

**Sheep grazing on crop residues increase soil mineral N and grain N uptake in subsequent wheat crops**

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## Acknowledgements

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GRDC Stubble Initiative

### Host farmers

Peter, Lynne & Jason Coleman



### Co-authors

**CSIRO** - Tony Swan, John Kirkegaard,  
Laura Goward, Brad Rheinheimer,  
Mark Peoples

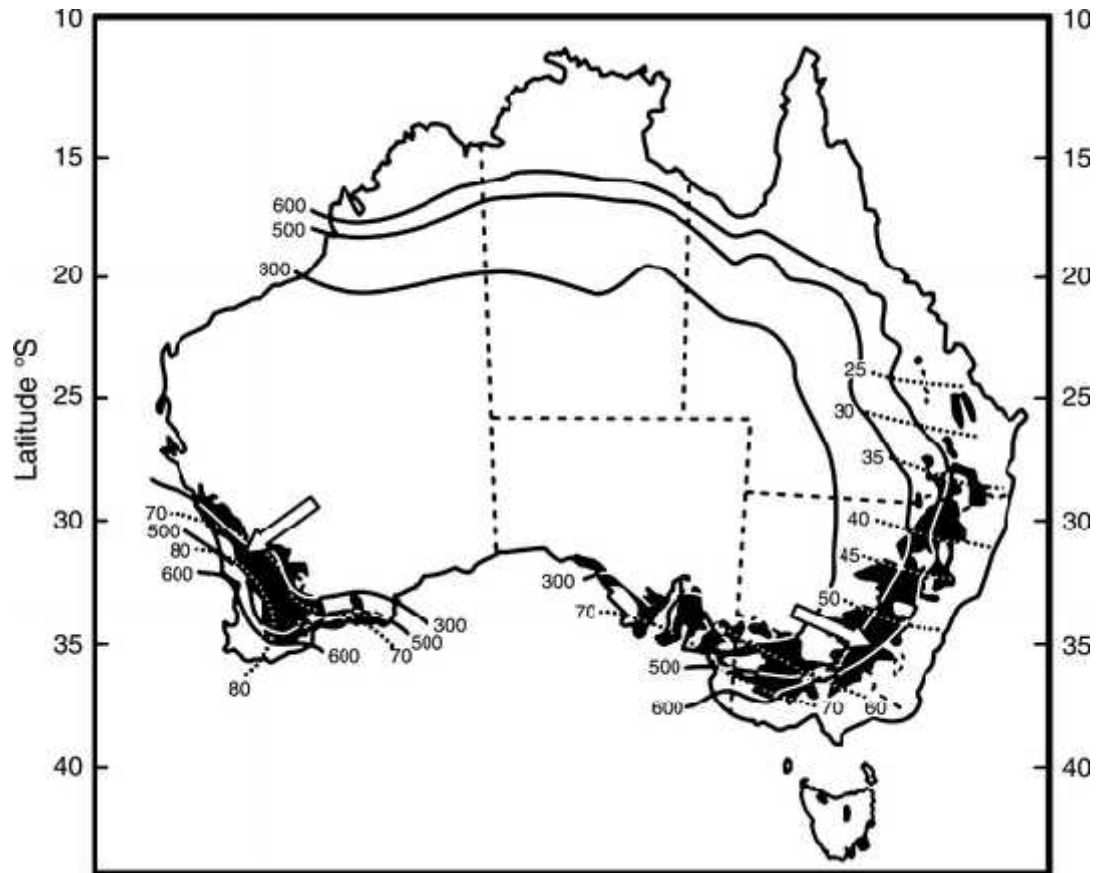
**FarmLink** - Tony Pratt, Kellie Jones, Paul  
Breust

**Steering committee** - Jason Coleman,  
Greg Condon, ChrisDuff, Derek Ingold,  
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## Grain Production in Australia

- Production (2014)
  - Wheat – 24 Mt
  - Barley – 8 Mt
  - Canola – 4 Mt
  - Pulses (chickpeas, lupins, lentils, field pea, faba bean) – 1 Mt
- Southern Australia
  - All crops grown during winter,
  - Land left fallow over summer

