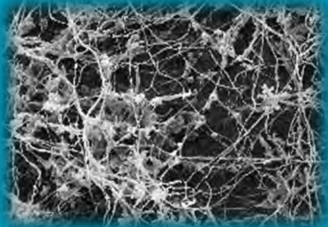
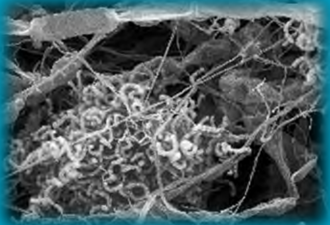




N cycling in Stubble retained systems

Gupta V, McBeath T, Kirkegaard J, Richardson A, Sanderman J, Llewelyn, R.
CSIRO Adelaide and Canberra

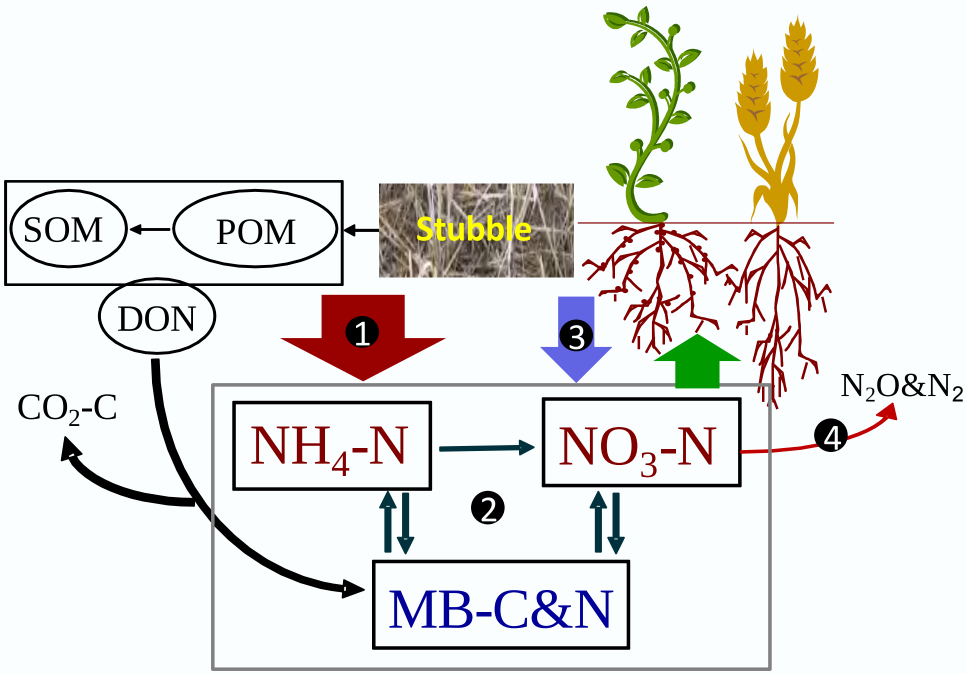
Stasia Kroker, Steve Szarvas, Drew Ernakovich
Bill Davoren, Mel Bullock, Claire Browne,
Verburg K, Wang E

BCG

Grains Research & Development Corporation

CSIRO

N cycling in agricultural soils: Processes, Factors and Prediction



- Biological processes that influence soil plant available N levels in cropping soils:
  1. Decomposition/Mineralization
  2. Microbial turnover
  3. N fixation
  4. N losses
- Factors
  - Soil and Crop type
  - Management
  - Season

N supply potential: Mineral N at sowing, N mineralization in-crop
N immobilization potential: N tie-up by microorganisms
Biological value of stubble: Stubble as a source of C and nutrients for microbes

Microbial Biomass and N mineralization and supply potential 2014 sowing

Karoonda
Sand

Horsham
Clay

Temora
Red brown earth

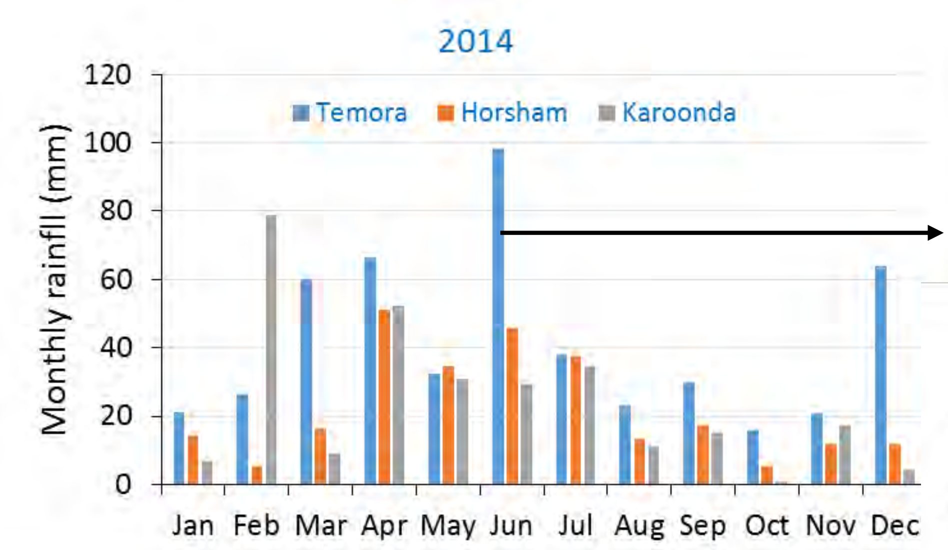
Location	MB-C	MB-N	DOC	Min N	N Supply potential
	µg /g Dsoil		*µg C/gDsoil*	*µg N/gDsoil*	*mg N / kg soil (crop season)**
Karoonda	138 + 11	20 + 2	63 + 5	9.1 + 1.3	19 + 1.6
Horsham	546 + 2	78 + 1	241 + 7	20.6 + 1.3	52.6 + 3.2
Temora	465 + 37	66 + 5	225 + 6	35.5 + 0.1	84.0 + 2.0

