IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Getting Nitrogen into the crop – efficiently and effectively

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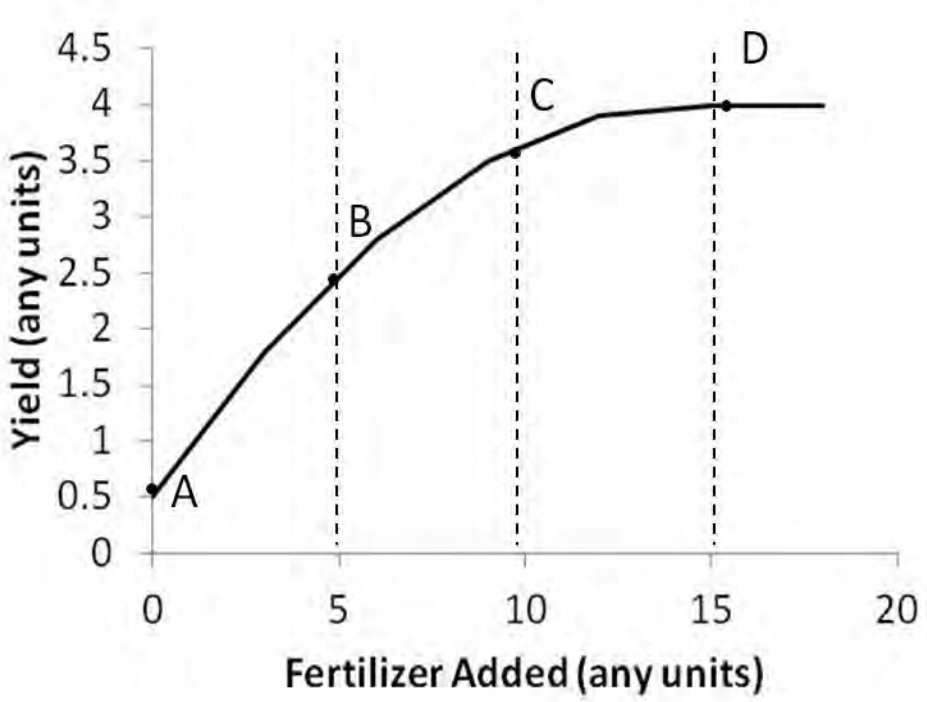
Better Crops, Better Environment … through Science

GRDC
Grains
Research &
Development
Corporation

Ballarat, February 2014.

Efficiency and Effectiveness



- Efficiency is important
- Effectiveness in more important – getting close to the potential - $/$

Question

Where is the highest efficiency?

A-B, B-C, C-D or >D?

- A-B 5 kg get 2.5 t/ha
  - 0.50 t/kg (*0.4 t/kg*)
- B-C 10 kg gets 3.5 t/ha
  - 0.35 t/kg (0.2 t/kg)
- C-D 15 kg gets 4 t/ha
  - 0.27 t/kg (0.1 t/kg)
- >D – 20 kg gets 4 t/ha
  - 0.0 t/kg (0.0 t/kg)

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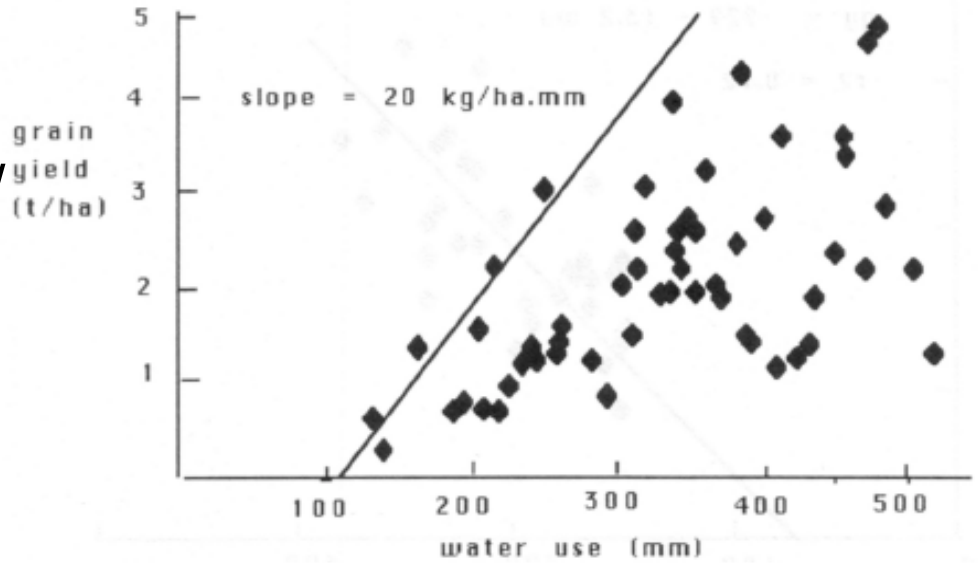
How does your farm line up?

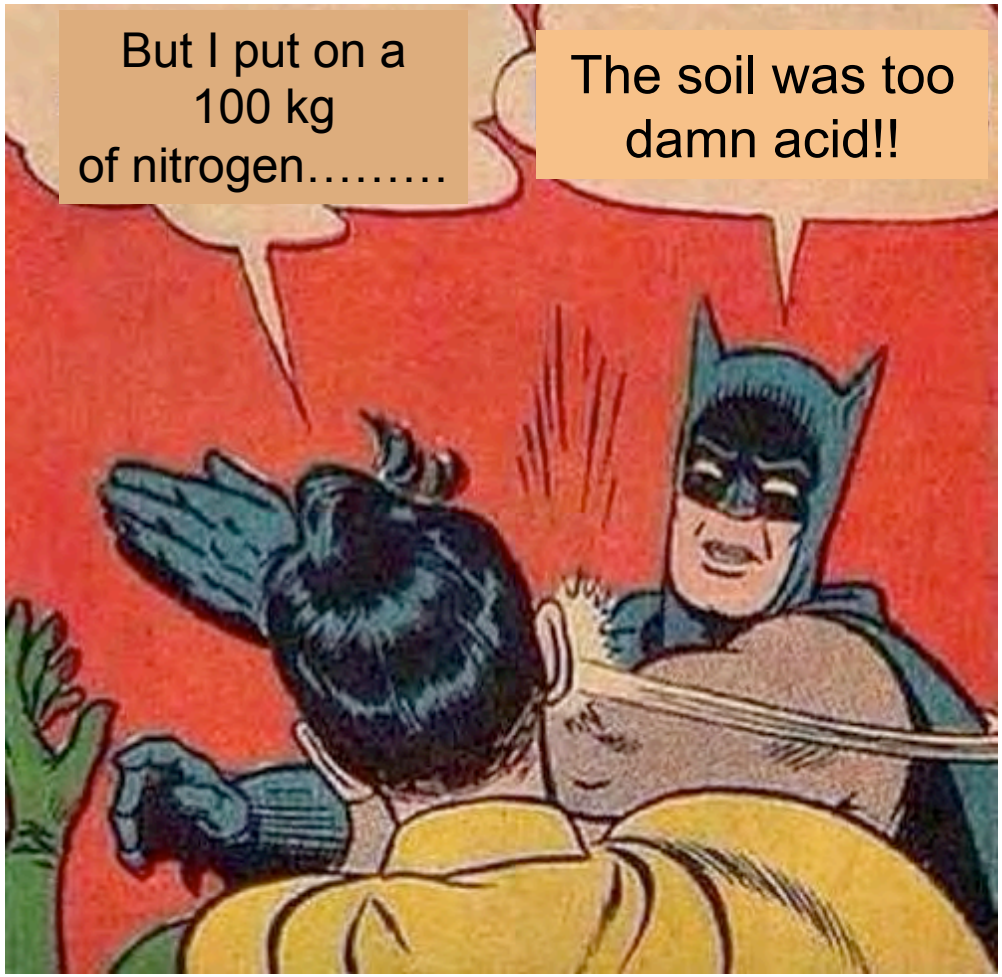
- Every farmer/advisor knows of WUE 20 kg/ha/mm



