Collection Brochures Agronomiques

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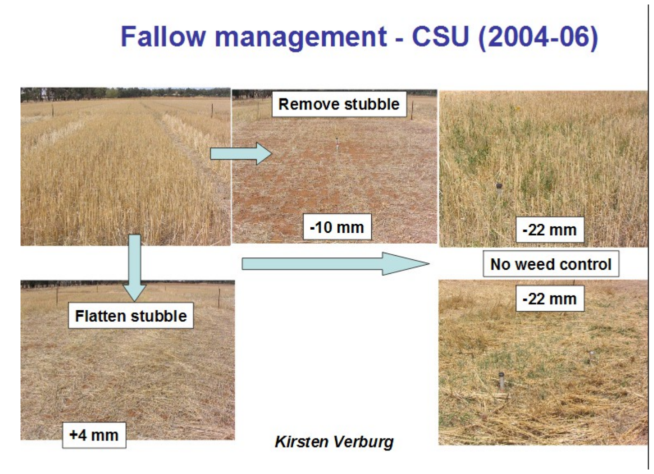
Gestion des chaumes de céréales.

Un moyen pour emmagasiner plus d'eau dans le sol.



Photos de l'essai de Kristen Verburg (Australie).

A gauche, chaumes non pâturés et lutte contre les mauvaises herbes dans les chaume. Conséquences sur le blé qui suit (année sèche).

Essai : mesure de l'humidité du sol selon le niveau de pâturage des chaumes (James Hunt Australie).

Désherbage chimique de chaumes (Australie).

Des travaux australiens montrent que le contrôle des mauvaises herbes sur chaumes réduit l'évaporation; la présence de paille améliore l'infiltration des pluies automnales.

Djamel BELAID.

مهندس زراعي

nb: *Si ces documents vous intéressent, nous vous conseillons de les sauvegarder. Car, ils ne sont disponibles que grâce à l'abonnement mensuel de 12 € que nous payons à l'herbergeur. Toute cessation de cet abonnement rendrait automatiquement le site indisponible.*

Sommaire

Articles australiens sur la gestion des chaumes.

Articles à traduire en français ou arabe avec google.

Ces articles mettent l'accent sur l'importance de :

-**désherber** les chaumes, cela semble étonnant mais selon les régions, les mauvaises herbes estivales sont nombreuses et elles réduisent l'humidité du sol,

-**laisser** de la paille au sol afin d'augmenter la quantité d'eau qui s'infiltre dans le sol lors des orages puis afin d'éviter son évaporation,

-**utiliser** des semis en sec qui pourront bénéficier, certaines années, de cette humidité conservée dans le sol,

-**utiliser** le semis direct afin de préserver l'humidité enmagasiner dans le sol.

0- Il faut avoir en tête que l'Australie se situe dans l'hémisphère sud et que les saisons sont inversées. Vous pouvez traduire ces textes en français ou en arabe.

1- Drivers of fallow efficiency: Effect of soil properties and rainfall patterns on evaporation and the effectiveness of stubble cover

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4- Roulage des couverts, une technique riche d'opportunités qui reste à maîtriser.

5- Lifting productivity in retained stubble systems

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7- Summer weeds drink too much.

8- Improving fallow efficiency

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1 - Drivers of fallow efficiency: Effect of soil properties and rainfall patterns on evaporation and the effectiveness of stubble cover

Kirsten Verburg (CSIRO Agriculture, Canberra) and Jeremy Which (CSIRO Agriculture, Toowoomba)

Take home message
-Soil properties (bulk soil and surface conditions) affect fallow efficiency through their effects on the different water balance terms.
-Rainfall patterns affect fallow efficiency as well as the effectiveness of stubble cover to reduce evaporation losses.
-The more limited effect of stubble retention on evaporation does not take away the benefits stubble cover provides in protecting the soil surface, increasing infiltration and reducing runoff and erosion.

Plant available water at sowing and fallow efficiency
Plant available water (PAW) at sowing will depend on:
-water left behind by a previous crop;
-rainfall amount during the fallow and its distribution; efficiency of water infiltration (versus runoff);
-evaporation;
-water use (transpiration) by weeds;
-drainage beyond the root zone;
-and in some cases subsurface lateral flow.

Fallow efficiency, defined as the proportion of rain falling during the fallow period that becomes PAW, is similarly affected by these water balance terms (Figure 1).

Fallow management like stubble retention or weed control can change the magnitude of some of these water balance terms. In this paper we discuss how soil properties and rainfall patterns affect evaporation and the effectiveness of stubble cover.

A graphical flow diagram illustrating fallow efficiency

Figure 1. The relative magnitude of the different water balance terms determines the balance of inputs and losses and hence the fallow efficiency.

Impact des propriétés du sol sur l'évaporation

De même que les propriétés du sol affectent la capacité d'eau disponible de l'usine (PAWC, voir le document de Verburg et al.,), elles influent également sur l'ampleur des différents termes du bilan d'eau en jachère et donc sur la PAW et l'efficacité en jachère. La plus petite granulométrie des sols argileux leur permet de conserver de plus grandes quantités d'eau que les sols sablonneux (c'est-à-dire les pertes de drainage plus faibles), mais rend également l'espace interstitiel plus fin. Ceci réduit le taux d'infiltration d'eau et peut augmenter les pertes de ruissellement, en particulier dans les précipitations de forte intensité et après des précipitations prolongées. Les conditions de surface du sol peuvent toutefois changer radicalement cette image - les fissures ouvertes dans les sols de rétrécissement contribuent à l'infiltration, tandis que l'étanchéité de surface augmentera le ruissellement.

La PAWC supérieure des sols argileux signifie également que l'eau des petits événements est stockée près de la surface du sol où il sera souvent perdu à l'évaporation si aucune pluie de suivi ne se produit. Dans les sols sablonneux, l'eau s'infiltre plus profondément dans le profil.

L'évaporation peut sécher le sol en dessous de la limite inférieure de culture dans la couche superficielle. Bien qu'il s'agisse d'un processus lent dans les sols argileux, la quantité de pluie nécessaire pour reconstituer ce «seau» non disponible après une période de sécheresse prolongée sera plus importante dans un sol argileux que dans un sol sablonneux. Ceci est illustré à la figure 2, où un sol argileux argileux fruitier peut contenir 11,9 mm d'eau entre la valeur sèche à l'air et la limite supérieure drainée, mais avec seulement 8,7 mm disponibles pour la plante et une capacité d'eau non disponible de 3,2 mm. Si l'évaporation avait séché le sol pour sécher à l'air et que nous avions un événement de pluie de 10 mm, seulement 6,8 mm seraient disponibles pour la croissance des plantes.

En revanche, le sol argileux lourd de la figure 2 contient 42 mm entre la limite supérieure de séchage à l'air et égouttée dont 20 mm sont disponibles pour la croissance des plantes. Dans le même scénario que précédemment, si le sol était sec et que nous avions un événement pluvieux de 10 mm, il n'y aurait pas d'eau disponible pour la croissance végétale, à moins qu'elle ne soit enfoncée dans un sol plus profond et moins sec. Plus de 22 mm de pluie doit tomber pour remplir le seau non disponible à la surface de ce sol. Heureusement, la structure fine du sol argileux lourd signifie également que le seau non disponible prendra beaucoup de temps à sécher, de sorte que, à plusieurs reprises, seules les couches supérieures du sol devront être remplies.

Conceptual diagram of the difference in unavailable water bucket size (UWC) in the surface 20 cm of a sandy clay loam and a heavy clay soil

Figure 2. Conceptual diagram of the difference in unavailable water bucket size (UWC) in the surface 20 cm of a sandy clay loam and a heavy clay soil

Impact of rainfall pattern

The interaction between depth of infiltration and susceptibility to evaporation loss also plays a role in determining the effectiveness with which rainfall is turned into PAW for the subsequent crop. Unless runoff is an issue, large rainfall events will infiltrate deeper than small events, allowing some of the water to be pushed below the evaporation zone and contribute to PAW at sowing. Single, isolated rainfall events have, however, typically a lower efficiency than more frequent events. When two or more rainfall events occur closely together, the resulting soil water 'pulses' can build on each other (Figure 3). The amount of water needed to refill the unavailable bucket in the surface layer (following evaporation) is reduced, thereby allowing the water to move deeper into the profile.