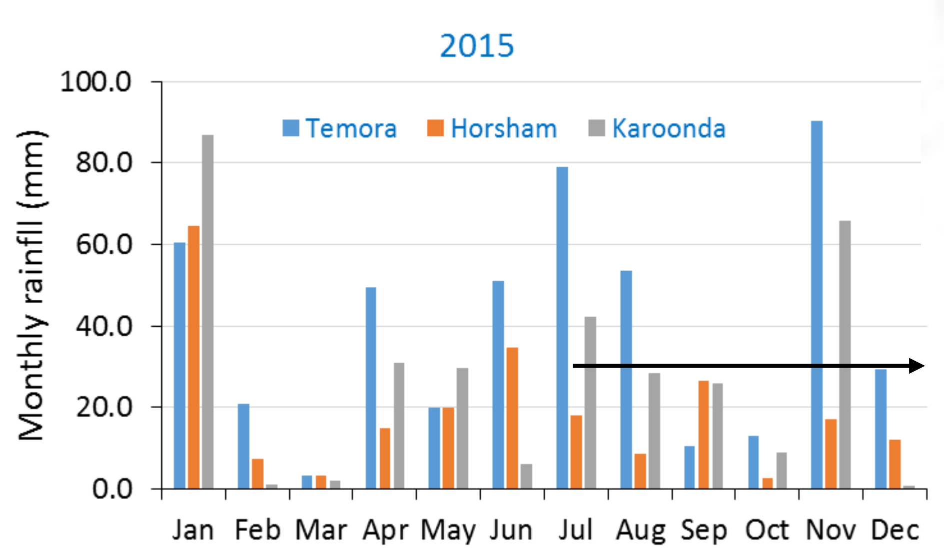
Fate of stubble and soil organic nitrogen as influenced by carbon availability in cereal stubble retained systems

