Richard Eckard

Nitrogen Management

Victoria
The Place To Be

Plants and Nitrogen

All plants need nitrogen (N) for growth

"Nitrogen (N) fertiliser can be a useful management tool for manipulating seasonal pasture growth rate, as and when additional forage is needed"

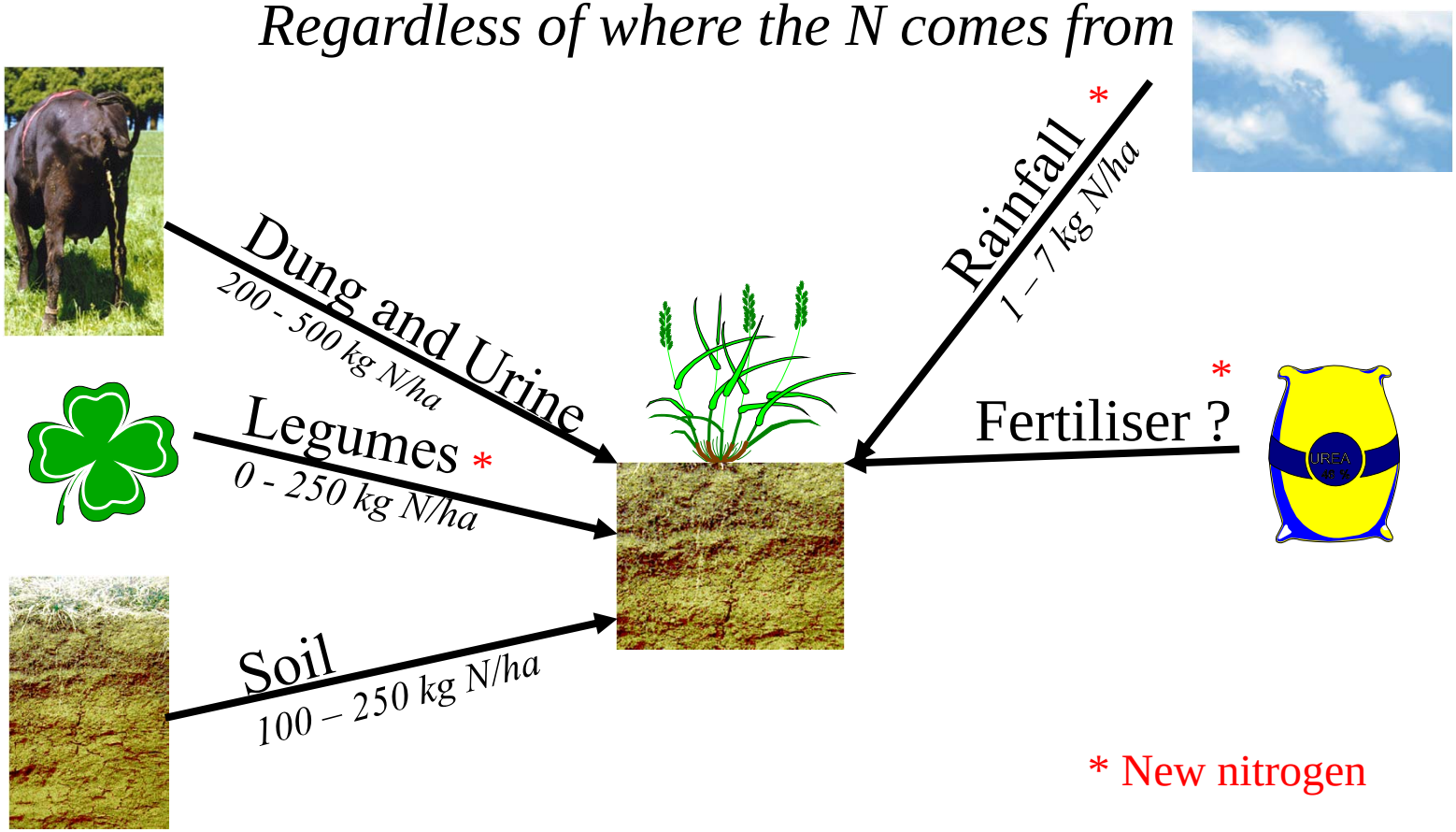
But,

too much nitrogen will increasingly be lost to the environment.

Nitrogen
Where does it come from?