The amount of overlap between soil water 'pulses' is affected by a balance between pulse frequency and pulse duration. Rainfall frequency is the driver behind pulse frequency, whereas pulse duration is affected by the amount of infiltrated rainfall, evaporative demand, stubble cover and soil type.

The above illustrates why the same amount of rainfall can result in different fallow efficiencies. Surface conditions can, however, complicate the picture. Surface sealing following multiple or prolonged rainfall events can reduce the infiltration rate and increase runoff. Conversely, a single large storm on a dry cracking clay soil can infiltrate deeper via the open cracks.

A stacked line graph showing the relationship between presence of stubble cover and fallow efficiency

Figure 3. Rainfall events (vertical blue bars) cause pulses of soil water that last for different amounts of time in the presence (black lines) or absence (grey lines) of stubble. When pulses overlap, more water infiltrates beyond the evaporation zone in the presence of stubble cover and this will increase fallow efficiency. (Adapted from Verburg et al. 2010)

Impact of rainfall pattern on the effectiveness of stubble to reduce evaporation

While rainfall pattern effects are beyond our control, fallow efficiency can be maximised by reducing the losses. Several trials in recent years have demonstrated that weed control dramatically reduces transpiration losses (e.g. Hunt et al. 2011; Routley 2010) and that stubble retention increases infiltration and hence reduces runoff losses (Whish et al. 2009; Hunt et al. 2011). The effect of stubble and stubble management (e.g. standing vs. flattened stubble) on reducing evaporation losses has, however, often disappointed people with many trials returning no significant treatment effects (e.g. Scott et al. 2010; Hunt et al. 2011; Hunt 2013). The exception is when large amounts of stubble are concentrated on a smaller area to create high loads (Hunt et al. 2011).

Several trials in recent years have demonstrated that weed control dramatically reduces transpiration losses and that stubble retention increases infiltration.

The observed limited effectiveness of stubble cover to reduce evaporation losses can be explained using the same concept of soil water pulses. The high evaporative demand experienced during summer in Australia limits the duration of the soil water pulses. In the case of sparse rainfall events this allows the system with stubble cover to 'catch up', despite the initial reduction in evaporation. Freebairn et al. (1987) showed this experimentally in soil evaporation studies using shallow weighing lysimeters. Stubble cover slowed evaporation for around 3 weeks following rainfall, but there was no longer term benefit to soil moisture levels. If the next rainfall event occurs prior to the system catching up, soil water will move deeper in the system with stubble cover and may store (more) water beyond the nominal evaporation zone. A higher level of stubble cover (as in experiments by Northern Grower Alliance, 2015) will prolong the duration of the soil water pulse, increasing the chance of events overlapping and of causing a lasting increase in PAW. In the event of small, isolated rainfall events, high loads of stubble may be detrimental to overall PAW with the water captured in the stubble layer and prone to evaporation.

As shown in Figure 3, evaporative demand plays a role too. A lower evaporative demand will lengthen the duration of soil water pulses and hence increase the chance of pulses to overlap. Indeed simulations as well as data from lysimeter experiments near Wagga Wagga by Verburg et al. (2012) showed that stubble cover later in autumn and early winter (when evaporative demand was lower and rainfall frequency higher) did cause a significant reduction in evaporation (10-15 mm over an 8-week period following sowing into a stubble load of 4 t/ha while differences over the preceding 4 months during summer were only 3-4 mm).

Final remarks

Understanding the drivers of fallow efficiency and awareness of the particular conditions experienced during the fallow will assist in explaining observed PAWs and predict which fallow seasons may have higher or lower fallow efficiency. When using PAW to inform management decisions, it is, however, recommended to confirm actual PAW levels through measurement (soil core, push probe).

While this paper specifically discussed the evaporation loss term of the water balance, it should be noted that the more limited effect of stubble retention on evaporation does not take away the benefits stubble cover provides in protecting the soil surface, increasing infiltration and reducing runoff and erosion.

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Photos :
http://www.australianoilseeds.com/__data/assets/pdf_file/0018/7362/Water-limited_Yield_Potential_John_Kirkegaard_Canola_Workshop_20_March_09.pdf
Lien :

2 - Soil water storage explains yield surprises
Author: Rebecca Barr

Plant-available water capacity overview
More than 1000 Australian soils have been characterised for plant-available water capacity (PAWC). This information is available online and through SoilMapp, an iPad app available from the Apple Store. CSIRO research in collaboration with state agencies, consultants and growers continues to add soils of regional agricultural significance to the APSoil database.

The GRDC-funded project 'Measuring and managing soil water in Australian agriculture' is working with groups of consultants and growers across the country to characterise soils for PAWC and discuss how this information can be used to inform management decisions in farm businesses.

Understanding the soil's capacity to store water can help in better predicting crop yields, particularly in years when rain does not follow traditional patterns.
Image of Kristen Verburg

CSIRO researcher Dr Kirsten Verburg says that understanding plant-available water capacity can help growers make more informed farm business decisions.

While some growers in southern Australia were surprised by higher-than-expected yields in the wake of a dry finish to the 2014 growing season, those who kept a close eye on their plant-available water (PAW) were able to more accurately predict yields, enabling better-informed management decisions.

CSIRO's Canberra-based principal research scientist Dr Kirsten Verburg says when rain did not arrive in spring, growers may have underestimated the volume of water remaining in their soil following a wet start to the winter grains season.

The key terms Dr Verburg recommends growers become familiar with are plant-available water capacity (PAWC) and plant-available water (PAW).

PAWC is the soil's total water-holding capacity, or the 'bucket'. It is the difference between the upper limit where the soil can hold no more water (known as the drained upper limit or field capacity), and the lower limit where any remaining water cannot be absorbed by the plant (known as the crop lower limit or wilting point). PAWC depends on soil texture and crop type and is independent of seasonal conditions.

"The reason it is important to understand PAWC is that it will affect how the crop responds to stored moisture and rain," Dr Verburg says.

"If, for instance, a soil has a large PAWC, then the crop will perform well for quite a while after significant rain. However, if the PAWC is small, the crop will need more frequent rain because the soil can't store as much moisture."

PAW is the available soil moisture and indicates how full the 'bucket' is at any point in time.

Soil moisture terms

Plant-available water capacity (PAWC) is the total amount of water that each soil type can store and release to different crops.

The upper limit of PAWC is the drained upper limit (DUL) or field capacity, at which point any additional water drains, pools or runs off.

The lower limit of PAWC is the crop lower limit (CLL) or wilting point where there may still be moisture in the soil, but it is contained in soil pores too small for plant roots to access.

Soil moisture is the current moisture level (usually reported as a percentage of H2O) as measured by monitoring equipment or modelling, such as Yield Prophet®.

Plant-available water (PAW) is the difference between the current soil moisture and CLL, and represents the volume of water stored in the soil that is plant-available at a point in time.

"In many areas of South Australia in 2014, the PAW was equal to the PAWC – the bucket was full – at the start of the season, and rains through to July kept it that way. This meant that where soils had a large PAWC, stored moisture was sufficient to get the crops through to harvest with good yields," Dr Verburg says.

For example, Riverton in SA's mid-north received only 50 millimetres of rain between August and October 2014 (Figure 1). However, good yields were still obtained because water stored in the soil compensated for the lack of spring rain.

"Knowing this, growers in this region who were on top of their PAW could see that regardless of rain from August onwards, there was still strong yield potential, which helped guide decisions on late fertiliser applications," she says.

Models such as Yield Prophet® can incorporate PAWC data as well as other agronomic information and rainfall to simulate the growing season and help predict yields. Dr Verburg says that growers who used Yield Prophet® in the 2014 season would not have been surprised by the final yields.

“In regions where there was a lot of early rain and good soils, Yield Prophet® would have predicted good yield potential from the end of July regardless of any further rain.”

Graph showing rainfall data
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Figure 1 Riverton, South Australia, rainfall data for 2014 compared with the long-term average.