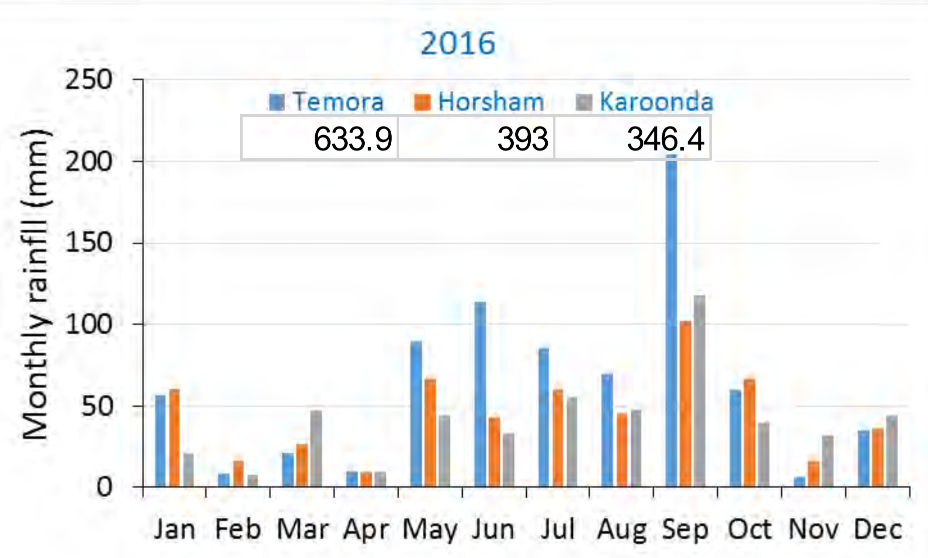
2014 – Grow ^{15}N labelled wheat

^{15}N Urea

Rainfall distribution during 2014 - 16







Karoonda: Soil and plant N traced from 2014 to 2016

Mallee sand

Year 1

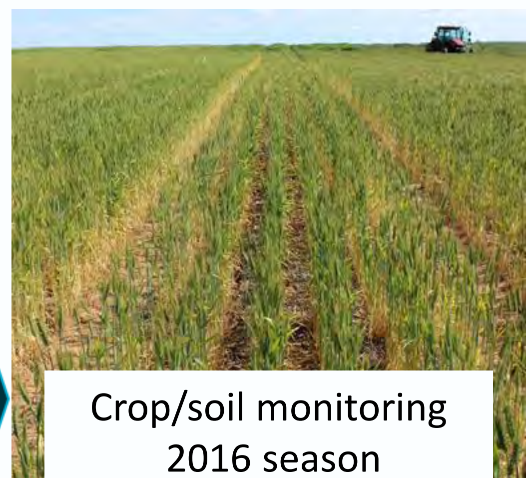
Summer 2014/15

Crop/soil monitoring 2015 season

Harvest 2015

