cropping and livestock.

Crop rotation: canola-wheat-canola-wheat-wheat rotation with the last crop under-sown to a lucerne or grass based pasture.

Tillage: direct-drill system since the early 1990s. No-till since purchase of ConservaPak in 1998.

Stubble management practices: traditionally have burned cereal stubble but sown into canola stubble. Recently have started using a rotary disc chain combined with heavy grazing to reduce stubble load. Occasionally bale straw.

Background

Bobbara Pastoral Company has been direct-drilling since the early 1990s. Cropping has played an important part of the farm business, both as a financial contributor and in the control of weeds, such as scotch thistle. Paddocks generally have a five year crop phase followed by a five to six year grass- or legume-based pasture phase, with the aim of maximising returns.

Cropping system

Rob McColl, has been the Cropping Manager at Bobbara Station since 2002. He said, '2002 was a real eye opener and never was it more evident that we needed to conserve as much moisture as possible. We received only 418 mm [of rain] that year including one rain event in February that delivered 156 mm. Our in-crop rain was half that of a normal year. Since then we have kept stubbles as clean as possible and cover on paddocks for as long as possible, to both capture and retain that water.

Rob McColl with his Conserva-Pak cultivator.

The soils look better since the move to no-till. There is more visible organic matter in the soil and plenty of worms.'

Rob sows with a ConservaPak cultivator (12 m, 30 cm row space) and a Flexicoil airseeder. Narrow press wheels have been replaced with 100 mm wide, pneumatic press wheels for improved seed soil contact. The 30 cm row spacing (compared to the 22 cm previously used) has improved residue flow through the machine and helps reduce soil throw onto other rows.

The ConservaPak gives:

- Excellent seed and fertiliser placement at the required depth because each of the seed and fertiliser placement units follows the ground level individually

- Good seed-soil contact, with the pressure of the press wheel easily adjusted for different conditions
- Good stubble handling capability
- Very little soil disturbance because of the use of narrow points.

It is a very reliable system that can be used in a variety of soil types, soil conditions and cropping systems.

Stubble and weed management

Rob uses a Brookfield disc chain to:

- Manage stubble
- Provide a light cultivation prior to under-sowing pasture
- Incorporating pre-emergent residual herbicides, such as trifluralin.

Rob finds that the disc chain complements minimum tillage well in that when a light cultivation is required it fills the gap. The disc chain is brilliant for incorporating trifluralin before sowing.

The disc chain was used on wheat stubbles in 2007 and did a great job preparing them for sowing. The shallow cultivation (2-3 cm) encouraged a germination of weeds which were cleaned up with a fallow knockdown spray.

Stubble will be grazed heavily (up to 50 DSE) if it is too heavy to sow through. On occasion, if necessary, stubble will be burnt to control crop disease and weeds.

Future opportunities and challenges

There is a concern that the 30 cm row space will limit yield in high yielding seasons (wheat over 4 t/ha). It is felt that the large increase in seed number per meter of row is likely to reduce tillering ability in wheat. As a solution to this, Rob is looking at using a paired-row sowing system. The tine spacing would remain the same (30 cm) but each sowing tube would be split, delivering seed to two rows 7.5 cm apart.

Rob is also concerned that if the 30 cm row space results in reduced tiller number per hectare the dry-matter production of the grazing cereals will be reduced. However he can usually sow into moisture that has been conserved by retained stubble that a narrower tined machine may not get through. This allows him to establish grazing cereals earlier, which may well be sufficient compensation for the effects of wider row spacing.

A disc chain can be used to mulch stubbles to increase the speed of breakdown and improve residue flow through seeding equipment.

Controlled traffic farming and inter-row sowing are not practical options for Bobbara Station due to the slope of most country. Erosion of the wheel tracks is likely and the sowing plant would have to be scaled back to get enough horsepower to the ground (perhaps with a track tractor). Inter-row sowing is also challenging on sloping country where the cultivator drifts sideways and is hard to keep between the rows.

Rob can see benefits of a disc machine for sowing but he believes he would have to go 'no stock' to remove summer compaction to avoid sowing problems. He is not convinced that the disc machine would work on hard compacted paddocks such as previous grazing-cereal paddocks.

CASE STUDY 3

Ken and Charlie Baldry, Wallendbeen

Property details: total 3500 ha; 1800 crop; 9000 ewes for prime lamb production.

Soil type: red basalt clay loam and granite sandy clay loam.

Farming system: mixed; no-till cropping; legume dominant perennial pasture to build up soil carbon and nitrogen.