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3 - Fallow Management affects the Risk of Deep Water Loss

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Résumé
In southern Australia a fallow period provides an opportunity to store water for the subsequent crop. Experimental data are presented that show that fallow management, in particular that of weeds and residue cover, not only affects the amount of water stored or lost during the summer, but also has an effect on the loss of water past the root zone during the subsequent growing season. Model simulations capture these effects and a scenario analysis indicates that retaining residues past sowing increases the risk of deep water loss relatively rapidly. This suggests that managing weeds and residues according to seasonal conditions has the potential to balance the agronomic benefits and environmental impacts of water storage.

Media summary
Analysis of experimental data and model simulations shows that summer fallow management in dryland cropping affects the risk of deep water loss.

Introduction

Fallow management, in particular that of weeds and residue cover has an effect on the loss of water past the root zone during the subsequent growing season.

Dans le sud de l'Australie, les cultures annuelles telles que le blé de printemps (Triticium aestivum) et le canola (Brassica napus) sont cultivées pendant l'hiver pour profiter de la période relativement courte où les précipitations dépassent l'évapotranspiration potentielle. Les précipitations très variables de la saison de croissance signifient que ces systèmes reposent souvent sur l'eau du sol conservée pendant la jachère de court été (décembre - mai) ou la jachère longue (août / septembre - mai). Alors que les mauvaises herbes d'été sont parfois retenues pour le pâturage, la période de jachère est également utilisée pour briser les cycles de maladie des feuilles et des racines, ce qui exige un contrôle strict des mauvaises herbes. Une combinaison de contrôle des mauvaises herbes et de rétention des résidus maximise le stockage des eaux dans le sol. Dans les années plus humides, cependant, cela augmente la perte d'eau et de nutriments au-delà des racines des cultures et des pâturages. Bien que la recherche sur les systèmes résiduaires non labourés ait mis l'accent sur leur avantage à stocker l'eau du sol, leur impact sur l'augmentation des pertes en eau profonde (drainage profond) a également été observé (Turpin et al., 1998; Kirkegaard et al., 2001). Minimiser la perte d'eau profonde est nécessaire pour éviter la dégradation des sols et la salinité des terres sèches (Keating et al., 2002, Williams et Gascoigne, 2003).

nb : quand l'auteur parle de « jachère », cela concerne la période d'inter-culture entre moisson et semis. On fera attention au fait que l'Australie se trouve dans l'hémisphère Sud et que les saisons sont donc inversées.

In this paper we explore the relation between fallow management and the risk of deep water loss through analysis of experimental data and model simulations. We focus on summer fallows in the cropping phase for a temperate climate with a mean annual rainfall of 558 mm, 63% of which falls between April and October (Wagga Wagga, NSW, Australia). While many of the observations will apply equally to drier and/or more Mediterranean climates, the magnitudes of certain effects may differ.

Materials and methods

Soil water content was monitored in four paddocks (all Red Kandosol soils) at three sites near Wagga Wagga, NSW between 1998 and 2000. Measurements were made to a depth of 3 or 6 m with the neutron moisture meter method at intervals of 2 to 6 weeks. Net summer water storage or loss within the root zone (1.3 m), and annual drainage loss from it, were calculated. One of the paddocks (at Charles Sturt University, Wagga Wagga) had two replicate weighing lysimeters ('north' and 'south') allowing direct assessment of evapotranspiration (Et) and drainage. The lysimeters were managed to represent the conditions of the field as closely as possible, but had 90-95 % of crop residues removed when biomass was measured at harvest.

Simulations of the lysimeter data reflected the experimental history of annual crops and a 4-year lucerne phase. They were carried out with the APSIM model (Agricultural Productions Systems Simulator; Keating et al. 2003; version 2.1). Configuration and parameterisation details were given by Verburg and Bond (2003). Rainfall for the simulations was obtained directly from the continuous lysimeter output when possible. In addition, long-term scenarios were set up to reflect a continuous wheat cropping system. These simulations used historical weather data (1957-2003) obtained from the SILO Patched Point Dataset (Jeffrey et al. 2001) for the nearby Australian Bureau of Meteorology station 73127. Sowing of wheat was conditional on rainfall within a sowing window (1 May – 15 June) or sown "dry" on 15 June. Simulation scenarios were run for four years and repeated 44 times by starting them every year from 1957 to 2000. The first three years of the simulation were identical in each scenario to minimise initialisation effects. Fallow management was varied after the third year and its effect evaluated during that fallow and subsequent growing season.

Experimental results

Field evidence

Deep water loss measured in the four paddocks was most affected by growing season rainfall and soil water deficit at sowing (Fig. 1). While it is not possible to control rainfall, the soil water deficit at sowing can be managed. It is affected by soil water deficit after the preceding crop and the storage or loss of water during summer. The former is optimised by good management of the crop, while the latter is affected by summer rainfall and management of plant growth and residues in summer. This is illustrated by the contrasting behaviour of two of the experimental sites during the 1999-2000 summer fallow (Table 1). At site 1 ("Waerawi", Old Junee, paddock D4) canola resprouted in response to 174 mm of rain between windrowing in early November and 31 December. During the summer fallow this caused a depletion of soil water storage of 29 mm. In contrast, site 2 (Charles Sturt University, Wagga Wagga, paddock 14) was covered with thick triticale residue and although its rainfall for the period was slightly less than at site 1, there was a net gain of 38 mm over summer. During the subsequent growing season this led to deep water loss (past 1.3 m) of 26 mm, whereas none was observed at site 1.

Table 1: Comparison of water balances of two sites between December 1999 and September 2000.

	Site 1	Site 2
Soil water deficit at harvest in November/December 1999	62 mm	76 mm
Change over summer fallow	29 mm used	38 mm stored
Soil water deficit at sowing in June 2000	91 mm	38 mm
Deep water loss (below 1.3 m) winter 2000	0 mm	26 mm

Figure 1: Correlation between deep water loss and growing season rainfall and soil water deficit at sowing.

Lysimeter evidence

There was a difference in Et between the two lysimeters in all but two summer fallow seasons between December 1992 and July 2002, ranging from 11 to 54 mm. Observations during the last three summer fallows indicated that different weed growth was responsible. During the 2001-02 summer fallow sufficiently detailed measurements were made to demonstrate that when weeds were included in APSIM simulations the different Et of the two lysimeters was predicted (Verburg and Bond, 2003).

Different weed growth during the summer fallow was also found to impact quite strongly on drainage collected from the lysimeters in 1993 (Fig. 2). Although the north lysimeter received supplementary nitrogen fertiliser in August, cumulative Et from the two lysimeters differed by less than 6.5 mm until early October. Most drainage had already occurred by late September, with significant differences between the two lysimeters in both amount and timing. The lysimeters were shown to have the same water storage at harvest in 1992. This implies that the different drainage patterns observed in 1993 were a consequence of different water loss during the 1992-93 summer fallow. Simulations discussed in the next section indicate that this can be explained by different weed growth.

Differences in drainage between the two lysimeters for the whole 9½ year record are striking (Table 2). The lysimeters were managed identically during the cropping seasons, except for extra fertiliser applied to the north lysimeter in 1993, and an irrigation experiment carried out on only the south lysimeter in 1996, which contributed a difference of < 5 mm in drainage in 1993, and 40 mm in 1996. The remaining difference is attributed to differences during the summer fallow, as confirmed by the simulations discussed below.

Table 2: Measured and predicted cumulative drainage (mm) from the lysimeters (1.8 m) between December 1992 and July 2002.

	North lysimeter	South lysimeter
Measured	69	197
Simulated	59	177

Figure 2: Observed cumulative Et (a) and observed and predicted drainage at 1.8 m from lysimeters (b) during the 1993 growing seasons.

Figure 3: Effect of time of residue removal on predicted long-term (1960-2003) average deep water loss at 1.2 m.