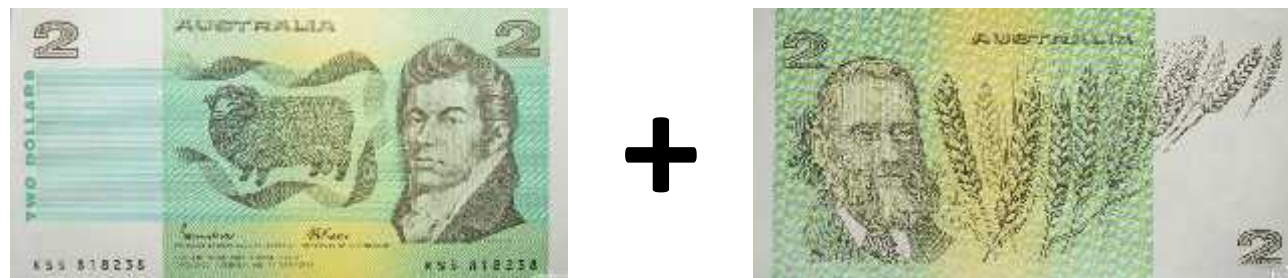
# Australian grain production



Kirkegaard et al., (2011) In: Rainfed Farming Systems (Springer) pp 715-754

## Southern Australian mixed farming systems

- Many Australian grain farms are 'mixed' farms
  - Livestock enterprise (sheep)
  - Crop enterprise (wheat-based)
- Mixed farms are synergistic (pasture-crop N dynamics & business risk)

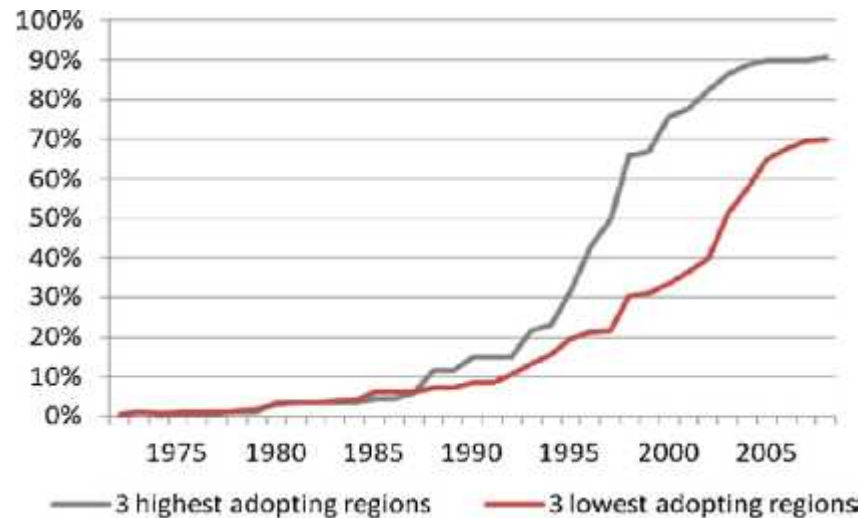




## Adoption of conservation agriculture (no-till) and controlled traffic farming (CTF)

Conservation agriculture founded on three principals (FAO);

- Direct planting of crop seeds without tillage
- Maintenance of **permanent soil cover** especially by **crop residues** and cover crops
- Crop diversity



Llewellyn, RS, D'Emden, FH, Kuehne, G (2012)  
Extensive use of no-tillage in grain growing regions of  
Australia. *Field Crops Research* **132**, 204-212.







## Research question

Will the benefits of no-till and controlled traffic farming systems be fully realised while sheep are grazing paddocks?

- Removing cover
- Compacting soil

# “Collective Inquiry”



## Treatments & experimental design

- Grazing
  - Nil graze
  - Stubble graze
- Stubble retention
  - Burn
  - Retain
- Factorial randomised complete-block design in two phases

Phase	2008	2009	2010	2011	2012	2013	2014	2015
Phase 1	Lucerne	Wheat	Canola	Wheat	Wheat	Canola	Wheat	Wheat
Phase 2	Lucerne	Lucerne	Wheat	Canola	Wheat	Wheat	Canola	Wheat

# Seasonal pattern & application of treatments





Spraying on tramlines (CTF)







FarmLink & CSIRO Temora Stubble site 2013 – nil graze, nil burn



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**FarmLink & CSIRO Temora Stubble site 2013 – stubble graze, nil burn**





## FarmLink & Temora Stubble site 2013 – nil graze, stubble burn





Contents lists available at [ScienceDirect](#)

## Field Crops Research

journal homepage: [www.elsevier.com/locate/forc](http://www.elsevier.com/locate/forc)



### Sheep grazing on crop residues do not reduce crop yields in no-till, controlled traffic farming systems in an equi-seasonal rainfall environment