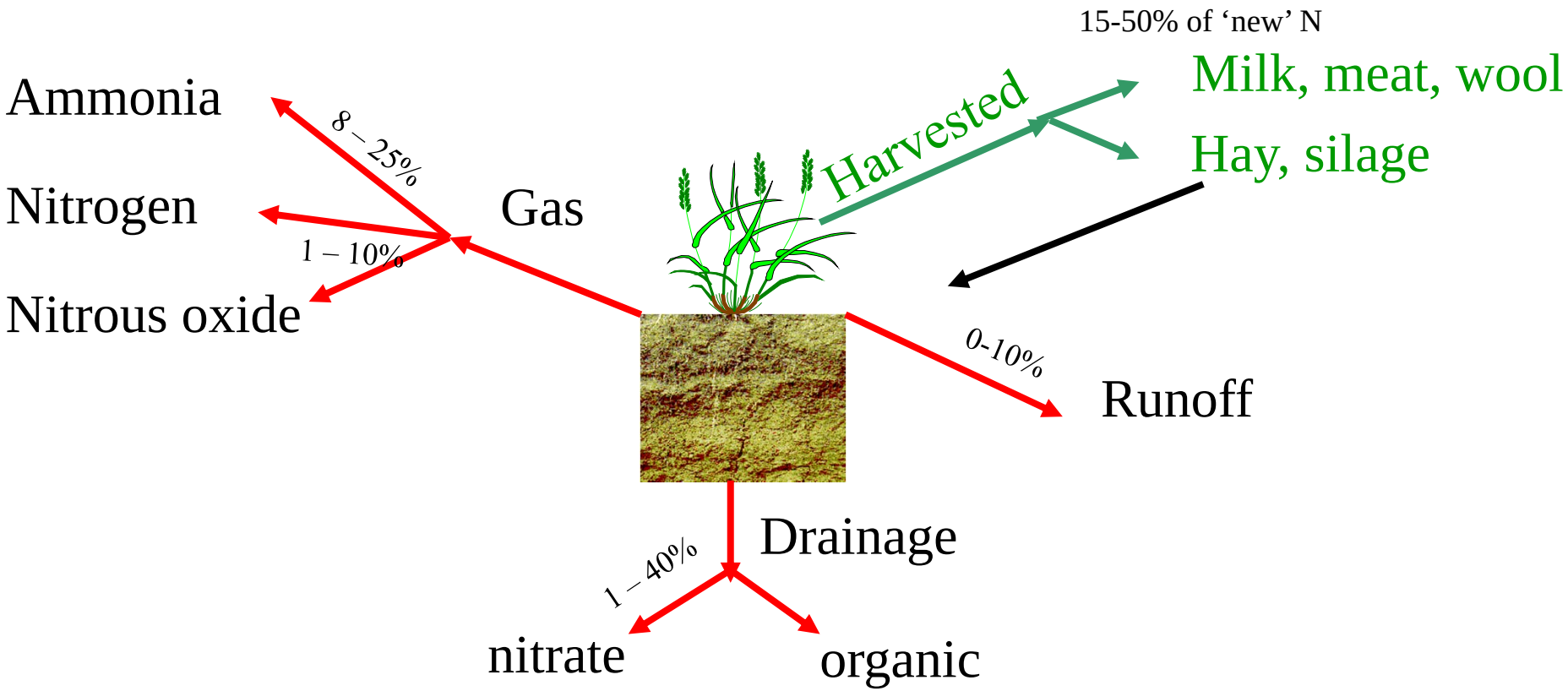
It takes about 600 kg N to grow 12 t DM/ha!

Regardless of where the N comes from



* New nitrogen

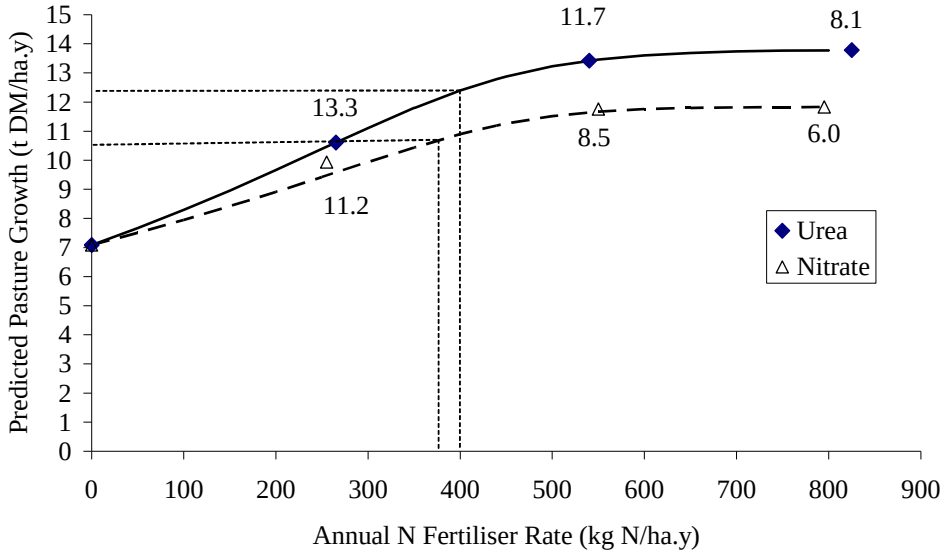
Nitrogen
Where does it go to?