Year 2

Summer 2015/16

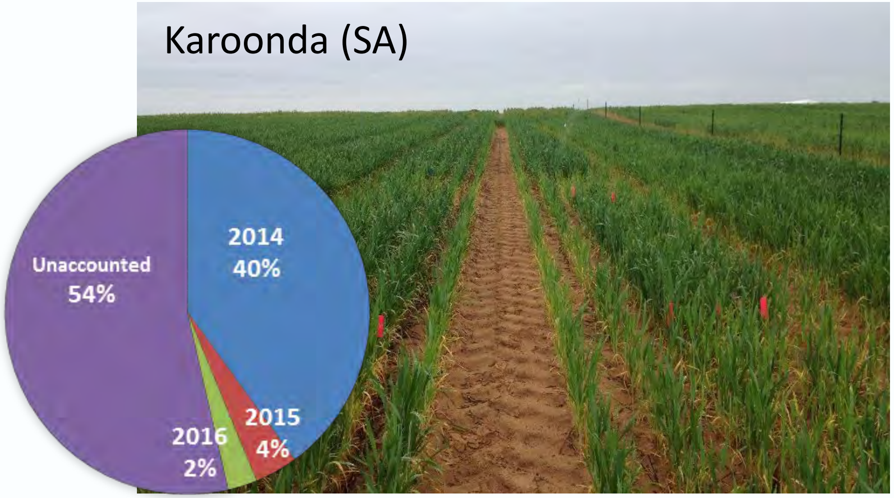


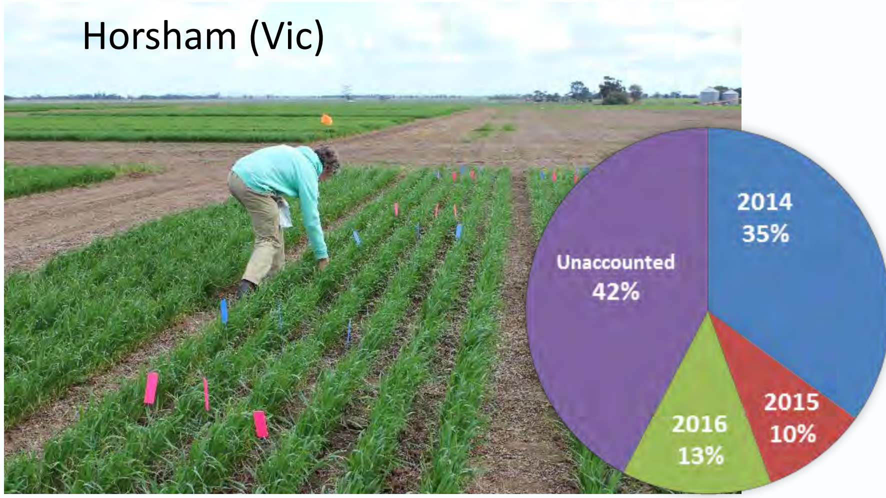
Crop/soil monitoring 2016 season

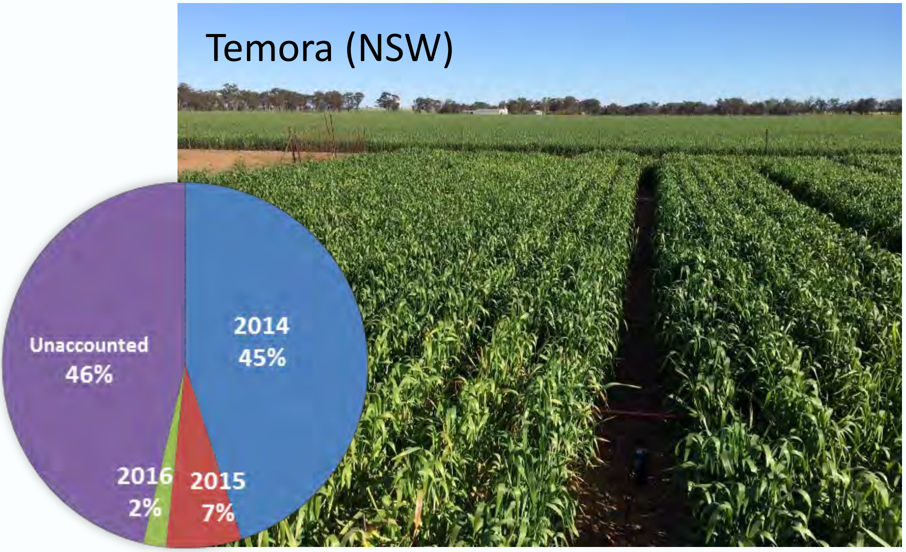
Harvest 2016

^{15}N Urea Fertilizer use efficiency

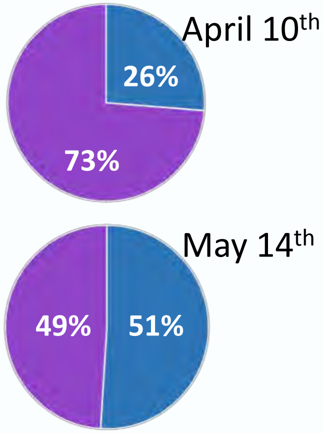
(Year 1 and Residual effects)