- What is the nitrogen use efficiency?
  - Partial Factor Productivity
    - kg grain divided by kg N
  - Partial Nutrient Balance
    - kg N removed divided by kg N applied
    - Yield*Protein%/0.571

Region	Cereal PFP kg grain / kg N	Cereal PNB kg N / kg N
Australia	52	0.82
North America	45	0.68
SS Africa	123	1.89
East Asia	32	0.46
World	44	0.66

Address the limiting factor……



- What is limiting production?
  - Until that is addressed – there is no extra response.
  - Weeds, disease, cold, heat, etc.
  - For soils – how do you know?

ASPAC

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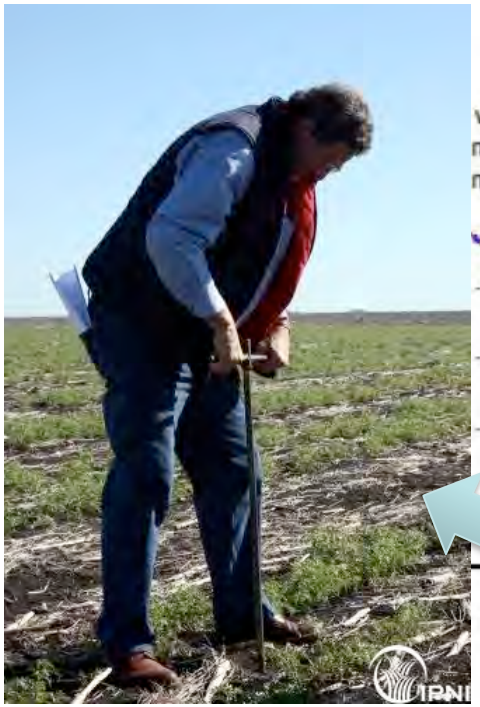
You get nothing for nothing…….

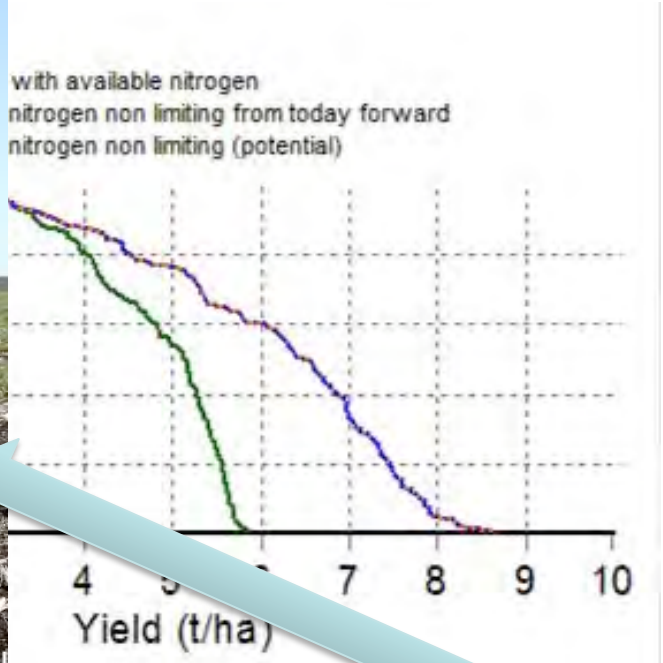
If produce is removed, nutrients go with it – if not replaced, then the soil reserves go down.

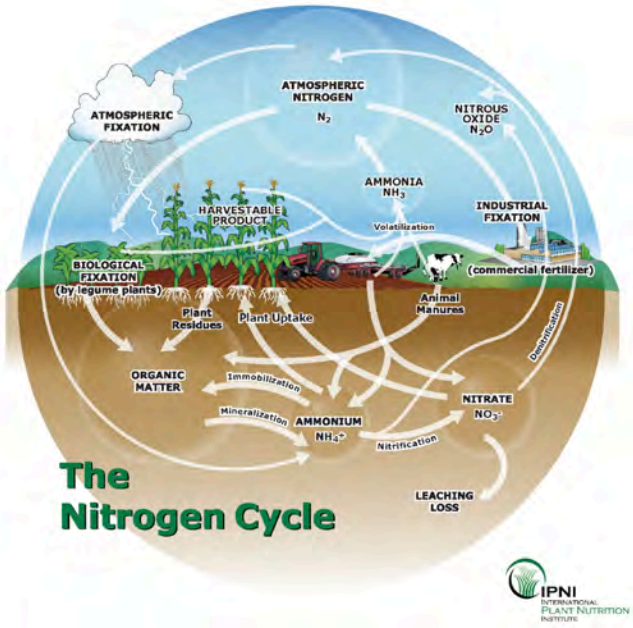
This is soil not the "magic pudding".

Have a target –

to estimate a N demand







N demand = (Yield * 22 * NUE) - N_{pre} – N_{min} + N_{imm}

5 t/ha wheat crop?