Crop rotation: 6 to 7 years crop, predominantly wheat and canola; 4 years perennial pasture–lucerne, fescue and sub clover.

Tillage: no-till.

Stubble management practices: heavy grazing and late cool burn.

Background

Charlie Baldry and his family operate a mixed farming business with livestock and perennial pasture an important component.

Cropping system

In 1996, Baldry & Sons purchased an Ausplow DBS (Deep Blade System) seeder to move from reduced-till (one cultivation prior to sowing) to no-till. It features:

- High break-out hydraulic tines
- A parallelogram press wheel sowing system
- 26 cm row space
- An anhydrous ammonia application system.

Due to back filling problems caused by soil throw, harrows were fitted after two years. Initially Agmaster Star harrows were used but they did not leave the country level enough, particularly when the stars were worn. More recently they have been replaced with K-Line finger harrows.

Charlie Baldry with his Ausplow DBS seeder.

Weed management

Charlie uses an integrated weed management system which includes:

- Silage production during the pasture phase
- Attention to detail ensuring spring/ summer fallows prior to cropping are kept weed-free
- Rotation of herbicide groups
- Some strategic cultivation–usually when incorporating lime.

The four to five year pasture phase is based on perennial species with a strong legume component, and includes lucerne, fescue and sub clover. The pasture phase is used to increase the nitrogen and carbon levels of the soil.

Stubble management

Stubbles are heavily grazed immediately after harvest. Summer weeds are controlled with herbicides and grazing to conserve moisture. Stubbles are burnt during late April and early May to:

- Enable effective use of pre-sowing herbicide

- Control cereal leaf and crown diseases (wheat on wheat)
- Prevent seeder blockages
- Prevent canola establishment problems in heavy wheat stubbles.

Livestock management

Livestock are used in combination with herbicides to control summer weeds in stubble. The stubble also supplies some summer feed.

Future opportunities and challenges

Charlie feels the grains industry will face a challenge if soft commodity prices remain firm and the profitability of cropping justifies the risk of growing a larger proportion of crop or even continuously cropping. The system will need to be able to increase soil carbon levels, rather than mine carbon and degrade fertility. He is unsure if a system exists which can maintain or preferably increase soil carbon levels without a pasture phase, particularly in high rainfall areas.

Extending the cropping phase or continuous cropping also runs into serious issues with weed management, particularly herbicide resistant weeds such as annual ryegrass. GM technology may or may not solve that problem.

Measuring soil strength using a penetrometer at the Bobbara Station Field Day 2007.

Field Day at Bobbara Station, 2007. Rob McColl said "If we are going to make annual cropping work in our dry climate, it will have to be with the kind of practice that conserves every drop of moisture we get, and has to be a no-till system with maximum ground cover".

CASE STUDY 4

Peter Cusack, Harden

Property details: 650 ha; 300 ha crop; 1600 sheep; contract sowing and spraying.

Soil type: loam and clay loam (better cropping); sandy loam (better suited to grazing).

Farming system: mixed; livestock an important component of the farm business; pastures are an important component of crop rotation, particularly on the lighter country.

Crop rotation: wheat–wheat–break crop–wheat undersown with pasture.

Tillage: no-till.

Stubble management: light grazing then sow with disc seeder.

Background

Peter Cusack and his family run a mixed farming operation at Harden based on a no-till system. He manages two distinct soil types–the better cropping country (loam and clay loam) and the lighter grazing areas (sandy loam). Livestock are a key component of the business. He currently runs 1600 merino ewes—1100 joined to terminal sires, 500 to merinos. Peter sold his cattle a few years ago due to the cost of feed and time taken to manage them.

Reduced-till farming was introduced in the early 1980s, and has helped reduce soil erosion and improve the soil's water holding ability.

Cropping system

The cropping program on the better soil type is usually two years wheat, then canola or lupins, one or two wheat crops, the final one undersown with lucerne which is maintained for three to five years.

Peter Cusack, son Will and the Excel Stubble Warrior disc seeder.

The lighter country has more emphasis on pasture, with a maximum three years crop then back to four to five years pasture, based on cocksfoot, phalaris, fescue, sub clover and arrowleaf clover.

In 2006 a single disc seeder (John Deere 1590 Disc Drill) was purchased to replace a tined swing rig, with the aim of:

- Retaining stubble
- Maintaining ground cover
- Minimising soil disturbance during sowing
- Improving seed placement
- Maintaining soil-seed contact
- Improving fuel efficiency
- Sowing at a higher speed than a tine machine.