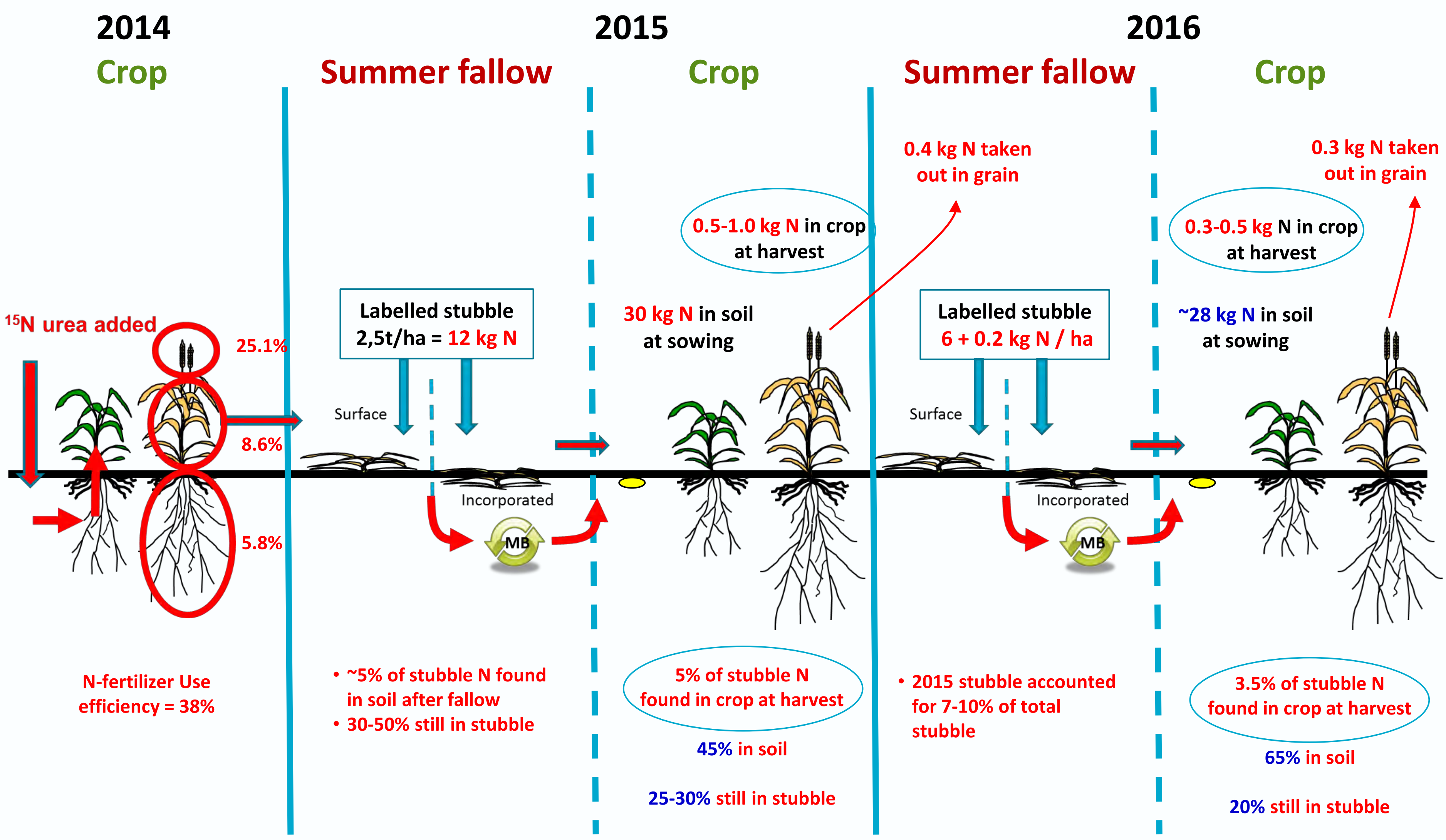




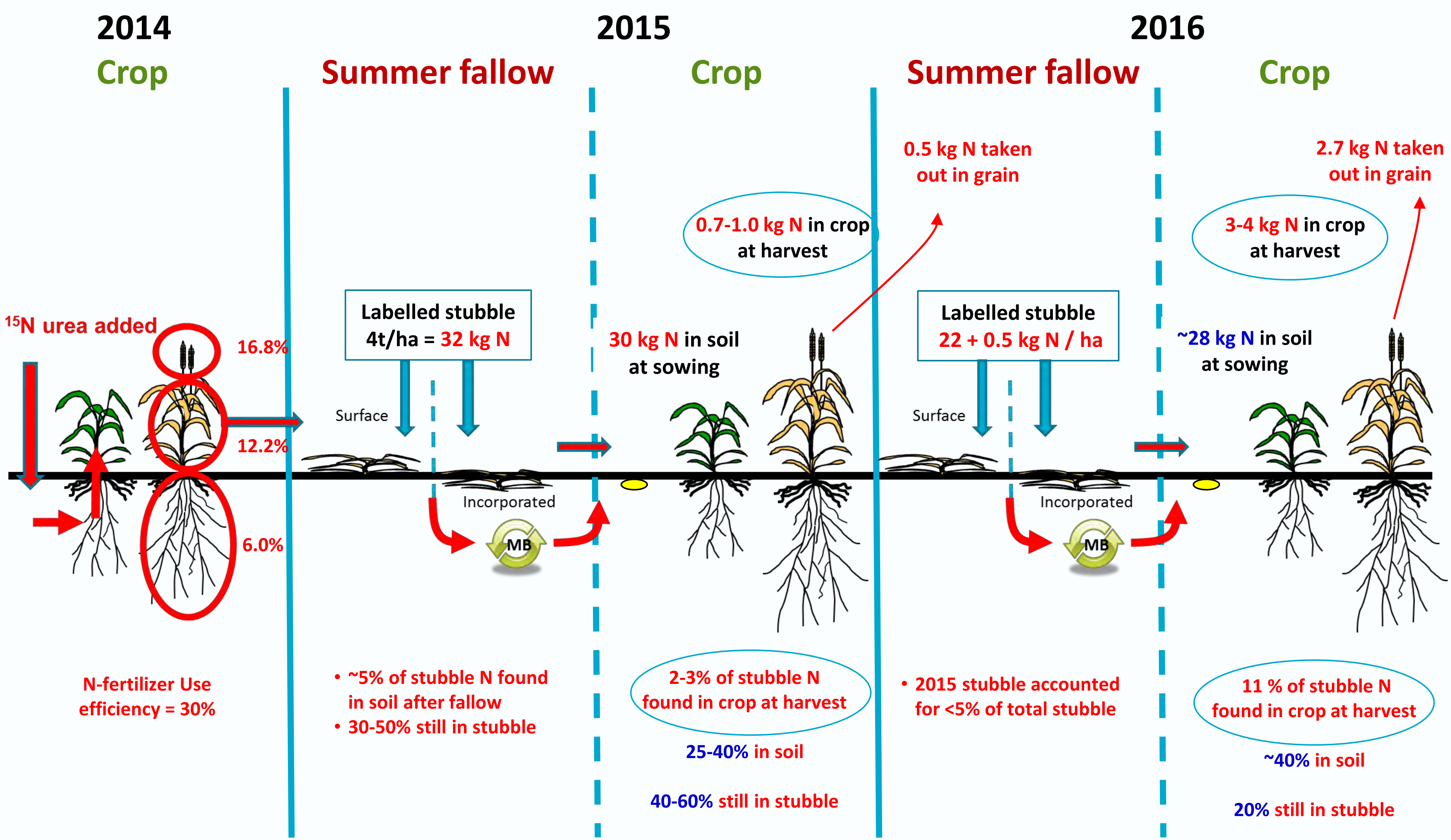
Cummins (SA) 2015



Fate of cereal stubble N in retained systems (Karoonda, SA)