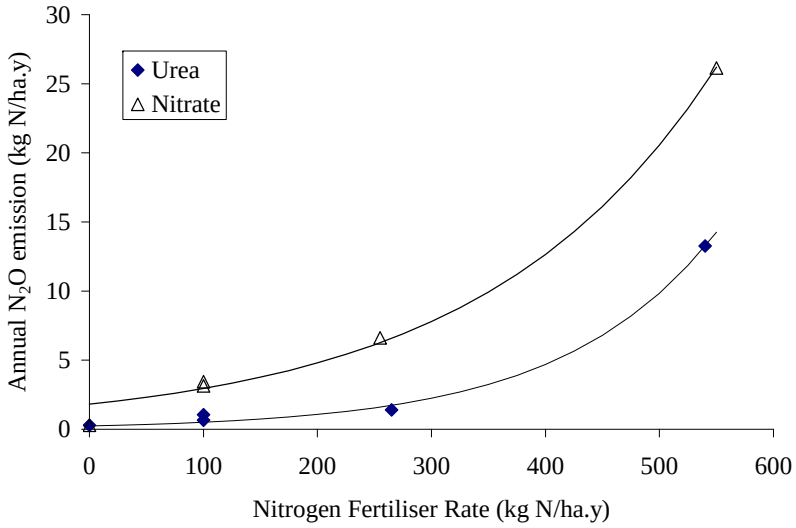


Only 30 to 40% of total N is fully recycled!

Eckard 2004

The balance between production and environment





Stocking rate is however, the single largest determinant of N required and N loss

Legumes

- A source of ‘new' nitrogen
- 0 and 250 kg N/ha per year
- Needs >25 - 30% clover in mix
- Average clover content
  - in Gippsland = 12%?
  - Western Victoria = 8-15 %?
- Temperature
  - N_2 fixation restricted at low soil temp (<10˚ C)
  - Only available during warmer months

- Most likely only 30 – 100 kg N/ha per year

Eckard 1998

Soil Organic Nitrogen

- ‘re-cycled’ N
- Sources:
  - Decaying grass and legume roots
  - Dung and urine
- N content:
  - Most pasture soils contain 6 – 8 t N/ha in the top 15 cm
  - BUT
  - Only around 1 - 3% available per year
    - Mineralisation is restricted at low soil temp (<10˚ C)
    - Only available during the warmer months
  - 50 – 250 kg N/ha per year from the soil

Eckard 2004

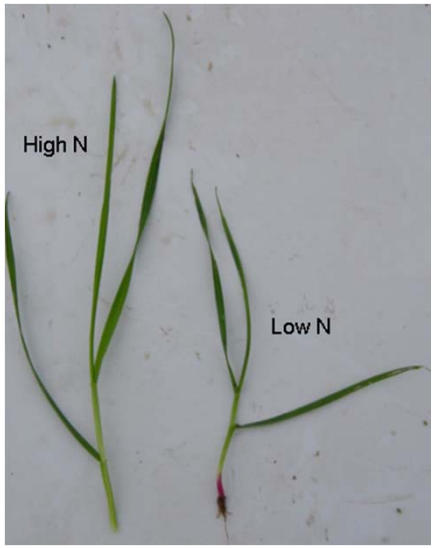
Nitrogen from Dung and Urine

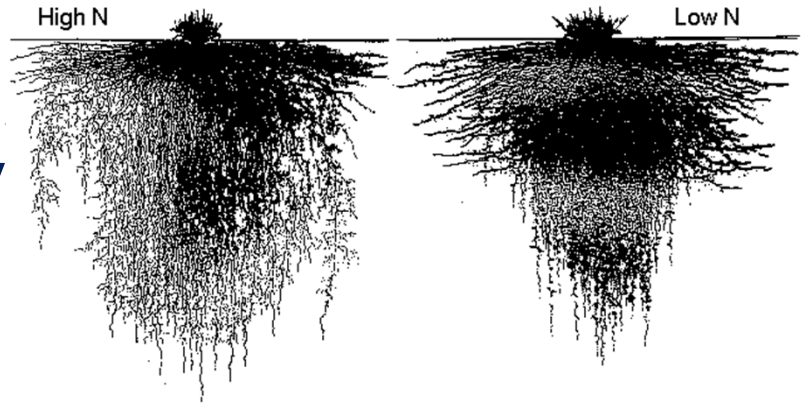
- ‘re-cycled’ N
- **60 - 90% of the N in urine is liquid urea**
- However, 40 - 60% of this N can be lost
- A single urine patch
  - Dairy cow = 1000 -1300 kg N/ha
  - Beef cow = 300 – 500 kg N/ha
- BUT
  - Covers entire paddock every 3 - 6 years

Eckard 2004

What does N do?