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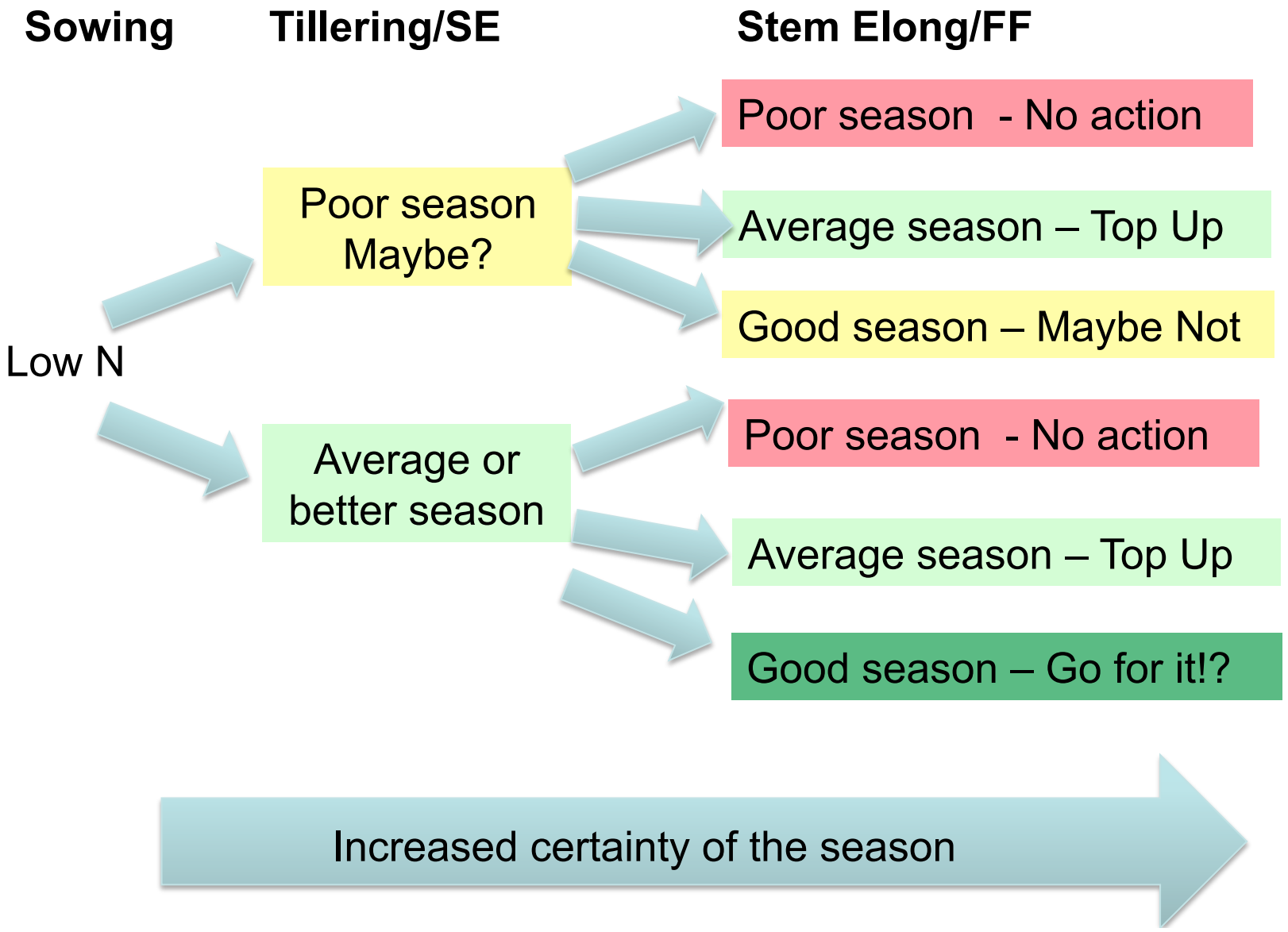
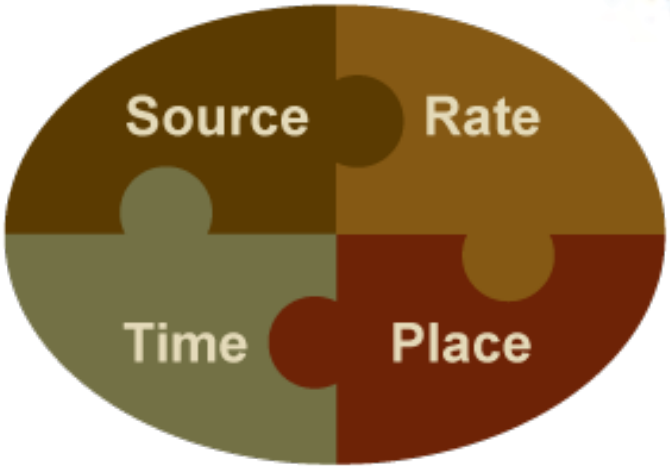
The Process – Take a tactical view



Effective and efficient use of N in-crop

- Just like everything
- *TIMING IS IMPORTANT*

4R nutrient stewardship



- Place –soil and/or foliar
- Source – UAN, GrUrea, SUrea, (AmS).
- Rate – to meet the unfolding potential (50 to 100 kg N/ha)