Simulations

Verburg and Bond (2003) presented a detailed evaluation of the water balance capabilities of APSIM using data from the lysimeters. They showed that the model captured the different drainage behaviours of the two lysimeters, with measured and simulated drainage for the whole 9½ year simulation period agreeing closely with observations (Table 2). When detailed information on weed dynamics was available its water use was also simulated very well (Verburg and Bond 2003). There has been little testing of residue impacts, largely due to a lack of adequate data, but the limited evidence presented by Verburg and Bond (2003) suggests that the model captures the effects on water storage satisfactorily, subject to uncertainties caused by residue configuration (standing vs. flat). This provides the necessary confidence to carry out a simulation analysis of the implications of the practice of retaining residues.

Previous studies on the impact of surface residues on soil water storage have pointed out that the effects are most marked when rainfall occurs regularly (Felton et al. 1987; Fischer 1987). The effects of different residue management will, therefore, be greater in wetter summers. We hypothesize that the effects of residue cover on soil water storage may also be more marked following the autumn break, when rainfall events tend to be more frequent and evaporative demand is lower. To test this hypothesis we studied the effect of the date of 90% residue removal on deep water loss during the subsequent growing season. By resetting the residue amount at the start of the fallow season to 4 t/ha and not allowing decomposition to take place, the effect of timing of removal was evaluated for the natural variation from year to year of soil water and rainfall, but in the absence of the confounding effect of varying residue amounts. An amount of 4 t/ha was chosen because it would not interfere with the sowing operation. It was further assumed that crop establishment was not affected by the residue cover and that summer weeds were controlled perfectly.

The results indicate that the effect of residue cover was

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indeed more critical late in the fallow period and early in the growing season before transpiration becomes significant (Fig. 3). During this period the long-term average deep water loss increased relatively rapidly for every extra week that residue cover was retained. Of course removal of residues between sowing and harvest is not possible in reality, but it does point out that the risk of deep water loss is reduced by residue removal before the growing season, using a light burn, or practices that enhance decomposition, such as mulching or rolling. Removal of 90% of residues on 1 May resulted in 42% less drainage (44 year average) than if they were left until harvest. This benefit is, however, accompanied by a 14% reduction in yield for the well fertilised and disease-free conditions simulated.

The effect of residue management on deep water loss and yield in individual years depends on seasonal conditions; for example in very dry years the extra yield obtained by retaining residue is not accompanied by an increase in deep water loss, and in very wet years the reverse is true. Residue management should therefore be adjusted in accordance with the seasonal conditions to minimise the risk of deep water loss while maximising yield. Deriving guidelines to balance these benefits and penalties is the subject of ongoing research and will include socio-economic as well as biophysical considerations.

Concluding remarks

The experimental and simulation analyses presented here suggest that water storage or loss during the fallow impacts quite strongly on the risk of deep water loss. This means that fallow management needs to find a balance between agronomic benefits and environmental impacts of water storage. In particular it has to be more responsive to seasonal conditions and aim for less year to year variation in soil water deficits at sowing than would be the case if one managed for optimal productivity or minimal environmental impact alone.

4 - ROULAGE DES COUVERTS, UNE TECHNIQUE RICHE D'OPPORTUNITÉS QUI RESTE À MAÎTRISER

Matthieu Archambeaud - TCS n°64 ; septembre/octobre 2011

Importée d'Amérique du Sud peu après le semis direct, la destruction des couverts d'interculture par roulage s'est fortement développée dans le monde et en France. La technique est si prometteuse qu'on peut aujourd'hui l'observer sur tous les continents, aussi bien en AC que désormais en AB ou en agriculture plus classique. Contrairement à la destruction par mulchage, le « rolo faca » (rouleau hacheur) permet de ne pas toucher au sol et par conséquent d'arrêter une végétation vivante à moindre coût, sans ou avec peu de chimie, et surtout sans toucher au sol et donc sans risque de relancer une germination. Par ailleurs, la conservation de la couverture morte après roulage permet de garder une protection au sol contre les agressions climatiques, le salissement, l'évaporation et les variations brutales de température. Enfin, l'incorporation progressive de la couverture au sol diminue le risque de faim d'azote pour la culture suivante, ce qui n'est pas le cas avec un mulchage.

Un couvert sensible est un couvert à forte biomasse

L'objectif du roulage est de blesser les plantes dans des conditions climatiques extrêmes pour qu'elles ne puissent pas survivre. Si les Sud-Américains utilisent la technique en conditions sèches et chaudes, en Europe, c'est le froid, voire le gel, qui en améliore l'efficacité. La technique intéresse naturellement les SDistes et les bios français, mais on voit se multiplier les essais en agriculture plus classique. En effet, la réussite de plus en plus fréquente de couverts à forte biomasse peut gêner la fauche ou le broyage : le roulage devient une solution économique et relativement simple de contrôler ce type de végétation.

Plusieurs conditions doivent être réunies pour assurer une destruction efficace de la couverture. En premier lieu, le roulage n'est efficace que sur une végétation haute et développée. Le facteur mécanique intervient tout d'abord : une plante développée pourra être blessée en plusieurs endroits, multipliant les portes d'entrée pour le froid, la chaleur, les pathogènes ou les ravageurs. Deuxièmement, on sait qu'à partir de la floraison, les plantes sont beaucoup plus sensibles à ce mode de destruction : les réserves du végétal sont alors réorientées vers la reproduction plutôt que vers la végétation.

Cette sensibilité est d'ailleurs valable au roulage comme au gel et parfois à la fauche et au broyage. Bien entendu, pour atteindre ce stade critique, le couvert doit auparavant avoir mis en place son appareil racinaire et aérien et avoir atteint son optimum de végétation, date à laquelle il aura par ailleurs rempli efficacement son rôle de couvert.

En fonction de la date de destruction envisagée, c'est donc la date d'implantation qui va déterminer la réussite du roulage. Si pour des intercultures longues, des dates relativement tardives de semis sont envisageables (sans toutefois attendre l'arrêt de la végétation), pour des intercultures courtes avant céréale, une date de semis très précoce est indispensable.

Le gel est une aide précieuse mais pas indispensable

En ce qui concerne les conditions d'opération, il est généralement recommandé de rouler lors d'une gelée : des plantes pouvant survivre normalement au froid, verront leurs tissus rendus cassants et atteints en profondeur par le rouleau, entraînant une mort certaine. La nécessité du gel sera rendue d'ailleurs d'autant plus nécessaire que l'outil n'est pas spécialisé (rouleau lisse, trop léger, etc.) ou que le couvert est trop faiblement développé (date de semis tardive, espèces résistantes au roulage et/ou manque de fertilité du sol). On entend également couramment que le roulage doit intervenir sur sol gelé pour éviter de porter atteinte à la structure, mais de façon générale, un sol bien couvert gèlera plus difficilement et c'est la biomasse du couvert elle-même qui servira d'amortisseur. Attention toutefois au poids des tracteurs qui circulent à cette période, bien que le besoin de puissance soit minime pour ce type d'opération.

Des rouleaux spécifiques

La spécificité du rouleau est également un facteur de réussite. Un simple rouleau lisse, ou mieux, un rouleau de type crosskill ou à barres, aura une certaine efficacité à condition d'opérer lors d'une gelée blanche et sur des couverts développés. Cependant, moins les conditions climatiques, le stade et le type de végétation seront propices, plus le rouleau devra être spécialisé. Un diamètre important du rouleau permet tout d'abord d'avoir une vitesse de rotation moins élevée et davantage de lames sur la bille : l'outil pianotera moins, tout en gardant de la stabilité et de la pression dans les biomasses importantes. Cela laisse aussi la possibilité de charger le rouleau avec de l'eau ou du sable en fonction de la météo et de la coriacité du couvert (sinon des masses de tracteur font tout aussi bien l'affaire).

L'inclinaison des couteaux par rapport au diamètre joue aussi, sachant qu'en fonction de l'angle d'attaque, on aura un outil plus ou moins agressif : dans la plupart des cas, un angle fuyant suffira à blesser les tiges mais l'inversion du sens de montage permettra d'augmenter l'effet des couteaux sur des couverts ligneux par exemple. Attention d'ailleurs dans le cas d'outils trop « mordants » par rapport au volume de végétation : un rouleau fait alors un très mauvais déchaumeur et se chargera d'ailleurs assez rapidement de terre. La disposition des lames sur la bille entre également en jeu : un montage « droit » (perpendiculaire au sens d'avancement) favorise le pianotage et réduit donc la stabilité ; la pression de pincement est de plus inutilement répartie sur toute la largeur de roulage.