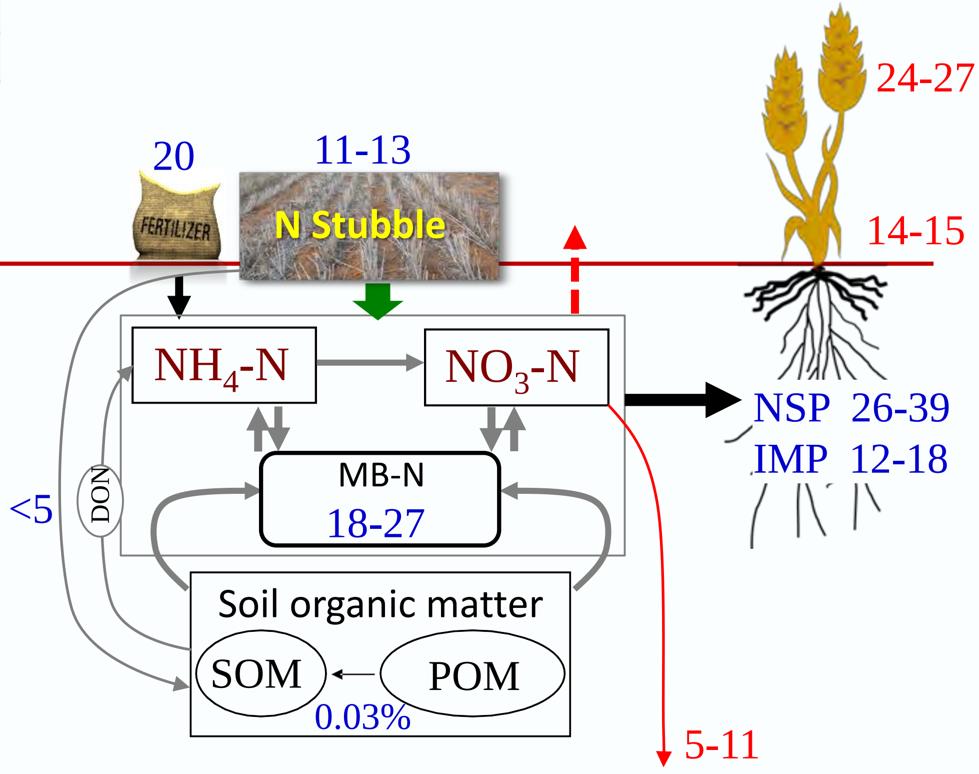


Fate of cereal stubble N in retained systems (Horsham, Vic)



Karoonda: Stubble management effect on N cycling during 2016 crop

Treatment	Grain yield (t/ha)	Protein (%)
No Stubble	2.05	8.00
Standing	2.11	7.85
Surface	1.94	7.60
Incorporated	2.02	7.68
F-test	*NS*	*NS*

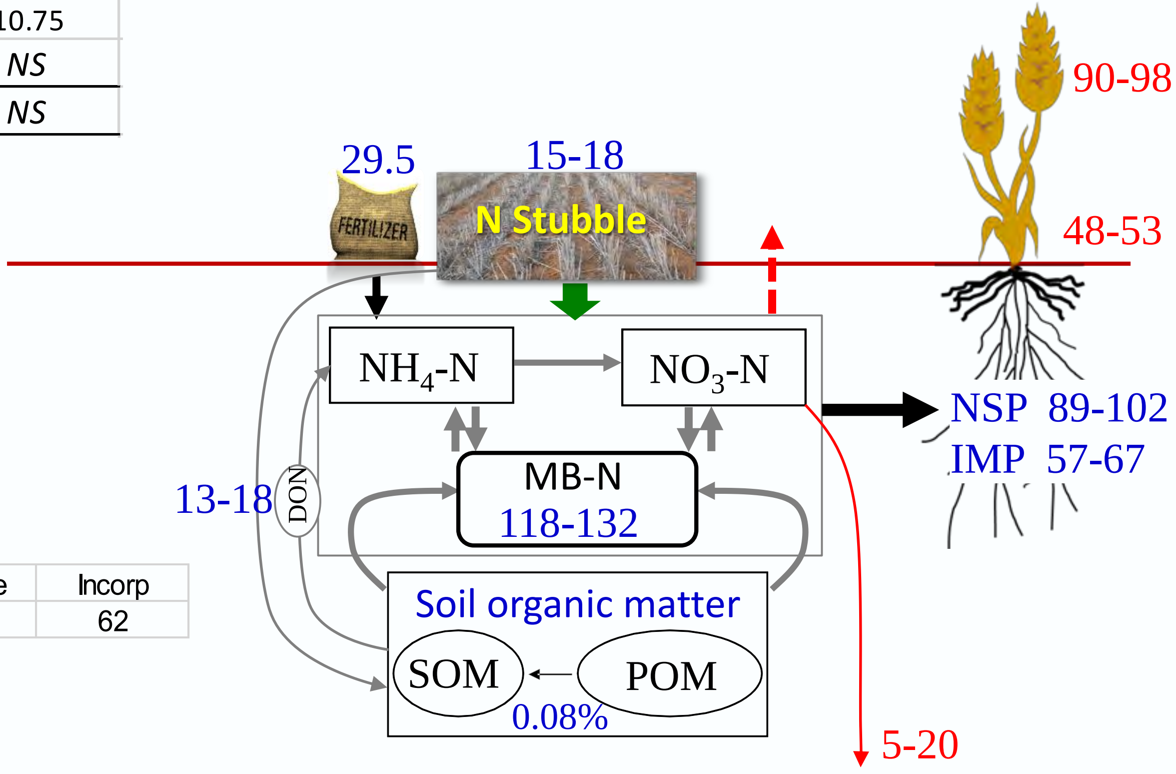


N in soil profile at sowing

	No Stubble	Standing	Surface	Incorp
kg N/ha	52	41	54	33

Horsham: Stubble management effect on N cycling during 2016 crop

Treatment	Grain yield (t/ha)	Protein (%)
No Stubble	5.52	10.30
Standing	5.74	10.67
Surface	5.26	10.80
Incorporated	5.31	10.75
F-test	*0.001*	*NS*
LSD	*0.18*	*NS*