20 mm rain equals 1 t/ha which demands about 40 kg N

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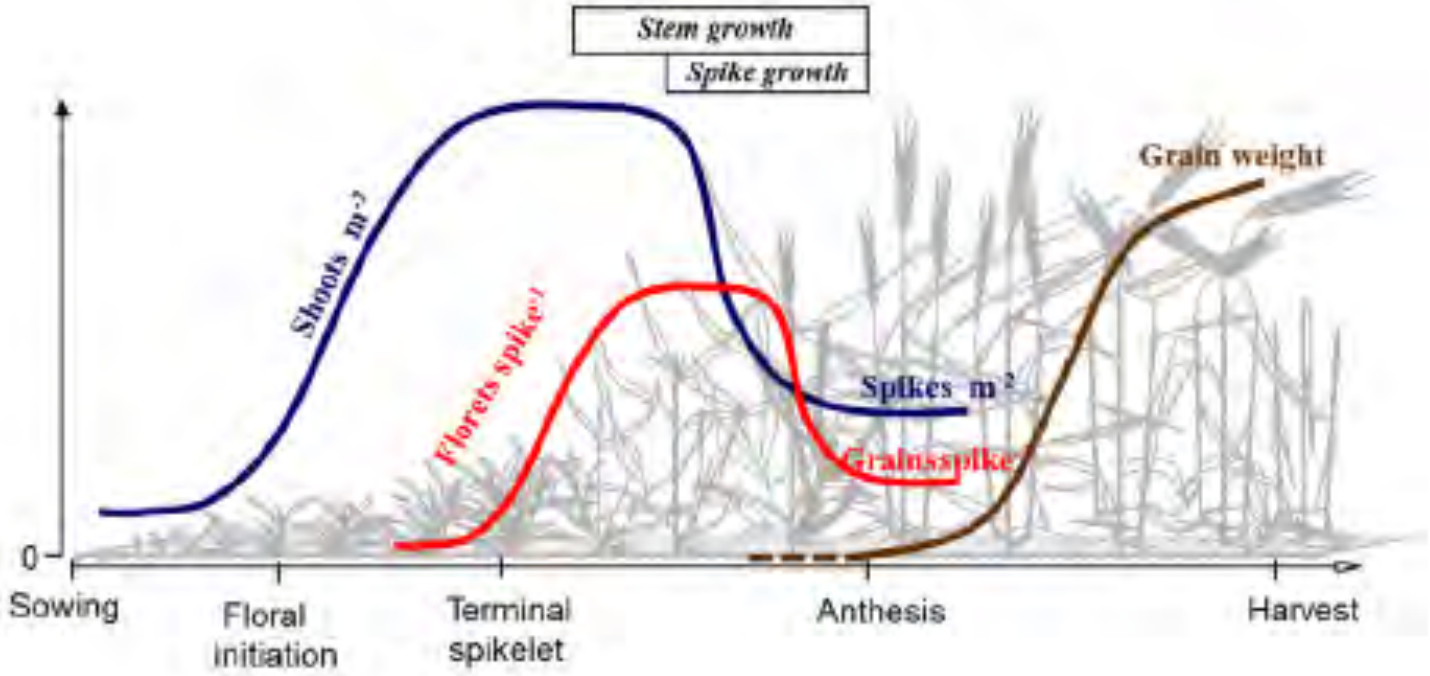
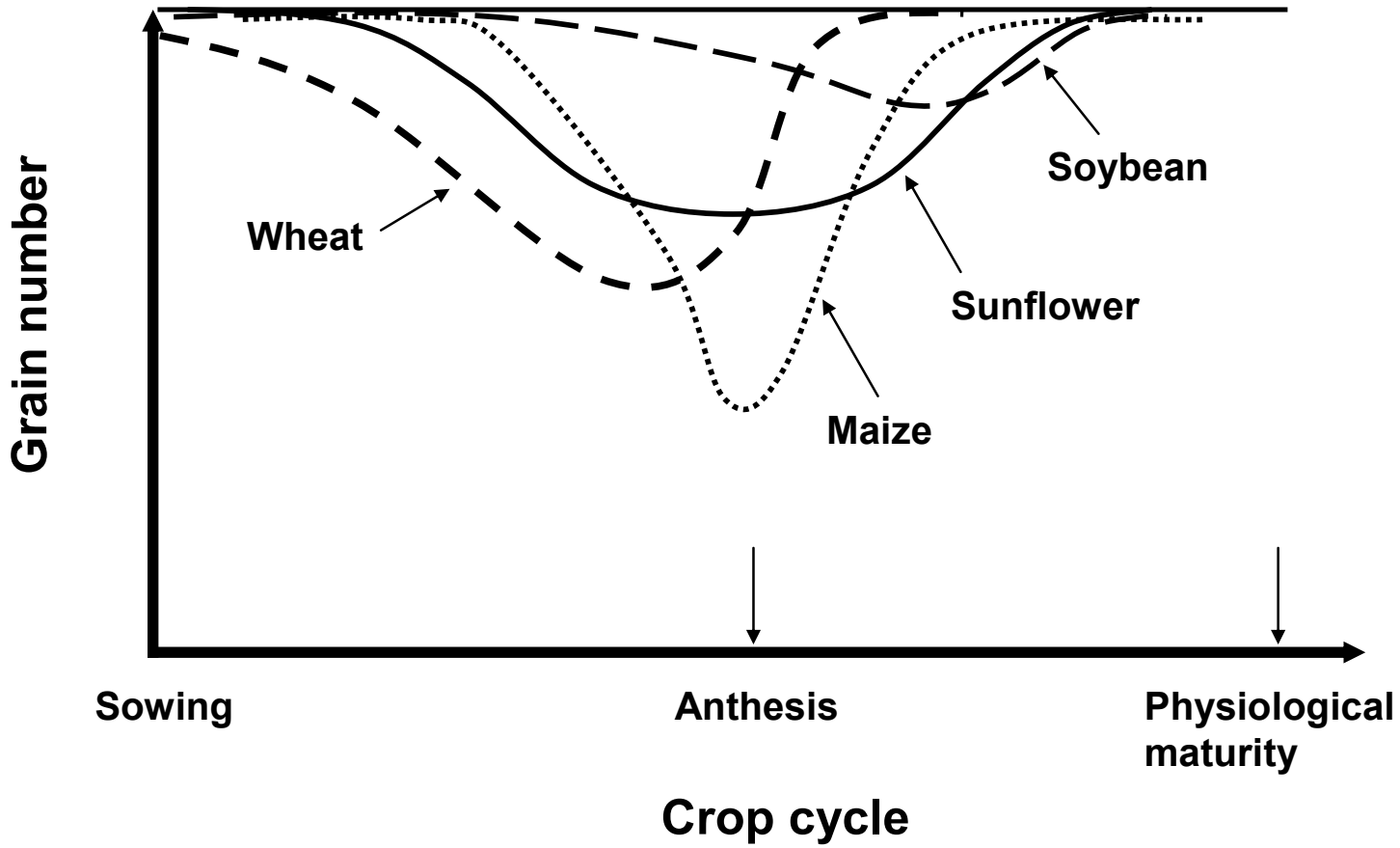
Yield = Grain number * Grain weight
Grain number = heads * grains/head



Slafer et al 2014

Critical times for stress impacts on grain number



Grain number is defined between DC31 and 10 days after flowering

V Sadras, SARDI

At DC31 or so……..

Probably around 50-80 kg N used up

- time to review and revise

How do you know if there is more N needed?

- Yield potentials
- N-rich strips in paddocks
- Plant testing
- NDVI *near or far*
- Looking!?!

Intervention Options
GRDC – N timing*form*rate 2013
Trial Locations

0, 25, 50 kg/ha N
DC32, DC39, DC55, DC70
UAN, GrUrea, SUrea.
8 sites across HRZ, report on 3 from Victoria

SFS – Jon Midwood

GRDC Grains Research & Development Corporation

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Site Differences: Mean of all rate, time and source.

Site	Yield	Protein	N Rem	Weights	Screenings
Inverleigh	5.13	10.6	114	76	13.1
Murnong	4.49	7.9	62	74	6.6
Westmere	5.38	11.2	107	76	2.5
Sign	**	**	**	**	**
Treatments	*	**	**	*	ns
Site*Tment	ns	*	ns	ns	ns

Each site had N up to GS32 – 50 to 120 kg N/ha

Screenings @ Inverleigh ?Stripe rust?

