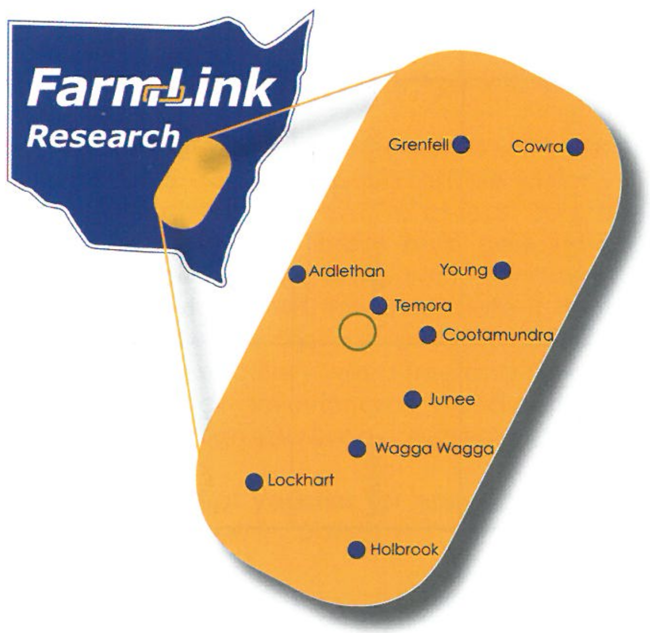
02

Sheep and no-till: no worries!

2012 Trial Site



Project Partners

CSIRO

FarmLink Research

une University of New England

Funded by

GRDC Grains Research & Development Corporation

Sheep and no-till: no worries!

James Hunt (CSIRO), Neil Fettell (University of New England, formerly NSW DPI), Tony Swan (CSIRO), John Kirkegaard (CSIRO), Paul Breust (FarmLink Research) and Mark Peoples (CSIRO)
Corresponding author: james.hunt@csiro.au

Key messages

- Sheep grazing on stubbles and crops do not reduce crop yields provided summer weeds are controlled and at least 70% stubble cover (2-3 t/ha cereal stubble) is maintained.
- Reduced water infiltration and yield from grazing are due to removal of cover rather than compaction – it is sheep's mouths that do damage, not their hooves.
- Sheep do compact soil, but only at the surface and natural shrinking and swelling of soils and sowing with knife points alleviates this.
- Grazing of stubbles and crops appears to make more N available to crops which can increase yield, though the mechanisms remain uncertain.

Background

A livestock enterprise, particularly sheep, in conjunction with a wheat-based cropping enterprise has long formed the basis of mixed farming systems throughout south eastern Australia. This enterprise mix is symbiotic, with sheep able to consume and give value to otherwise wasted by-products from cropping (crop residues, weather damaged and spilt grain, early vegetative crop growth) whilst the legume-based pastures used for sheep production allow paddocks to be spelled from crop production, increasing soil nitrogen and reducing crop weeds and diseases. The presence of both livestock and crops also diversifies farm business, offsetting production and price risk and increasing resilience. In recent times much attention has been given to the potential for conservation farming practices such as no-till seeding with complete stubble retention and controlled traffic to increase crop yields and water-use efficiency. Advocates argue that the full potential of no-till and controlled traffic may not be realised if sheep are grazed on cropping country, removing residue cover and trampling soils, but there is little contemporary research evidence to support this view. We report results from two four-year experiments designed to test whether sheep grazing in no-till farming systems damage soil and reduce crop yields.

Aim

To assess the impact of sheep grazing on crops, stubbles, soil structure, water dynamics and crop yield.

What we did

Experiment 1 – Temora

The first experiment was located on a red chromosol soil 5 km SSE of the township of Temora in SE NSW (539 mm average annual rainfall with equi-seasonal distribution) and consists of six treatments;

1. Nil graze, stubble retention
2. Nil graze, stubble burn
3. Stubble graze, stubble retention
4. Stubble graze, stubble burn
5. Winter graze, stubble graze, stubble retention
6. Winter graze, stubble graze, stubble burn

These treatments were applied in two different phases in adjoining areas of the farmer's paddock which had been in lucerne pasture since 2005. In Phase 1, lucerne was sprayed out in late spring 2008, in Phase 2 it was sprayed out in late winter 2009. Following lucerne removal, large plots (7 x 16 m) were established which allowed all operations to be conducted using controlled traffic. All plots were fenced so they could be individually grazed by sheep.