Un montage hélicoïdal des lames, ou plus simplement un montage en « ailettes décalées », permettra de contourner le problème.

Choisir les espèces et les variétés sensibles

Le dernier point à aborder concerne la sensibilité des espèces, voire des variétés. La question est d'autant plus importante que la couverture doit parfois être détruite en dehors des périodes de froid, avant un semis d'automne ou de printemps tardif par exemple. Les espèces qui montent seront ainsi plus facilement détruites que celles qui restent au ras du sol : un radis fourrager sera aisément tué, au contraire d'une navette ou d'un colza dont les organes de réserve souterrains sont protégés du froid et du roulage.

La physiologie de la plante et son stade de développement jouent également, les tiges creuses étant plus facilement détruites que celles qui sont pleines ou déjà lignifiées. Une moutarde verte se détruit facilement, ce qui n'est plus le cas d'une moutarde fleurie dont la tige a durci. Dans le même ordre d'idée, un trèfle incarnat fleuri ou une féverole se détruisent aisément par roulage, à l'inverse d'un trèfle violet ou d'une luzerne qui sont des plantes pérennes. Le cas des céréales est encore plus intéressant : le roulage (conventionnel) d'une céréale en herbe renforce le tallage et donc la vigueur des plantes, alors qu'elle peut être détruite par un simple passage de rouleau (spécifique) au stade épiaison. Attention toutefois de seulement blesser les tiges de céréales et non de les trancher : la plante s'épuise à essayer d'alimenter des talles pincées mais en émettra de nouvelles, si celles-ci sont tranchées (comme pour un broyage, une fauche ou un pâturage d'ailleurs).

Sélectionner des variétés adaptées

Le choix de la variété entre également en ligne de compte pour tous les facteurs abordés précédemment, il est nécessaire de choisir des couverts qui atteindront le stade adéquat à la date de destruction envisagée : ni trop avancé (risque de montée à graines) ni trop peu (difficulté de détruire la couverture par roulage).

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Au final, si on veut augmenter les chances de succès, c'est-à-dire de destruction totale sans utilisation de travail de sol ou de chimie complémentaire, notamment dans les zones hors gel de l'ouest de la France, le choix des espèces et du rouleau est primordial. Quand les conditions ne sont pas réunies, un deuxième passage peut être envisagé, voire l'utilisation complémentaire de doses réduites de désherbants, comme l'a montré Arvalis (lire notre encadré page 8).

Une technique riche d'opportunités à explorer

En dehors de la destruction des couverts, et à condition de connaître ses avantages et ses limites, le roulage peut devenir un outil performant de gestion des plantes. Tout d'abord, sans aller jusqu'à la destruction totale du couvert, un passage de rouleau à l'automne ou au printemps peut permettre de calmer une végétation jugée trop vive et de différer ainsi une destruction mécanique ou chimique ultérieure, voire d'achever la destruction dans la culture qui suit avec un programme de désherbage adapté.

Les différences de sensibilité des végétaux au roulage, qui sont souvent vues comme un inconvénient, peuvent être considérées d'un autre oeil en faisant du rouleau un « désherbant mécanique sélectif » qui éliminera les plantes sensibles et conservera les plantes résistantes. On peut envisager la destruction de plantes hautes (implantées ou spontanées) au profit de plantes-relais tapies dans le fond d'un couvert (céréale, colza, trèfle ou luzerne par exemple), l'affaiblissement de plantes vivaces fleuries dans une jachère ou dans une prairie sans faucher et donc sans relancer de tiges (chardon, rumex…). Pourquoi également ne pas remplacer les socs de la bineuse par des rouleaux pour assurer un désherbage localisé de l'interrang sans toucher au sol et en conservant le mulch ? Enfin, des utilisations comme aplatisseur ou éclateur de C.

WALIGORA/PIXEL IMAGE chaumes de céréales, maïs, tournesol ou colza ne sont pas à exclure.
Si le roulage des couverts semble simplissime au premier abord, on s'aperçoit en fait qu'il n'en est rien et que c'est un ensemble de paramètres qui détermine la réussite. Cependant, la maîtrise technique du roulage permettra sans doute de passer d'un simple outil de destruction des couverts à un outil polyvalent capable de calmer et de sélectionner des végétations, de désherber en association avec d'autres moyens mécaniques et/ou chimiques, et sans doute encore d'autres atouts qui restent à découvrir. Toutefois, avant de se lancer dans l'achat ou la construction de rouleaux perfectionnés, essayez déjà celui qui est dans la cour.

5 - Lifting productivity in retained stubble systems

Author: James Hunt, Tony Swan, John Kirkegaard, Laura Watson, Brad Rheinheimer, Mark Peoples, Neil Fettell, John Small, Tony Pratt and Paul Breust

Take home messages

-Stubble reduces yield in canola-wheat rotations, particularly at higher yields

-Crop diversity is one of the main principles of conservation agriculture – inclusion of legumes and barley can improve profitability and sustainability of stubble retained systems

-Burning wheat stubble in canola-wheat-wheat rotations in C & SNSW increases profit, but can be operationally difficult and comes at a cost to soil health and possibly sowing opportunities

Background

Recent experiments in central and southern NSW using modern zero and no-till methods in farmers' paddocks (Table 1) and small plot trials (Table 2), as well as longer term experiments have shown that in canola-wheat rotations, cereal stubbles reduce yield. The average yield penalty from retaining stubble across 22 years at the CSIRO Harden field site is 0.3 t/ha for wheat and 0.4 t/ha for canola. The NSW DPI SATWAGL experiment at Wagga Wagga recorded similar penalties, and at both sites yield penalties due to retaining stubble were positively related to growing season rainfall. Experiments investigating these penalties in modern farming systems will be ongoing as part of research by CWFS, FarmLink and CSIRO in the GRDC stubble initiative.

It needs to be remembered that stubble is essential for reducing wind and water erosion, maximising infiltration of summer rainfall events and maintaining good soil structure, and at least 70% stubble cover (2-3t/ha cereal stubble) should be kept on all paddocks at all times during the summer fallow period. However, retaining levels greater than this past sowing is unlikely to provide any yield benefits, and will often lead to yield reductions.

Yield penalties from stubble retention are largely due to N tie up and temperature effects, and identifying and addressing these problems before they occur can improve profitability in stubble retained systems.

Table 1. Yield of canola under different stubble (wheat) treatments in paddock scale trials managed by zero-till farmers conducted by CWFS in 2013 as part of the GRDC Stubble Initiative. Values with a different letter indicate yields are significantly different ($P<0.05$) within each site.

PROBLEM: Soil bacteria and fungi that break down retained stubble compete with crop plants for N, and this has to be taken into account when budgeting N in stubble retained systems. A rough rule of thumb is that every tonne per hectare of cereal or canola stubble will tie-up (immobilise) 5 kg/ha of N. This means that in a paddock with a typical SE NSW cereal stubble load of 5 t/ha, 25 kg/ha of N will be tied up if the stubble is retained, and this must be compensated for with fertiliser N if yield is to be maintained.

SOLUTION: Add more N to paddocks with retained cereal stubbles (5 kg/ha N per 1 t/ha of stubble). Assume that there is no net mineralisation when budgeting N for these paddocks.

Temperature effects

PROBLEM: Retained stubble cools the temperature of the soil and the air immediately above the stubble where plants are growing. This reduces establishment and slows growth rates, particularly of canola, and often results in reduced biomass and yield. This effect is generally worse when stubble is spread evenly across the soil surface rather than retained standing.

During spring, stubble can also insulate the crop canopy from the warmth of the soil during frost events, and in 2013 greater frost damage and lower yields were observed where stubble was retained (Table 3)

Table 3. Grain yield and frost damage for different stubble treatments applied prior to sowing at the FarmLink and CSIRO stubble initiative site at Temora.