Murnong – 4.5 t/ha – 8% protein – hmmmmm?

N response in yield and protein

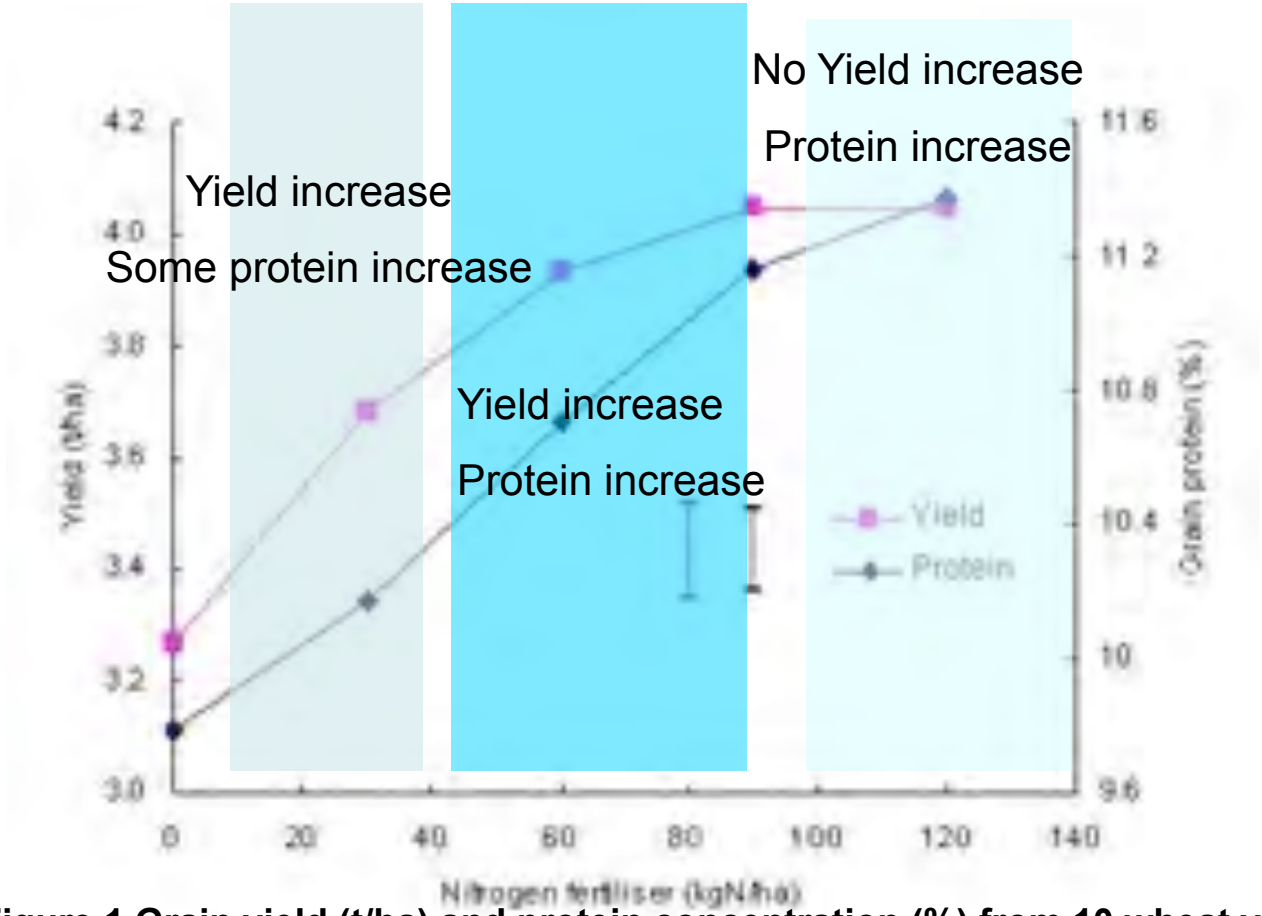
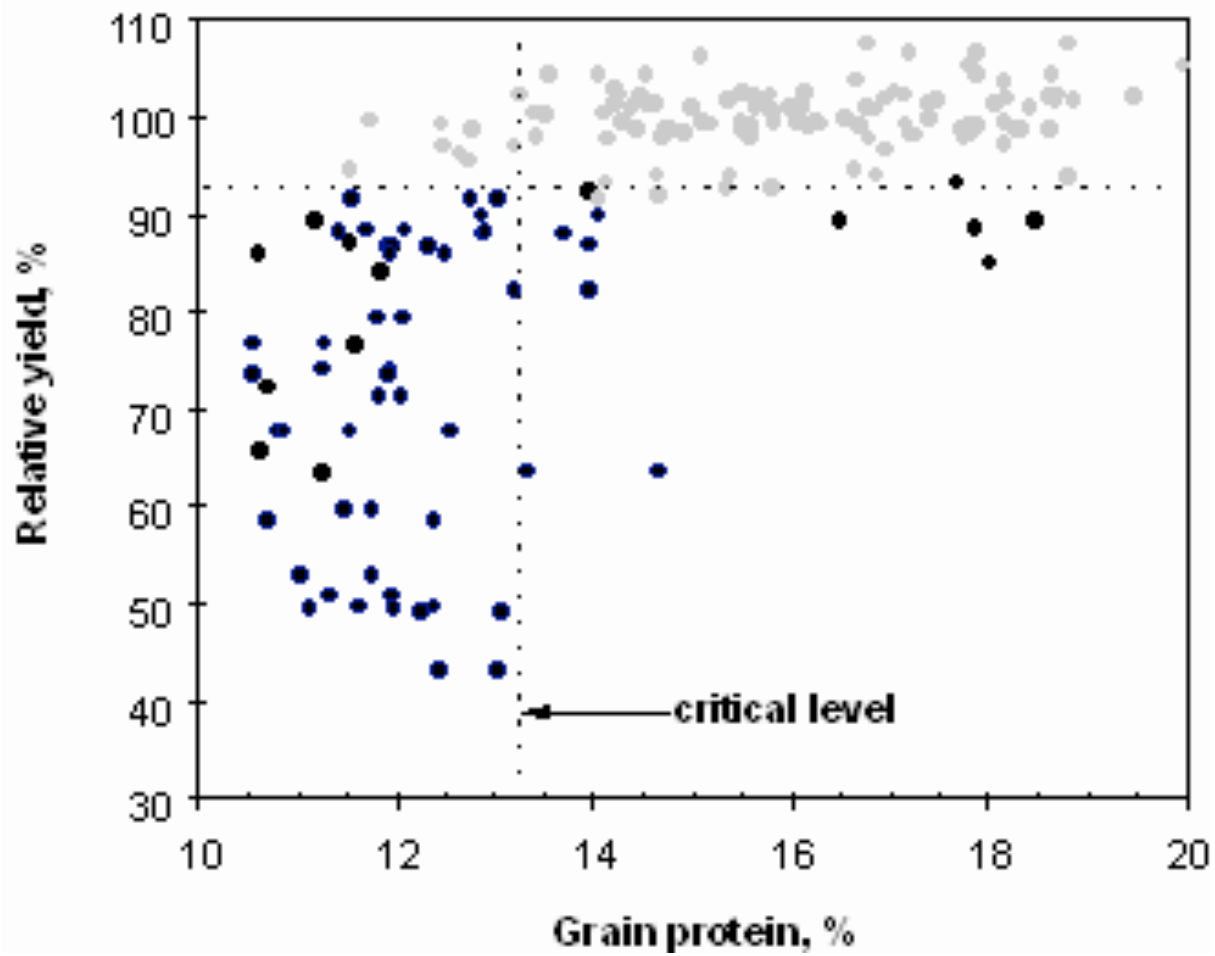
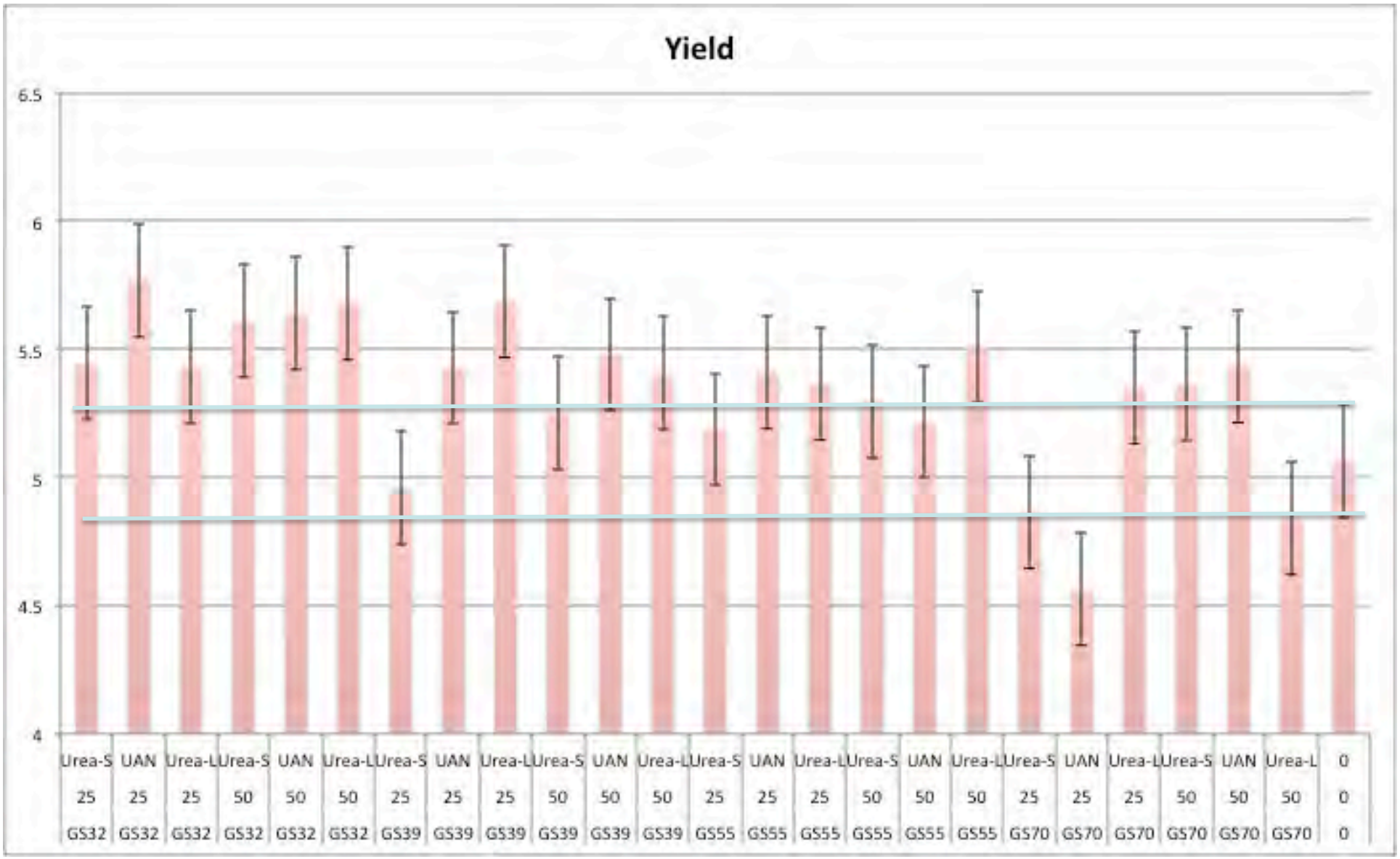