N in soil profile at sowing

	No Stubble	Standing	Surface	Incorp
kg N/ha	84	104	81	62

N cycling and microbial turnover – Pinery fire effects
(Sowing 2016)

Treatment	MB-C	MB-N	DOC	Min N	Immobilization potential (kg N/ha)	SOC	Total N	C:N ratio
	kg / ha					%		
Burnt	620	88.6	284	13.9	44.3	4.0	1.86	21.6
Stubble	1088	155.5	373	39.8	77.7	4.2	1.84	22.7
F-test	*Sig*	*Sig*	*Sig*	*Sig*	*Sig*	*Sig*	*NS*	*Sig*

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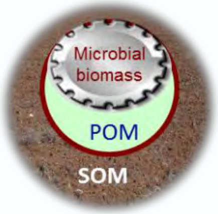
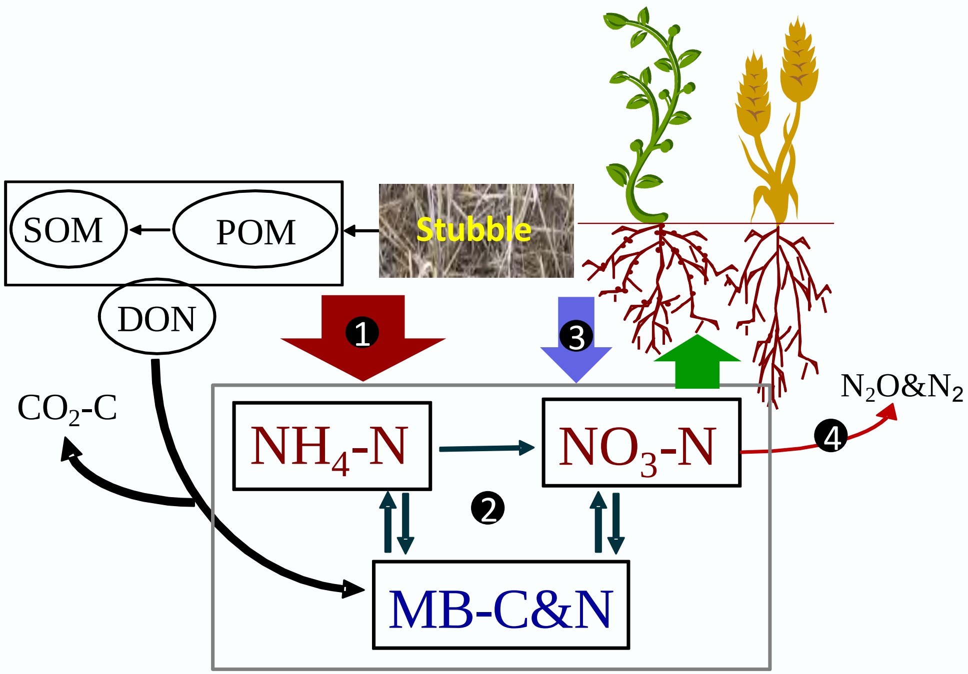


Soil Nitrogen supply potential

- N supply potential – Soil biological capacity, organic N pools and microbial turnover
- N immobilization potential – soil biological capacity to tie-up mineral N
- The rate of mineralisation in a growing season is controlled by soil moisture, temperature and the amount and quality of organic matter (e.g. C:N ratio)

Location	Soil type	MB-C	N immobilization potential	N supply potential
		kg C / ha	kg N / ha	
Waikerie/Karoonda, SA	Sand and sandy loam	150 - 300	15 - 25	10 - 35
Streaky Bay, SA	Calcarosol - sandy loam	210 - 400	15 - 30	20 - 50
Minnipa, SA	Calcarosol - loam	560 - 710	40 - 51	42 - 56
Appila, SA	Loam	450 - 585	32 - 42	35 - 45
Wongan hills, WA	Loamy sand	250 - 350	18 - 25	25 - 40
Condobolin, NSW	Sandy loam	240 - 585	17 - 42	20 - 45
Kerrabee, NSW	Loam	420 - 525	30 - 40	35 - 50
Temora, NSW	Red earth	525 - 735	35 - 55	50 - 100
Millewa, NSW	Sandy loam	150 - 310	11 - 22	14 - 31
Rutherglen, Vic	Reb brown earth	350 - 700	25 - 50	30 - 100
Horsham	Sandy loam	140 - 230	12 - 24	10 - 16
Horsham	Clay	546 - 819	39 - 59	52 - 72
Leeton/Warialda, NSW	Clay	350 - 1000	25 - 60	25 - 75