Peter said, 'Some exceptional crop establishment results were achieved in 2006. The pasture establishment and density were very impressive as well. I believe we achieved a yield advantage in cereals due to conservation of moisture.'

'Establishment and cleanliness of the early sown fodder crop was excellent due to the fact that we could sow one day after the opening rain and follow up with a knockdown spray before the crop came up, four to six days later.'

In 2008 this sowing unit was replaced with a larger machine, a 9 m Excel Stubble Warrior

(23 cm row space). The Excel is very similar to the John Deere disc opener with a few improvements, such as a heavier bar which improves soil penetration in dry soil and the accessibility of parts locally.

The Excel Stubble Warrior consists of a 45 cm (18") single disc on a seven degree angle with a rubber depth gauge wheel, followed by a seed firming wheel, and then a slot closing wheel. The seed is placed in the shadow of the disc along with fertiliser in a single boot system. Each unit is set individually and seed placement is very accurate.

Peter has sown in excess of 5000 ha with the disc seeders over the past three years. Disc life was just under 4000 ha, similar to a knife point in the same country. He sees the advantages of a disc seeder over a tine machine include:

- Superior stubble handling capability
- Higher sowing speed
- Less soil disturbance and power requirement resulting in marked reduction in fuel consumption
- Easy seeding depth adjustment to match soil moisture.

Peter sees few limitations with the disc machine compared to a tined machine, but he has reported:

- There is no soil levelling ability so any ruts (e.g. sheep tracks) remain in the paddock from season to season, although the unit does neatly seed over them
- The disc units have to be greased daily
- Herbicides cannot be incorporated.

To conserve moisture summer weeds in stubble are controlled primarily with herbicide. Lucerne paddocks are winter-cleaned prior to coming back into crop. If pasture paddocks are particularly grassy Peter will sow a fodder rape crop for stock feed and to manage the grasses. When Peter makes hay or silage to conserve fodder he always chooses the weediest paddock, to help reduce the weed seedbank.

Depth gauge wheel on the Excell Stubble Warrior disc seeder.

Stubble management

Ideally, Peter would prefer not to graze stubble paddocks and retain standing stubble cover. He lightly grazes all stubble paddocks; a balance between optimising ground cover and feeding sheep over summer. When feed is very short over summer he will sacrifice one stubble paddock and supplementary feed sheep there, rather than over-graze all paddocks.

A key to managing stubble is spreading residue evenly at harvest. This aides residue flow during sowing.

Livestock management

Sheep are grazed on pasture paddocks during the winter crop season and rotationally grazed on all paddocks during summer. Supplementary feeding (grain, hay or silage) is only used in drought situations.

Future opportunities and challenges

Peter sees the inability to effectively incorporate pre-sowing residual herbicides as a challenge in his full stubble retention, direct-drill system. He sees Roundup Ready® canola and the application of a non-selective herbicide as an additional weed management tactic to add to the system. The use of a disc chain for light cultivation to incorporate herbicide may also be an option.

Although Peter does not cultivate or burn stubble, he would consider using these tactics to help in an integrated weed management program.

CASE STUDY 5

Terry Brown, Harden

Operation details: 2500 ha crop on properties at Harden, Milvale, and Wallendbeen; no livestock enterprise.

Soil type: loam to heavy clay and self mulching grey clay.

Farming system: no-till crop with no livestock grazing on paddocks while in crop phase of rotation. Pastures are legume only to enable grass weed control in the pasture phase.

Crop rotation: 6-year rotation of canola-wheat-canola-wheat-canola-wheat/legume pasture.

Tillage: no-till

Stubble management: historically wheat stubble is burnt and canola stubble mulched with a disc chain. To reduce stubble burning it is intended to bale wheat stubble then disc chain as soon as moisture permits after harvest.

Background

Terry Brown's cropping operation is over a range of soil types and environments (rainfall and season length). He has been no-till farming since 1998, and the tillage practices have been adapted to best suit the conditions of each soil type as required. Retention of soil moisture and weed elimination are important factors in the management program. To assist with the logistics of managing a large area of crop he block farms (manages paddocks in groups) with units of approximately 200 ha.

The farming objective is to maximise returns by careful agronomic management and the adoption of the best farming techniques available, to minimise input costs without compromising returns.

Terry Brown's Flexicoil air seeder with tow-behind air cart and coil packer.