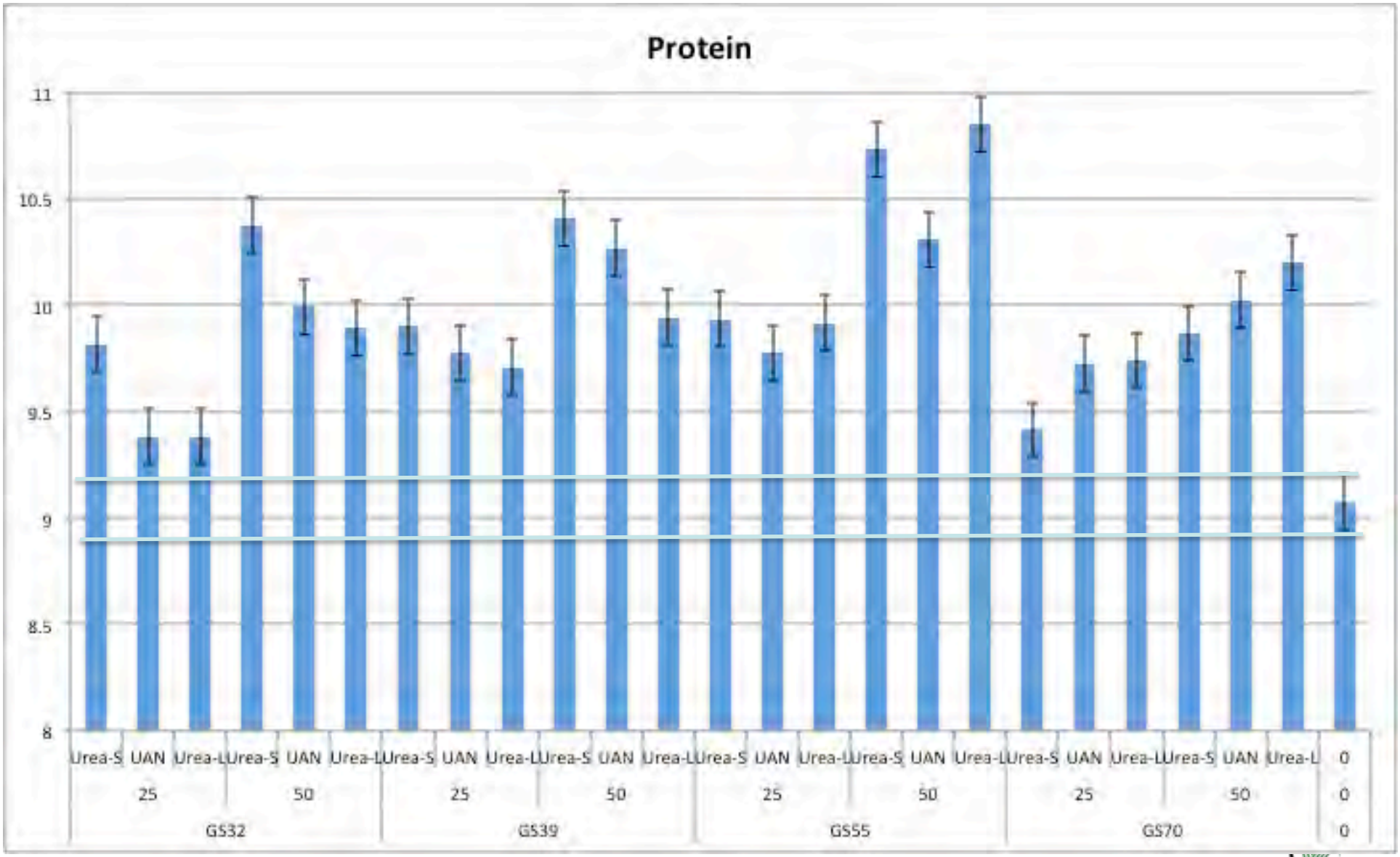
Figure 1 Grain yield (t/ha) and protein concentration (%) from 10 wheat varieties with 0, 30, 60, 90 and 120 kg/ha applied nitrogen in a trial at Parkes in 2011.(Gardner and McMullen, 2012, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Comparison-of-grain-yield-and-grain-protein-concentration-of-commercial-wheat-varieties)