Soil Nitrogen supply potential



Crop Sequence	Dune
first year effects	
wh-wh-**wh**-wh	27
wh-pasture-**wh**-wh	36
wh-lupin-**wh**-wh	38
second year effects	
wh-wh-wh-**wh**	30
wh-pasture-wh-**wh**	46
wh-lupin-wh-**wh**	50

LSD 8; Karoonda 2011-12

- N mineralization estimates as a proportion of soil OC or TN are same for all treatments
- N Supply potential estimates show 10-20 kg N/ha differences between treatments

Managing N supply in Stubble retained systems

- Cereal stubble contributes 2-10% of next cereal crop N and decreasing in subsequent years
- Stubble retention impacts N cycling biological processes & N availability in all environments and different seasons
- Nitrogen mineralized from SOM (and crop residues) contributes ~50% of crop N uptake.
- Biological value of stubble:
  - Cereal stubble increases N immobilization potential of soil – removal/burning
  - Magnitude of stubble effect depends on cropping history (pulses in rotation, # of cereals) and soil organic matter quality
- Fertilizer use efficiency
  - Urea fertilizer N use efficiency 30-45% (Yr1), 4-10% (Yr 2), 2-13% (Yr 3)

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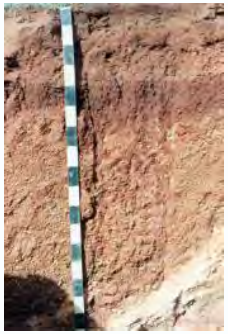
N Use Efficiency of Stubble Retained Wheat Crops - LEP soils

T McBeath, Blake Gontar, A Ware, S Kroker, Ashley Flint and Ed Hunt

Aims

To measure N supply potential on different soil x residues.

To estimate N use efficiency of wheat on key Lower EP soil types.



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GRDC Grains Research & Development Corporation
Your GRDC working with you
LEADA Lower Eyre Agricultural Development Association

Nitrogen Use Efficiency (NUE) Monitoring

- Climate
- Soil- fertility and constraints
- Crop Type/ Sequence
- Fertiliser Input

N Inputs (kg N/ha)			N Output (kg N/ha)
Fertiliser N	Mineral N	Nitrogen Supply Potential (NSP)	N yield
0.5 N added	Mineral N (0- rooting depth cm)	Mineralised N (21 days)+ Microbial biomass N (0.5)	Grain Yield Grain N

$$\text{NUE} = \frac{\text{Nitrogen Yield (Grain Yield x (Protein/0.567))}}{\text{Fertiliser (x efficiency) + sow min N + soil N supply in-season (mineralisable)}}$$

Soil	Site	Residue	2015 NUE (% of N available)
Sand over Gravel	Lincoln	Lupin	12
		Canola	16
Sand over clay	Lincoln	Lupin	25
		Canola	30
Sand	Mt Hill	Vetch	26
		Pasture	38
Red Brown Earth	Ungarra	Beans	40
		Barley	47
Loam over Sodic Clay	Yeelanna	Beans	60
		Canola	43
Deep Clay	Cummins	Beans	68
		Canola	48

Nitrogen Use Efficiency (NUE) Monitoring

Lincoln soils		N Inputs (kg N/ha)			N Output (kg N/ha)	NUE (%)
	Residue	Fert N	NSP	Min N	N yield	
Sand Over Clay	Lupins	74	102	155	72	25
	Canola	99	90	146	86	30
Sand Over Gravel	Lupins	74	85	173	34	12
	Canola	90	34	131	38	16

- Soil constraints - low NUE
- 10 t/ha biomass -1.5 t/ha grain yield
- Reduced soil-specific and fertiliser N inputs?

Mt Hill sand	N Inputs (kg N/ha)			N Output (kg N/ha)	NUE (%)
Residue	Fert N	NSP	Min N	N yield	
Pasture	31	42	44	27	26
Vetch	31	34	48	37	38

- Lack of protection of organic matter/N for soil driven supply
- Potential for losses are higher
- Fertiliser and legumes needed to maintain N supply

Cummins Deep clay	N Inputs (kg N/ha)			N Output (kg N/ha)	NUE (%)
Residue	Fert N	NSP	Min N	N yield	
Beans	102	80	45	120	68
Canola	100	65	78	93	48

- High functioning microbial turnover* = high NUE
- Wheat on bean residue is operating at a higher NUE.

Summary

- A clear soil x climate drivers of NUE and WUE
- Can we more strategically manage N using this knowledge?
    - Soil-specific N?
    - N inputs more responsive to fallow conditions?
    - Better use of legumes?
    - More thorough evaluation of our in-season N strategies?
- Are growers/ advisors interested in evaluating NUE across LEP?

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