Cropping system

The cropping phase of the rotation is based around a Flexicoil airseeder (12 m wide, 23 cm row space) fitted with press wheels. When sowing pasture the press wheels are swapped with rotary harrows and combined with System 75 coil packers.

The original plant was purchased in 2002 with auto-steer added to the tractor in 2007 with the aim of minimising costs by eliminating overlap, and to reduce driver fatigue.

The sowing outfit has:

- Very accurate seed and fertiliser placement
- Good seed–soil contact to maximise germination, especially for canola
- The ability to move between press wheels and rotary harrows depending on soil type, available moisture and crop
- Good ground following capability
- The ability to sow with good results into a range of soil types, in any condition.

Some of the disadvantages of the outfit include:

- The tow behind air-cart generates some side movement on hilly country

- Inability to change row spacing because it is an alternate tine machine
- Machine height in transport can be an issue on the road and moving between paddocks
- The cultivator wheels require higher than expected maintenance–the wheel bearing and stub axles need regular checking and replacing. The wheels could be larger.

Stubble management

Up until 2007 Terry burnt stubble in late April/early May to prepare for cropping. However in 2008 he purchased a 13 m Kelly disc chain to mulch stubble and incorporate pre-emergent herbicide (trifluralin). The plan for 2009 is to remove the bulk of the straw by baling, and retain the balance of the crop residue to help retain soil moisture and maintain soil structure. Terry would like to eliminate stubble burning.

Weed management

Terry relies on application of herbicide to manage summer weeds in crop stubble, using high water rates (80 to 100 L/ha).

Oats baled for silage has been used very successfully to dramatically reduce the weed population in some *problem paddocks* over the past few years. The paddocks are sown to oats, cut and baled for silage, then treated with a knockdown herbicide immediately to control any regrowth.

Livestock management

Terry has no livestock of his own and only runs sheep on pasture paddocks under a share-farm arrangement.

Paddocks are not grazed during the cropping phase as Terry finds:

- Weeds can be better controlled with herbicides when there are no stock to compromise efficacy (e.g. timing, dust, target leaf area)
- Compaction by grazing livestock is avoided
- The large area of crop can be better managed if he is not spending time managing sheep.

Flexicoil tine and press wheels used for sowing crop.

Rotary harrows used in conjunction with coil packer to sow pasture.

Future opportunities and challenges

Terry believes that handling heavy stubble loads remains a major challenge. He may try baling stubble to improve residue flow through machinery at sowing. He is also interested in trying a disc chain or stubble mulching to aid sowing into heavy stubble loads.

'Our biggest challenge is to maintain crop yield and manage disease with heavy stubble loads and remain viable'.

PROPOSED CASE STUDIES

2008/2009

Stubble management demonstrations will be conducted on the five case study farms in the 2008/2009 year with the following aims:

1. To compare different farming systems using different seeding and tillage methods
2. To evaluate the effects of stubble grazing (mixed farming) on soil and crop parameters
3. To investigate the effects of stubble retention and management on soil parameters.

Each demonstration will include up to four treatments (Table 4). All management decisions will be made by the farmer.

Treatments

Table 4 Collaborators and planned treatments for 2008/2009 stubble management demonstrations.

Collaborator	Treatments
Peter Holding	Normal harvest height + graze
	Normal harvest height + graze + burn
	Normal harvest height + harrow (Coolamon harrows) + graze
Bobbara Station	Normal harvest height + graze
	Normal harvest height + mulch (Brookfield disc chain)
	Normal harvest height + mulch (Brookfield disc chain) + biological product
	Normal harvest height + bale
Charlie Baldry	Normal harvest height + graze
	Normal harvest height + graze + burn
	Normal harvest height + mulch (Kelly disc chain) + graze
Peter Cusack	Normal harvest height
	Normal harvest height + light graze
	Low harvest height + light graze
	Normal harvest height + harrow (Coolamon harrows) + light graze
Terry Brown	Normal harvest height + mulch (Kelly disc chain)
	Normal harvest height + mulch (Kelly disc chain) + burn
	Normal harvest height + mulch (Kelly disc chain) + bale

Measurements

It is planned that the following soil and crop parameters will be measured for each stubble management treatment at each demonstration site.

- Stubble load–immediately after harvest and before sowing, including measurements across the width of the header swarth
- Soil moisture–to 60 cm at harvest and at sowing
- Soil nitrogen–to 60 cm at harvest and at sowing
- Penetrometer resistance–at sowing
- Crop establishment
- Early dry matter production
- Crop yield and quality.