Protein as an indicators of missed yield



http://landresources.montana.edu/FertilizerFacts/21_PostHarvest_Evaluation.htm


Yield
6.5
6
5.5
5
4.5
4
Urea-S 25 GS32
UAN 25 GS32
Urea-L 25 GS32
Urea-S 50 GS32
UAN 50 GS32
Urea-L 50 GS32
Urea-S 25 GS39
UAN 25 GS39
Urea-L 25 GS39
Urea-S 50 GS39
UAN 50 GS39
Urea-L 50 GS39
Urea-S 25 GS55
UAN 25 GS55
Urea-L 25 GS55
Urea-S 50 GS55
UAN 50 GS55
Urea-L 50 GS55
Urea-S 25 GS70
UAN 25 GS70
Urea-L 25 GS70
Urea-S 50 GS70
UAN 50 GS70
Urea-L 50 GS70
0 0 0


Protein
11
10.5
10
9.5
9
8.5
8
Urea-S
UAN
Urea-L
25
50
0
GS32
GS39
GS55
GS70

Effect of timing – mean of all sites, rate and source.

Time	Yield	Protein	N Rem	Weights	Screens
DC32	5.54	9.9	97	76	7.8
DC39	5.43	9.9	95	75	7.2
DC55	5.33	10.3	97	76	7.2
DC70	5.07	9.8	88	75	7.3
Sign	**	**	**	ns	ns

Early N = Yield – window is from DC32 to DC39

Late N = Protein – window is DC55 but before DC70

Similar experiment @ Longerenong

Responses		N applied at:				
	Nil N	DC31	DC42	DC65	DC72	LSD p>0.05
Yield (t/ha)	3.31	3.94	3.23	3.29	3.14	0.31
Protein (%)	8.6	9.4	10.4	9.8	8.9	0.4
N recovered (kg N/ha)	50	65	59	57	49	
% Recovery		75%	44%	33%	-4%	

- 20 kg N/ha applied at various times
- Yitpi
- Mean of several forms

Summary of where to put your N dollar:

sowing to stem elongation

stem elongation to flowering

after flowering

V Sadras, SARDI

Foliar, soil or what??

- N is taken up through the leaves
  - Urea > ammonium > nitrate
- Limited by either urea toxicity, salt burn or leaf area.

- Timing is important
- Worst effect if flag leaf is damaged
- The amount taken up through leaves is probably 10-15 kg N/ha
- Rest is taken up through roots.
- Leaf and soil – amm. loss.

Source*Timing – significant interaction for protein (not yield). For mean of 3 sites and 25/50 N rates

Source	DC32	DC39	DC55	DC70
Urea-S	10.2	10.1	10.3	9.6
Urea-L	9.7	9.8	10.3	10.0
UAN	9.8	9.9	10.0	9.9
LSD	0.2			

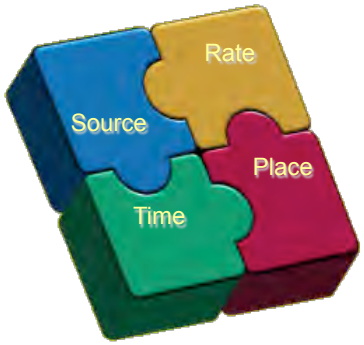
Early use of fluids v granules

Treatment	Plant N 4 DAA (kg/ha)	Plant N 10 DAA (kg/ha)	Total Plant N at Anthesis (kg/ha)	Yield (t/ha)	Protein (%)
UAN streaming nozzles	23	30	30	1.54	9.6
Urea top dressed	19	26	30	1.69	8.5
UAN inter-row only	19	25	27	1.50	8.7
UAN standard nozzles	22	25	24	1.51	8.6
Liquid Urea	20	31	17	1.26	8.9
LSD (P=0.05)	***NS***	***NS***	***8.4***	***NS***	***0.11***