SOLUTION: Harvesting high, keeping stubble standing and then inter-row sowing on wider row spacing can reduce this effect somewhat (Table 4), but most experiments suggest that canola establishment, growth and yield is improved by removing cereal stubble to levels below 2 t/ha.

As well as reducing crop yields, harvesting low and spreading stubble is very costly (Table 5). At a FarmLink and CSIRO stubble initiative site near Wagga, harvesting low and spreading stubble, cost 0.14 t/ha of grain yield even

though the header was being driven by an experienced operator according to the yield monitor. It is estimated that this yield loss plus increased fuel consumption and reduced efficiency, cost the grower approximately $64/ha. This does not take into account the additional risk of weather damage and downgrading due to slower harvest.
Figure 1. Canola establishment and growth in an experiment conducted by FarmLink and CSIRO

Figure 1. Canola establishment and growth in an experiment conducted by FarmLink and CSIRO in a zero-till system near Wagga Wagga (Bonito sown 19 April with 50 kg/ha MAP). Stubble on the left was harvested high and then burnt whilst the stubble on the right harvested low and spread (John Deere 9770 STS with Power Cast tailboard).

Table 4. Canola establishment and NDVI on 30 May 2014 following different stubble management treatments applied in a zero-till paddock near Wagga Wagga. Treatments were applied to a 7.6 t/ha stubble, the chopped treatment used a K-Line Trashcutter in December and the burnt treatment was applied in late March.

Table 5. Grain yield, harvest efficiency, speed and fuel consumption from the yield monitor of a JD9770 STS header in 7.6 t/ha stubble near Wagga Wagga in 2013. All differences are statistically significant ($p<0.05$).

Crop diversity – the forgotten main principal of conservation agriculture
In central and southern NSW, there has been strong adoption of two of the three main principals of conservation agriculture as defined by the FAO; 1) direct planting of crop seeds and 2) retention of permanent soil cover, particularly with crop residues. However, the all important third principal 3) crop diversity is neglected, and canola and wheat dominate cropping rotations. Many of the constraints currently experienced in retained stubble systems could be overcome with the inclusion of more crop types, particularly legumes. This includes pulses, pastures and forage/hay crops. Brown manures certainly remove some of the constraints of retained stubble, but can reduce profitability at a paddock scale, although this may be compensated for by whole-farm operational benefits.

Most legumes do not seem to suffer the same yield penalty experienced by canola and wheat in the presence of large cereal stubble loads. Numerous experiments in SA have shown that the yield of pulses is frequently higher with retained stubble. This is due to stubble providing a ‘trellis’ which increases height of lowest pods and improves harvestability, and also reduced splashing during rainfall events carrying soil-borne diseases up onto foliage. In southern Australia, high profile practitioners of zero-till tend to come from regions suited to growing high value pulse crops (e.g. the Wimmera of Victoria and upper Yorke Peninsula of SA) and these play an important role in their crop sequences.

Legume residues are also less antagonistic to canola than cereal residues, primarily because there tends to be less of them and they break down faster. For this reason, canola growing after legumes yields more than canola growing after wheat, even when extra N is added to the canola growing after wheat (Table 6). Due to this yield increase and reduced fertiliser N requirement, a pulse (e.g. lupins) followed by canola can be as profitable as wheat followed by canola, even if the pulse itself is not as profitable as wheat.

Growing canola after a legume also provides a ‘double break’, which is essential for reducing seed-banks of annual ryegrass and black oats, and inoculum of diseases such as crown rot.

Wheat can be grown very cheaply after a double break, has fewer stubble borne disease problems (yellow leaf spot, crown rot) and typically yields well. Recent GRDC research in the Victorian Mallee has found that crop sequences including a double break were more profitable than continuous cereals or sequences with a single break (see Ground Cover 111 July-August 2014 page 42). Growing barley instead of wheat-on-wheat further increases diversity, overcomes more stubble constraints (yellow leaf spot), and is often more profitable than a second wheat. It also helps manage frost risk, contributes to IWM by allowing later sowing with a double knock and improved competition with weeds.

Table 6. Comparisons of grain yields, applied N and gross margins of canola following different crops at Eurongilly.

Future research – Sequences for seeders
As outlined above, a crop rotation of legume – canola – wheat – barley has the potential to overcome many of the constraints imposed by retained stubble in canola-wheat rotations. In theory, it should improve profitability and sustainability of retained stubble systems. However, this has not been experimentally tested. As part of the CSIRO and FarmLink GRDC stubble initiative project, a new farming systems experiment at the Temora Ag Innovation Centre will test this. It will compare the yields, profitability and sustainability of three different sequence systems

(Conservative, Aggressive and Sustainable) with zero- and no-till seeding equipment (Excel single-disc with Aricks wheel vs Flexi-Coil tine with Stiletto knife-points and deep-banding/splitting boots). Sequence systems are as follows;

Conservative – TT canola, wheat, wheat (wheat sown at low density with trifluralin/diuron IBS and 20 kg/ha up-front N)

Aggressive – RR canola, wheat, wheat (wheat sown at high density with Sakura®/Boxer Gold® and 40 kg/ha up-front N)

Sustainable – vetch/pea hay, TT canola, wheat, barley (wheat sown at low density with Sakura® and 20 kg/ha up-front N)

As with all systems experiments, the first meaningful results will not be available until the second year of experimentation – 2015.

Conclusion
Retaining cereal stubble past sowing reduces yields in canola-wheat rotations. Yield reductions can be reduced by adding more N to stubble retained paddocks, keeping stubble tall and inter-row sowing, and by growing canola after legumes rather than cereals. Late burning of cereal stubbles in zero- and no-till systems consistently increases subsequent crop yield, particularly canola, but needs to be balanced against the operational and NRM benefits of stubble retention.

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Date: 30.06.2014

6 - Close eye on research lifts WUE and saves the sheep

Author: Nicole Baxter

Photo of bearded man

Derek Ingold has adopted a range of practices, including buying a disc seeder, to improve water infiltration on his family's 2400-hectare property near Dirnaseer in southern New South Wales.

PHOTO: Nicole Baxter
Adopting a range of practices to improve water infiltration is proving beneficial for the Ingolds near Dirnaseer in southern New South Wales

Owners: Derek, Susan and Alexander Ingold
Location: Dirnaseer, New South Wales
Farm size: 2400 hectares
Annual rainfall: 525 millimetres
Soil type: red kandasol
Soil pH (CaCl): 5.0 plus
Enterprises: crop (70 per cent), pasture (25 per cent), remnant vegetation (5 per cent)
Sheep numbers: 2500 ewes
Typical crop sequence: cereal/broadleaf/cereal
Crops grown: canola (TT Gem), wheat (Whylah, EGA Wedgetail, Sunvale and Suntop)
Sowing equipment: 12-metre Boss disc seeder on 254mm row spacings with Flexi-coil air cart; all machinery is set on a 3m controlled-traffic layout

Related videos:
Watch the GroundCover TV Extension Files on Early Sown Wheat
Still from Early Sown Wheat playlist

Derek and Alexander Ingold have implemented a package of practices to maximise water and nitrogen availability on their farm near Dirnaseer, 75 kilometres north-east of Wagga Wagga in southern NSW.

For the past eight years, the father and son have closely watched a study by CSIRO and FarmLink Research investigating the management practices needed to increase grain productivity and whole-farm returns on their 2400-hectare farm.

The GRDC initiated the study in 2008 to challenge growers and researchers across Australia's southern and western cropping regions to increase grain productivity by 10 per cent.

The study showed water use efficiency (WUE) could be improved by:

- maintaining 70 per cent stubble cover;
- taking a zero-tolerance approach to summer weeds;
- sowing earlier with slow-maturing crops;
- avoiding a build-up of excessive early biomass;
- using break crops; and
- improving the timeliness of operations.

Lutte contre les mauvaises herbes en été

A partir de la récolte, les Ingolds utilisent des herbicides pour contrôler les mauvaises herbes estivales afin de maximiser la disponibilité de l'eau et de l'azote pour les cultures suivantes.