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- No negative effect of grazing on soil water balance provided 70% stubble cover maintained
- No negative effect of grazing on crop yield

## Grazing increased soil mineral N ( $\text{NO}_3 + \text{NH}_4$ ) prior to sowing

Main effect of grazing = 102 to 121 kg/ha mineral N

Soil mineral N to 1.75 m measured prior to sowing

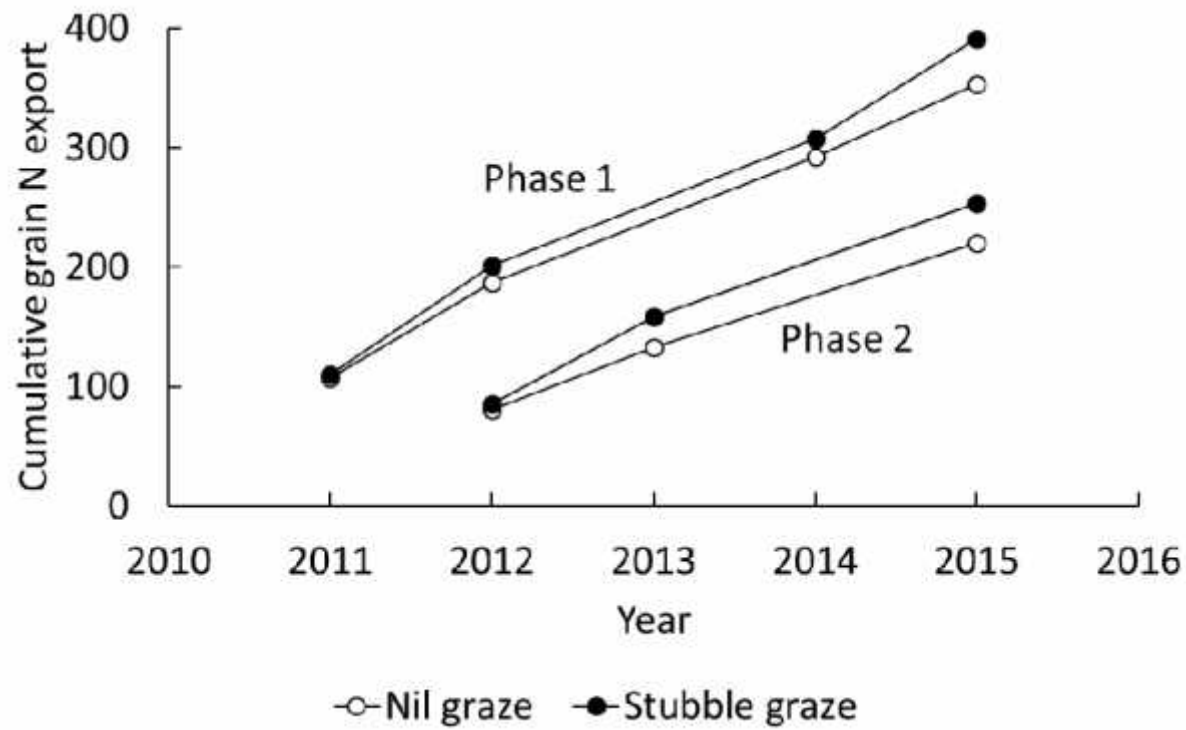
<b>Phase year</b>	<b>Nil graze</b>	<b>Stubble graze</b>
<b>Phase 1 2011</b>	79	107
<b>Phase 1 2012</b>	99	127
<b>Phase 1 2014</b>	132	121
<b>Phase 1 2015</b>	90	145
<b>Phase 2 2012</b>	73	81
<b>Phase 2 2013</b>	93	94
<b>Phase 2 2015</b>	145	170
<b>P-value</b>		0.018
<b>LSD (P=0.05)</b>		26

Wheat grain N uptake (kg/ha)  
 (main effect 85 to 92 kg/ha N)