Crops (wheat and canola – Table 1 and 2) were sown in mid-late April in all years of the experiment. Weaner ewes (3-6 per plot) were used to graze crops in treatments 5 and 6 in July whilst crops were still in the vegetative stage. Following harvest in each year (late November-early December), weaner ewes grazed stubbles in treatments 3, 4, 5 and 6. Sheep were not removed from the plots if it rained during grazing. At the end of each summer fallow period, all residues were removed from a 1 m² area in each plot and infiltration rates measured using a drip infiltrometer. The stubble burn treatments were applied in mid to late March of each year and thus had no bearing on soil water accumulation during the summer fallow period.

Soil water was monitored during the summer fallow period using time-domain reflectometry (TDR) soil water probes (Campbell Scientific CS615) at the soil surface (7.5 and 15 cm depth) and a neutron moisture meter (NMM) for the subsoil (10 to 180 cm depth). Summer weeds that emerged at the site were promptly controlled with herbicide.

313 mm rain fell during the first summer fallow period at the end of 2009, including five significant individual events (Figure 2). The subsequent summer fallow periods were exceptionally wet with 477 mm falling during the summer fallow of 2010/2011 and 462 mm during 2011/2012. In-crop rainfall was 182 mm in 2009, 460 mm in 2010, 200 mm in 2011 and 175 mm in 2012. Long-term average rainfall for Temora is 330 mm April-October and 216 mm November-March.

What we found

Experiment 1 - Temora

In the set-up year of Phase 1 (2009), winter grazing of the crop reduced yield by 0.4 t/ha and protein increased accordingly. The nil graze treatment accumulated more water during the summer fallow period following large and intense rain in mid-February and early March (Table 1). The extra water accumulated was stored deep in the profile (Figure 1) indicating that the difference in accumulation was due to improved infiltration in the presence of stubble rather than reduced evaporation. This hypothesis is supported by measurements of soil water at the surface which showed no difference between the nil graze or winter and stubble grazed treatments (Figure 2). Grazing reduced infiltration rates measured at the end of the summer fallow period. We hypothesise that this was due to the removal of stubble by grazing and subsequent rain-drop impact damage rather than soil physical effects due to grazing, as infiltration rates in the surrounding un-grazed farmer's field (low stubble cover ~1.6 t/ha of a drought-affected canola crop) were as low (11 mm/h) as those in the winter and stubble grazed treatment (16 mm/h). The amount of stubble remaining in the grazed treatment (0.8 t/ha) was below the 2.0 t/ha or 70% cover level commonly recommended for the prevention of run-off and soil erosion on clay soils. Despite the differences in plant-available water prior to sowing in 2010, in-crop rain was sufficient to sustain crop growth and there were no significant differences in crop yield between the grazing treatments (Table 1) or stubble burn treatments (data not shown). Differences in plant-available water persisted at maturity (data not shown), but heavy rain during the summer of 2010-2011 filled the soil profile and had all but removed the differences prior to sowing in 2011.

In 2011, the winter and stubble graze plots were split and winter grazing only applied to one half of the plots so soil effects from the previous year's grazing could be separated from the plant effects of grazing the crop in 2011. There was no difference in yield between these two halves of the winter and stubble graze plots (data not shown), and the winter and stubble graze treatment out-yielded the nil and stubble graze treatment by 0.6 t/ha. This result was most likely due to the differences in mineral nitrogen which were measured between treatments at the start of 2010 and persisted until the last N measurement made prior to sowing in 2012. There is no clear explanation as to why such a large difference in N developed; much smaller differences which are seemingly due to N tie-up in the nil graze treatment have developed in Phase 2 of this experiment (Table 2) and the Condobolin experiment (Table 3). This difference in N did not result in any differences in crop yield in 2012, but did increase protein in the winter graze treatment relative to the nil graze treatment.