Après que les mauvaises herbes ont été contrôlées, les moutons sont autorisés à brouter le chaume, mais Derek dit que ce n'était pas toujours le cas. Il y a une dizaine d'années, ils ont cessé de brouter les moutons sur les chaumes et avaient commencé à éliminer les moutons de leur système, croyant que les moutons avaient endommagé le sol et réduit l'infiltration d'eau.

«Initialement, je pensais que les moutons faisaient des dégâts importants», dit Derek. «Vous les mettiez sur un chaume et en une journée ou si le sol serait pulvérisé et poudreux."

Ainsi, lorsque la recherche de FarmLink a reçu un financement de la GRDC dans le cadre de l'Initiative nationale de l'UME, Derek a rejoint le comité directeur et a encouragé l'équipe de recherche à étudier les effets du pâturage des moutons sur les rendements des céréales.

"À l'époque, j'espérais que l'étude confirmerait que les moutons baissaient nos rendements afin que nous nous débarrassions d'eux", dit-il en souriant - mais il n'était pas censé l'être.

La recherche dirigée par le Dr James Hunt du CSIRO, en collaboration avec FarmLink Research, des consultants locaux en cultures et des cultivateurs, a été entreprise sur la propriété de Peter, Lynne et Jason Coleman, au sud de Temora, en Nouvelle-Galles du Sud. Il a montré que les moutons n'étaient pas aussi préjudiciables que d'abord pensé dans un système bien géré.

Couverture du sol par les chaumes

Selon le Dr Hunt, les moutons qui paissent le chaume et les cultures n'ont pas d'impact négatif sur les rendements des céréales, à condition que le pâturage soit bien géré, que les mauvaises herbes soient maîtrisées et que 70 pour cent de la couverture végétale (deux à trois tonnes par hectare de chaume) est maintenue pendant la phase de chaume.

Après avoir vu les résultats, Derek est maintenant assez confiant pour permettre à ses brebis de pâturer les pâturages de chaume pendant deux à quatre semaines en été et en automne. Mettre les brebis sur les chaumes permet aussi de terminer les agneaux de la famille sur la luzerne.

Photo of CSIRO water use efficiency researcher Dr James Hunt

Water use efficiency researcher Dr James Hunt, from CSIRO
Le Dr Hunt indique que les résultats du test ont également montré que tout compactage causé par le pâturage des moutons sur les chaumes était peu profond et transitoire, disparaissant habituellement après le sol soit mouillé à nouveau.

«L'infiltration d'eau réduite et le rendement du pâturage sont dus à l'enlèvement de la couverture plutôt qu'à la compaction», dit-il. "C'est la bouche des moutons qui font des dégâts, pas leurs sabots."

Une autre constatation qui a changé l'avis de Derek sur la question de savoir si garder les moutons était l'effet bénéfique qu'ils avaient sur le recyclage des éléments minéraux.

Le Dr Hunt affirme qu'il est fort possible qu'il y ait plus d'azote mesuré sur des parcelles qui ont été broutées en raison du retour de l'azote dans l'urine et une solubilisation accrue de l'azote organique à pH élevé sous un dépôt d'urine important (le sol de l'exploitation est acide).

Selon Derek, un autre avantage de ne plus utiliser d'herbicides en été et en automne est que ces résultats ont renforcé son approche concernant la résistance des mauvaises herbes vis-à-vis des herbicides.

Pour maintenir l'eau du sol et l'azote stockés pour les cultures, les Ingolds veillent à garder les enclos exempts de mauvaises herbes jusqu'en avril, lors de l'application de pulvérisations avant le semis.

Bien que le semis directs aient été utilisés depuis le début des années 1980 et que les semoirs à dents aient été utilisés à la fin des années 90, Ingolds a acheté un semoir à disques Boss de 12 mètres réglé sur des espacements de 254 millimètres en 2012 afin d'améliorer leur capacité à semer entre rangs tôt dans le chaume lourd.

Derek dit que la raison principale pour maintenir le chaume est d'augmenter l'infiltration des précipitations. La couverture de chaume réduit également l'érosion sur les collines de Ingolds si de fortes tempêtes frappent.

Pour maximiser les rendements grâce à la gestion des risques, les Ingolds ont zoné leur propriété, les moutons étant confinés dans les parties inférieures du paysage (où le gel est une menace potentielle pour les rendements des cultures).
Sur les bas pays, la luzerne est cultivée pendant cinq à six ans, suivie par un ou deux ans de pâturages, puis de canola, de blé et de retour à la luzerne.

Les agneaux sont autorisés à brouter la luzerne jusqu'au début de mai (attention l'Australie est dans l'hémisphère Sud, les saisons sont inversées) avant qu'ils ne soient mis sur le blé de pâturage et ensuite vendus sur le marché d'exportation en juillet à environ 30 à 32 kilogrammes de poids habillé.

Le pays le plus élevé de la famille est cultivé intensivement pendant environ 10 à 15 ans, en fonction de la charge de graines de mauvaises herbes et de l'azote du sol.

Avant de réutiliser un semoir à disques, on a utilisé un semoir à distribution pneumatique Flexi-coil avec des dents et des roues plombeuses. Cependant, le semis entre les rangs de chaume sur les parcelles en pente s'est avéré impossible parce que la partie du semoir portant les dents se déporte latéralement.

Après une année d'utilisation du semoir à disques, Derek considère la machine comme l'un de ses meilleurs investissements. Un système de circulation contrôlée d'une largeur de trois mètres a également été mis en place sur les parcelles pour éviter la compaction des sols. (*Ce système est possible avec GPS et espacements des roues réglées sur 3 m et passant chaque année au mê^me endroit dans les parcelles*).

Au moment de la récolte, les récoltes sont coupées le plus haut possible pour augmenter la capacité de récolte et éviter de manipuler trop de résidus au sol au moment du semis

Pratique des semis précoce
Pour profiter des efforts consentis pour conserver l'humidité du sol et l'azote pendant l'été et l'automne, les Ingolds aiment semer tôt leurs blés de pâturage dans des enclos sans mauvaises herbes.

Les variétés Whylah et EGA Wedgetail sont généralement semées du 7 au 14 avril (*ce qui correspondrait à 7 au 14 octobre dans l'hémisphère Nord*), ce qui leur permet d'établir des racines profondes pour l'écoulement dans l'humidité stockée et l'azote plus tard dans la saison de croissance. L'azote est appliqué en culture pour correspondre à la disponibilité et au rendement attendus de l'humidité du sol, ce qui est évalué par un abonnement au modèle de prévision des récoltes Yield Prophet®. Cette stratégie a également contribué à éviter une accumulation excessive de biomasse précoce, ce qui peut causer de l'échaudage si les conditions devenaient trop sèches en fin de cycle.

La menace de résistance aux herbicides est maintenue faible en appliquant les taux d'herbicide à l'étiquette, en utilisant des variétés de canola (colza) tolérantes à la triazine et en brûlant des andains étroits en automne pour détruire les graines de mauvaises herbes résistantes aux herbicides.

Si la charge de mauvaises herbes devient insoutenable sur un paddock (parcelle) particulier, les Ingolds ont la possibilité de le faire tourner de nouveau à la luzerne.

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«Les moutons offrent une meilleure marge brute que les cultures d'engrais », dit Derek.

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7 - Summer weeds drink too much.
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Controlling summer weeds is potentially one of the most cost-efficient methods of improving water use efficiency in the Mallee

By Michael Walsh, Claire Browne and James Hunt

Managing the fallow period to maximise the storage of summer rainfall is well recognised as a vital part of improving water use efficiency (WUE) in Australia's northern cropping region. In much of the southern and western regions, changes in rainfall pattern and totals highlight the importance of storing as much summer rainfall as possible across these areas as well.

[Photo (left) by Emma Leonard: Weeds and volunteer cereals growing over summer can reduce subsequent wheat yields by more than 50 per cent.]

While stubble cover has been proposed as an important part of increasing infiltration and reducing evaporation, in the Mallee controlling summer weeds is proving to be the key to maximising the storage of summer rainfall.