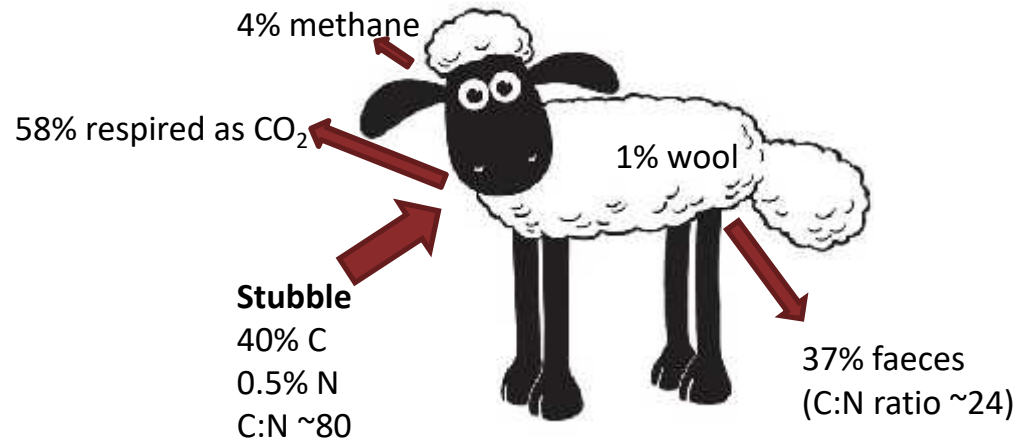
Phase year	Graze treatment	Stubble management	
		Stubble burn	Stubble retain
Phase 1 2011	Nil	107	108
	Stubble	111	110
Phase 1 2012	Nil	92	79
	Stubble	89	92
Phase 1 2014	Nil	99	112
	Stubble	109	106
Phase 1 2015	Nil	63	61
	Stubble	77	84
Phase 2 2012	Nil	88	81
	Stubble	86	86
Phase 2 2013	Nil	77	51
	Stubble	79	73
Phase 2 2015	Nil	81	88
	Stubble	92	94
P-value		<0.001	
LSD (p=0.05)		8	



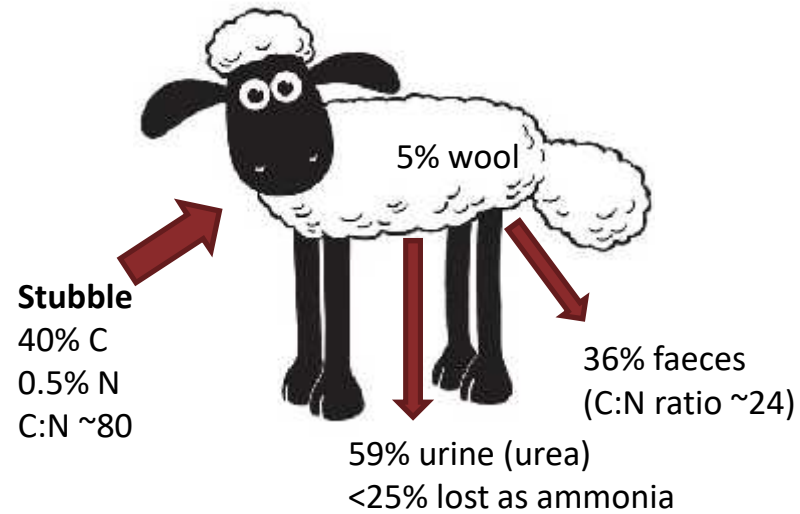
## Cumulative grain N uptake in Stubble Retain treatments



# What happens to C in stubble when sheep eat it (assuming no weight gain)?



What happens to N in stubble when sheep eat it (assuming no weight gain)?



## C & N dynamics when stubble grazed

	Stubble retained	Stubble grazed
Post harvest stubble mass	7 t/ha	7 t/ha
Amount of stubble consumed	-	3 t/ha
Amount of stubble remaining	7 t/ha	4 t/ha
N mass in stubble remaining	35 kg/ha	20 kg/ha
N mass in urine	0 kg/ha	9 kg/ha
N mass in faeces	-	5 kg/ha
C mass in stubble remaining	2.8 t/ha	1.6 t/ha
C mass in faeces	-	0.4 t/ha
Immobilising power of C	<b>112 kg/ha N</b>	<b>64 kg/ha</b>

## Conclusions

- Grazing stubble makes more N available to wheat crops
  - Soil mineral N prior to sowing
  - Grain N uptake
- Dominant mechanism is likely reduced immobilisation rather than faster cycling
- Stubble grazing increases rate of N mining...
- ...but mixed farming systems have pasture leys!
- Can we train termites to do the same thing in crop-only systems?