Table 1. Stubble remaining after grazing in December of the previous year, steady-state infiltration rate at the end of summer, soil bulk density, soil strength, plant available water (PAW) and mineral N at sowing, wheat grain yield and protein in Phase 1 of the Temora experiment which began in 2009.

	Stubble remaining after summer grazing (t/ha)	Summer infiltration rate (mm/h)	Bulk density (Mg/M³)	Soil strength (KPa)	PAW at sowing (mm)	Mineral N at sowing (kg/ha)	Grain yield (t/ha)	Grain protein (%)
2009 Wheat (Gregory)								
Nil graze	-	-	-	-	20	143	1.6	14.4
Stubble graze	-	-	-	-	20	143	1.6	14.6
Winter and Stubble Graze	-	-	-	-	20	143	1.2	14.9
P-value	-	-	-	-	-	-	<0.001	0.006
LSD (P<0.05)	-	-	-	-	-	-	0.2	0.33
2010 – Canola (Tawriffic)								
Nil graze	5.4	33	1.22	222	155	178	4.1	-
Stubble graze	0.8	20	1.23	365	110	205	4.2	-
Winter and Stubble Graze	0.8	16	1.25	516	99	279	4.0	-
P-value	-	0.041	0.549	0.005	<0.001	0.014	0.62	-
LSD (P<0.05)	-	11	0.06	135	19	53	NS	-
2011 – Wheat (Bolac)								
Nil graze	8.0	102	1.35	298	201	93	4.6	13.1
Stubble graze	4.0	49	1.38	355	183	126	4.6	13.5
Winter and Stubble Graze	4.0	44	1.40	460	187	199	5.2	13.0
P-value	-	0.006	0.819	0.010	0.011	0.001	<0.001	0.158
LSD (P<0.05)	-	29	NS	91	11	49	0.2	0.6
2012 – Wheat (Wedgetail)								
Nil graze	9.8	-	-	-	203	99	4.7	10.5
Stubble graze	4.2	-	-	-	192	144	4.8	10.9
Winter and Stubble Graze	3.8	-	-	-	196	168	4.7	11.2
P-value	-	-	-	-	0.127	0.005	0.768	0.022
LSD (P<0.05)	-	-	-	-	NS	38	NS	0.5

Grazing again reduced infiltration rates in 2011, but rates in all treatments were much higher than at the start of 2010 and well in excess of rainfall rates in the region. Likewise grazing increased soil strength in both 2010 and 2011, but not to levels detrimental to plant growth (>2000 KPa).

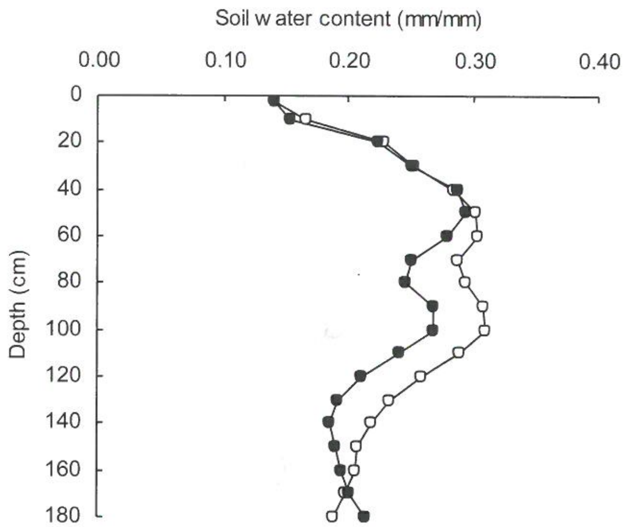


Figure 1. Volumetric soil water content down the soil profile of the nil graze (0) and combined grazed treatments (*) on 16 March 2010 in Phase 1 of the Temora experiment.