In collaboration with CSIRO, BCG (formerly the Birchip Cropping Group) has established a four-year study at Hopetoun, in north-west Victoria. Research at this site will further investigate the role of summer weed control and stubble treatments in relation to storage of summer rainfall and subsequent grain yield.
At the end of the 2008 growing season, six treatments (Table 1) were established on a light-textured (sand) soil and a heavy-textured soil with subsoil salinity (clay loam). To determine the amount of plant-available soil water stored over summer, soil water was measured, after harvest, when stubble treatments were established, and then again immediately prior to sowing in 2009.
In this study weeds were controlled by herbicide or cultivation when more than 10 plants per square metre were counted or when a significant (10 millimetre) rainfall event stimulated an emergence. This resulted in between two and three treatments to control weeds between harvest (27 November 2008) and seeding (14 May 2009). Over this period 94mm of rainfall was recorded with less than 10mm of rain falling between the end of January and the end of April.

Retaining stubble and controlling summer weeds resulted in an extra 49mm of stored soil water (48mm plus 1mm) at the clay site and 37mm (32mm plus 5mm) at the sand site (Table 1).
Previous work indicates that weeds and volunteer cereals growing over summer can reduce subsequent wheat yields by more than 50 per cent. Additionally, the greater the density of these weeds and volunteers the bigger the yield loss.

Controlling summer weeds can be one of the most cost-effective input investments available to growers in the Mallee. Preliminary indications are that the control of summer weeds can return $5 for every $1 invested in their control.

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8- Improving fallow efficiency

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Take home message

-While ~20% of rain is stored during fallows, small changes in soil management can improve this apparent low efficiency and have large impacts on profit.

-Water stored can be improved through longer fallow, weed control, soil cover and reduced compaction. This can be achieved through reduced tillage, controlled traffic and planting crops before the soil fills.

-Stubble retention combined with reduced or zero tillage almost universally results in better water storage.

-Better water storage results in better yields, especially in dry years.

-Soil water and N mineralisation can be tracked using a number of decision support tools (e.g. Australian CliMate, Soil Water App, Yield Prophet).

Getting water into the soil

Storing soil water is a challenge in our environment where evaporation potential is higher than rainfall in all months. Typically, we have 2-3 times the evaporation potential compared to rainfall. High clay content soils, which hold so much water in the surface, make the value of small falls of rain less useful than we might hope for. High intensity rainfall, a feature of summer rainfall in the northern grain region, can result in valuable water being lost as runoff and resultant erosion.

The starting point for improving rainfall capture is to minimise runoff. Soil cover is a crucial factor determining infiltration (Table 1). Cover, either as crop residue or a crop canopy, reduces surface sealing. A puddled crust of 1-2 mm thickness is enough to slow infiltration. On average, a soil cover greater than 40 per cent over the summer can reduce annual runoff by 15-30mm compared to bare fallows.

Table 1. Influence of tillage and soil cover on runoff and water storage on a grey brigalow clay (Greenwood 1978-83).

Tillage management (fallow cover)	Bare fallow (<5%)	Disc tillage (25%)	Blade tillage (45%)	Min/no till (>65%)
Fallow efficiency (%)	21	25	26	32
Range of FE	9-29	8-38	17-36	12-32
Reduced runoff (mm)	-	24	32	15
Extra soil water (mm)	-	13	16	36

Soil cracks also offer a pathway for rapid uptake of rainfall, with intense storms putting some water at depth through cracks, out of evaporations harm's way. Avoid cultivation if soil cover is low and soil is cracked (Figure 1).

Graph indicating Infiltration of simulated rainfall on a brown clay near Wallumbilla

Figure 1. Infiltration of simulated rainfall (40 mm at 100 mm h-1) on a brown clay near Wallumbilla where the soil was cultivated with no soil cover after cultivation, left uncultivated with low cover and cracks, or cultivated with good cover.

Soil water content (How wet?) is important in determining the rate of infiltration. When a soil is full, further rain will either runoff or evaporate. Crop sequences need to be flexible to capitalise on wetter than average conditions and likewise be prudent when soil water is low. As a general rule, fallows longer than one summer are wasteful in terms of storing water. If the soil profile is greater than 50-75 per cent full, planting another crop should be considered.

Keeping it in?

Once rainfall is captured in the soil, the next major challenge is to keep it there for crop use. This is not as easy as it might first seem. During fallows, an average of 65 per cent of rainfall is lost as evaporation - this high loss is largely a result of the high water holding capacity of our clay soils, infrequent rainfall and high evaporation conditions. Many small falls of rain are 'captured' in the top 10 cm, only to be lost to evaporation before the next rainfall.

Stubble can reduce evaporation by increasing the reflectance of the soil surface and reducing the velocity of air movement at the soil surface, but these differences are not long lived. If it stays dry for a few weeks, any gains associated with stubble can be lost. Surface cover and good soil structure allow water to move below the "hot" zone where it will be relatively safe from evaporation "pull". Improvements in water storage have mostly been explained by reductions in runoff losses although evaporation reduction can be important in extending planting dates.

Weeds can be a serious cause of water loss within a crop and fallow - up to 5 mm/day. It is essential that weeds be controlled while they are small to avoid use of soil water and seed setting.

Money in the bank?

Extra water safely stored in the soil through best management can be worth up to 500 kg/ha, especially in dry years. Figure 2 shows a comparison of grain yields from all tillage trails in southern and central Queensland over a 30-year period. Minimum/no-tillage results in superior yields except in wetter years. In order to make use of available water, nutrition and disease management are equally important, with good rotations a key part of the better water management game. It would be fair to say that farmers have got better at agronomy (compared to researchers) with time than the results in Figure 2 suggest.

Graph illustrating comparison of grain yields from tillage trails in southern and central Queensland

Figure 2. Comparison of grain yields from 120 experiment years from tillage trails in southern and central Queensland in the 1970's to 2007 (Thomas et. Al 2007).

Soils are different

While it seems obvious, soils vary greatly, even in the one paddock, so are there any general rules? Much is talked about regarding tillage or no-tillage. Recent research by Dang et al (2014) has shown that an occasional tillage does not appear to undo hard-won gains in soil structure. Some common principles can be summarised as:

-soil cover from stubble or crops is good, and generally the more the better;
-when no soil cover occurs, tillage may be the best option;
-water storage and use is best when crops are growing – provide cover and keep soil drier;
-compaction can only be a bad thing for roots and infiltration; and
-weeds will always be robbers of moisture and nutrients, but may be tolerated at times if small and don't seed.

But each soil needs to be managed differently, and good observation with contrasting management is the best way to learn about your soil. For example, the following observations from a simple rainfall simulation demonstration raised many questions and much discussion (Figure 3).

Graph indicating infiltration of simulated rain on a Brigalow-belah clay near Wallumbilla

Graph indicating infiltration of simulated rain on a red brown earth near Goondiwindi

Figure 3. Infiltration of simulated rain on two soil types: a Brigalow-belah clay near Wallumbilla (left) and a red brown earth near Goondiwindi (right) (Cawley et. Al 1992).

An example fallow decision pathway

A possible decision pathway for deciding what tillage strategy to follow after harvest.

How long to fallow?

If good rain occurred before harvest, and the soil profile is greater than 3/4 full, extending a fallow is a waste of time, water and money. Remember that on average, only one mm in every 4-5 mm of rain (20-25 per cent) is stored in the soil. Push probes, soil cores and SoilWaterApp should be useful here.

Are weeds a problem?

If no, best option is to do nothing. If weed control is necessary, either spray, or cultivate to maximise stubble cover.

Is soil cracked?

If yes, cracks indicate moisture is gone. Do not cultivate until cracks close.

Once cracks are closed, either a) maintain stubble cover or b) if little cover, create a rough surface

Roughness can be created with tillage, but don't use harrows. Extra cover (stubble) cannot be created after harvest so look after it.

What happens if no stubble is available?

Once cracks are closed, tillage is needed to maintained roughness and break crusts. Hard setting soils especially need tillage and roughness (some of these soils may need a pasture phase to improve soil structure).

What happens if the soil is fine and no stubble is available?

An unenviable position - hope for gentle rain and plant a crop as soon as possible.

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