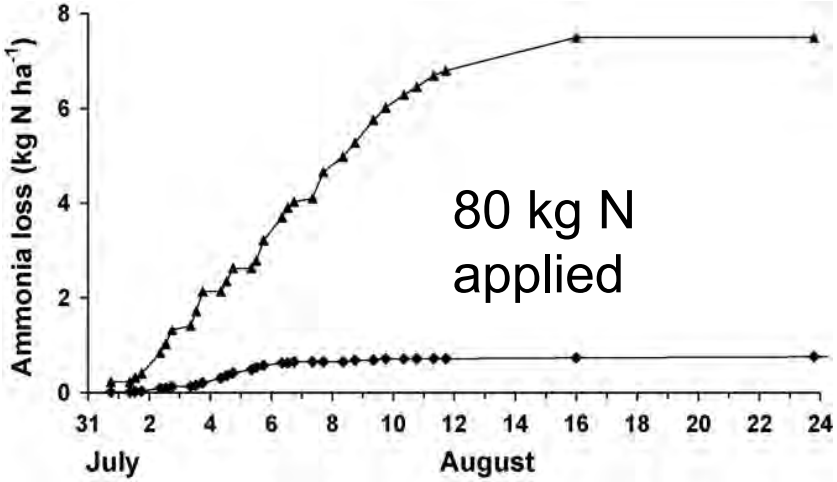
Applied at DC32 – low crop cover, N stress
Rain treatment –
folluw-up rain + 12% yield,-0.3% protein

BCG – T McClelland

Right Product



- Losses from Urea top dressed – 10% (Turner et al. 2010)
- Loss reduced to 1% with NBPT



- Losses 8-10%
  - Rain >7 mm 50% reduction
  - Bury to 5 cm – 75% reduction
  - NBPT – 90% reduction
  - Polymner coating – 50-98%
  - UAN – 30% reduction (half of the N is urea)

  (Bishop and Manning, 2011)
- Degree of loss depends on conditions after spreading!

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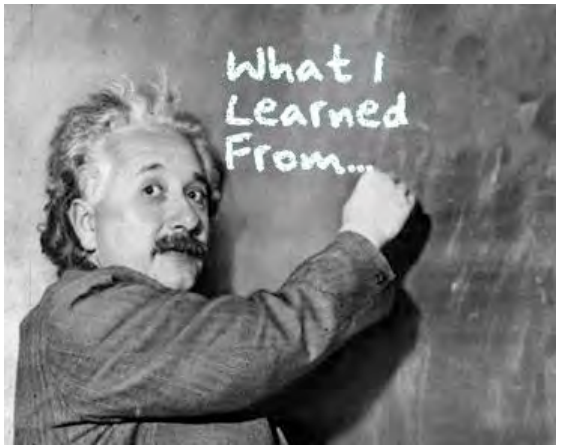
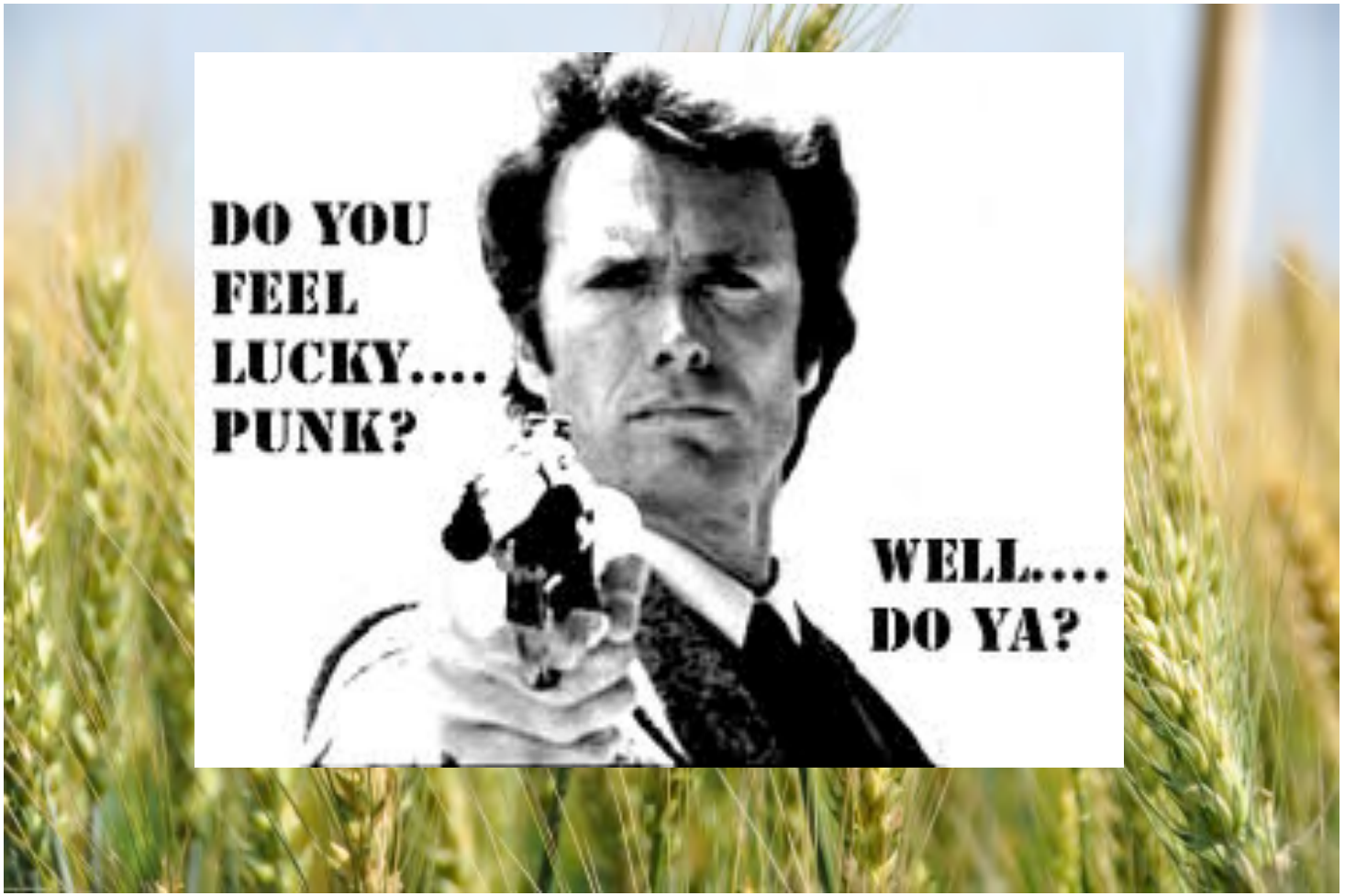
Some take aways



- How good is your N management?
  - Grain Protein – did you leave yield on the table
  - What PFP and PNB did you achieve
- Invest in N between DC31 and DC55 as yield is king
- Late N to change grades is an option but luck is needed.
- There would need to be compelling circumstances to justify moving away from top-dressed urea, provided as the season unfolds.
- Operation successful – but the patient died

So where now with nitrogen:



part science and a punt on the seasons.