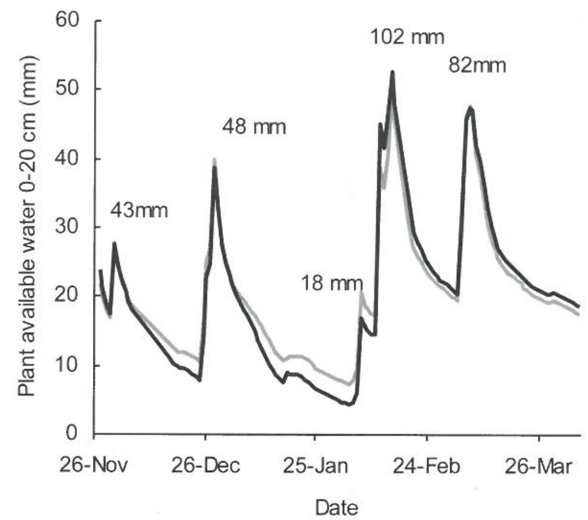


Figure 2. Plant available water from 0 to 20 cm depth as measured by FDR probes in the nil graze (-) and stubble and winter graze treatments(-) during the summer fallow of 2009/2010 in Phase 1 of the Temora experiment. The numbers next to curve peaks are amounts of rainfall in corresponding events.

In the set-up year of Phase 2 (2010), winter grazing of the crop increased yield by 0.6 t/ha (Table 2). There were no effects of grazing on yield in either 2011 or 2012. Grazing reduced infiltration and increased soil strength in both 2011 and 2012, but not to levels likely to reduce fallow efficiency or decrease yield.

Commercial practice

The data supports the conclusions of a recent review reporting that soil physical effects from grazing sheep trampling tend to be shallow and transient and reductions in subsequent crop yield are rare (http://www.ausgrain.com.au/Back%20Issues/196magrn10/8-concerned.pdf). However, loss of cover associated with overgrazing is clearly a risk. These findings give confidence that provided a critical level of soil cover is maintained (>70% or 2.0 t/ha of cereal stubble), livestock can be retained within modern conservation cropping systems without compromising crop performance, and may continue to provide production and business risk benefits in the future. These findings are further supported by paddock scale research in the Wimmera-Mallee conducted by Birchip Cropping Group – see BCG 2011 Season Research Results manual page 299 and BCG 2012 Season Research Results manual pages 159-163 and 183-190.

Acknowledgements

This research was funded by GRDC projects FLR00005, CWF00013 and CSP00111. We thank the Catch More, Store More, Grow project steering committee for their advice on conduct of the Temora experiment, and the Coleman family for hosting this experiment.

Table 2. Stubble remaining after grazing in December of the previous year, steady-state infiltration rate at the end of summer, soil bulk density, soil strength, plant available water (PAW) and mineral N at sowing, wheat grain yield and protein in Phase 2 of the Temora experiment which began in 2010.

	Stubble remaining after summer grazing (t/ha)	Summer infiltration rate (mm/h)	Bulk density (Mg/M³)	Soil strength (KPa)	PAW at sowing (mm)	Mineral N at sowing (kg/ha)	Grain yield (t/ha)	Grain protein (%)
2010 – Wheat (Bolac)								
Nil graze	-	-	-	-	48	185	6.9	13.6
Stubble graze	-	-	-	-	48	185	6.9	13.4
Winter and Stubble Graze	-	-	-	-	48	185	7.5	13.3
P-value	-	-	-	-	-	-	0.012	0.419
LSD (P<0.05)	-	-	-	-	-	-	0.4	NS
2011 – Canola (45Y82								
Nil graze	11.5	59	NA	308	145	92	3.4	-
Stubble graze	5.5	36	NA	494	143	94	3.3	-
Winter and Stubble Graze	5.5	34	NA	563	135	105	3.1	-
P-value	-	0.022	-	0.002	0.338	0.696	0.114	-
LSD (P<0.05)	-	16	-	111	NS	NS	NS	-
2012 – Wheat (Bolac)								
Nil graze	7.4	79	1.18	150	138	73	4.8	10.5
Stubble graze	3.3	36	1.28	360	140	76	4.9	10.3
Winter and Stubble Graze	3.1	24	1.27	524	132	90	4.8	10.5
P-value	-	0.003	0.059	0.006	0.438	0.032	0.451	0.595
LSD (P<0.05)	-	24	NS	168	NS	13	0.2	NS