Thank you

James Hunt

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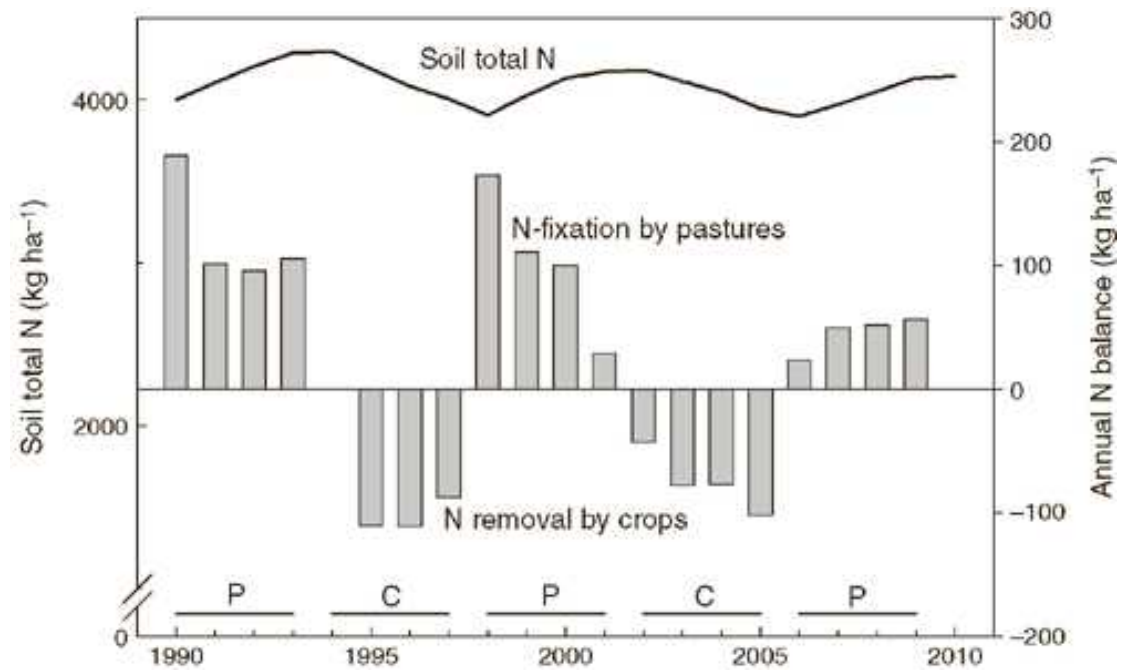
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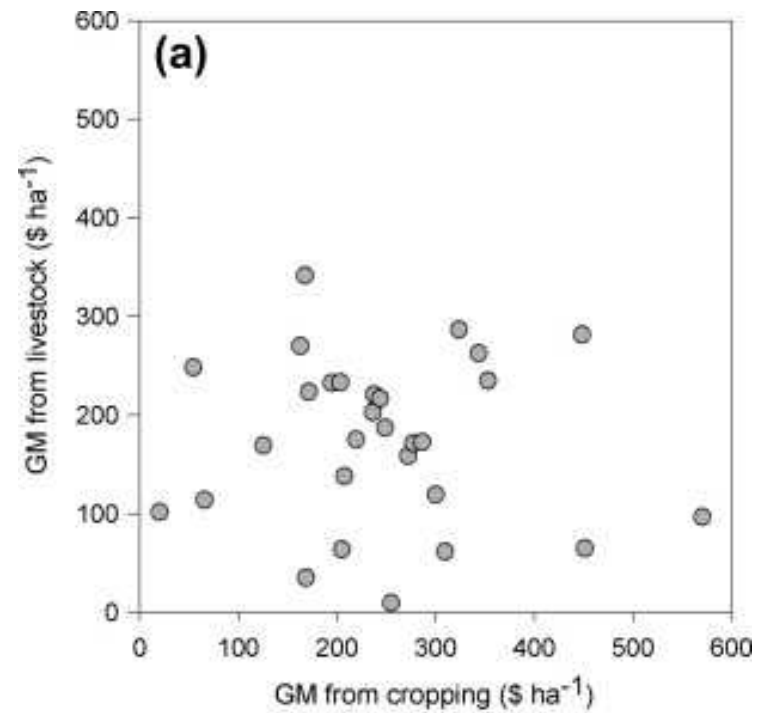


## Benefits of mixed farms – N for crops from legume based pastures



Angus, JF, Peoples, MB (2012) Nitrogen from Australian dryland pastures. *Crop and Pasture Science* **63**, 746-758.

## Benefits of mixed farms – Financial Risk Mitigation



Bell, LW, Moore, AD (2012) Integrated crop-livestock systems in Australian agriculture: Trends, drivers and implications. *Agricultural Systems* **111**, 1-12.