- Essential for protein
- Growth rate
  - 30 – 150% increase
  - Leaf length and width
  - Plant vigour
  - Cold and stress tolerance
- Root volume
  - Water use efficiency
  - Nutrient uptake





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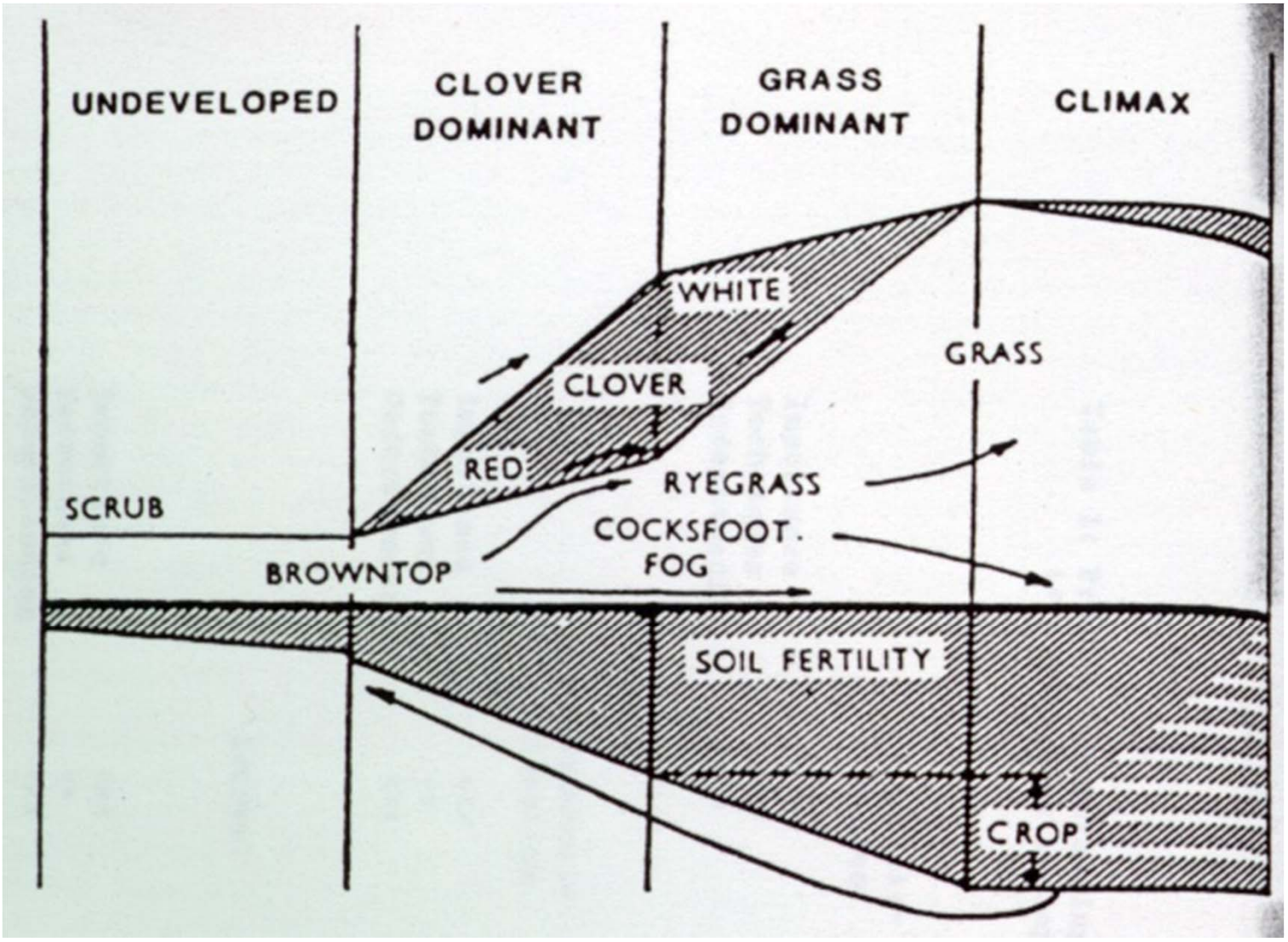
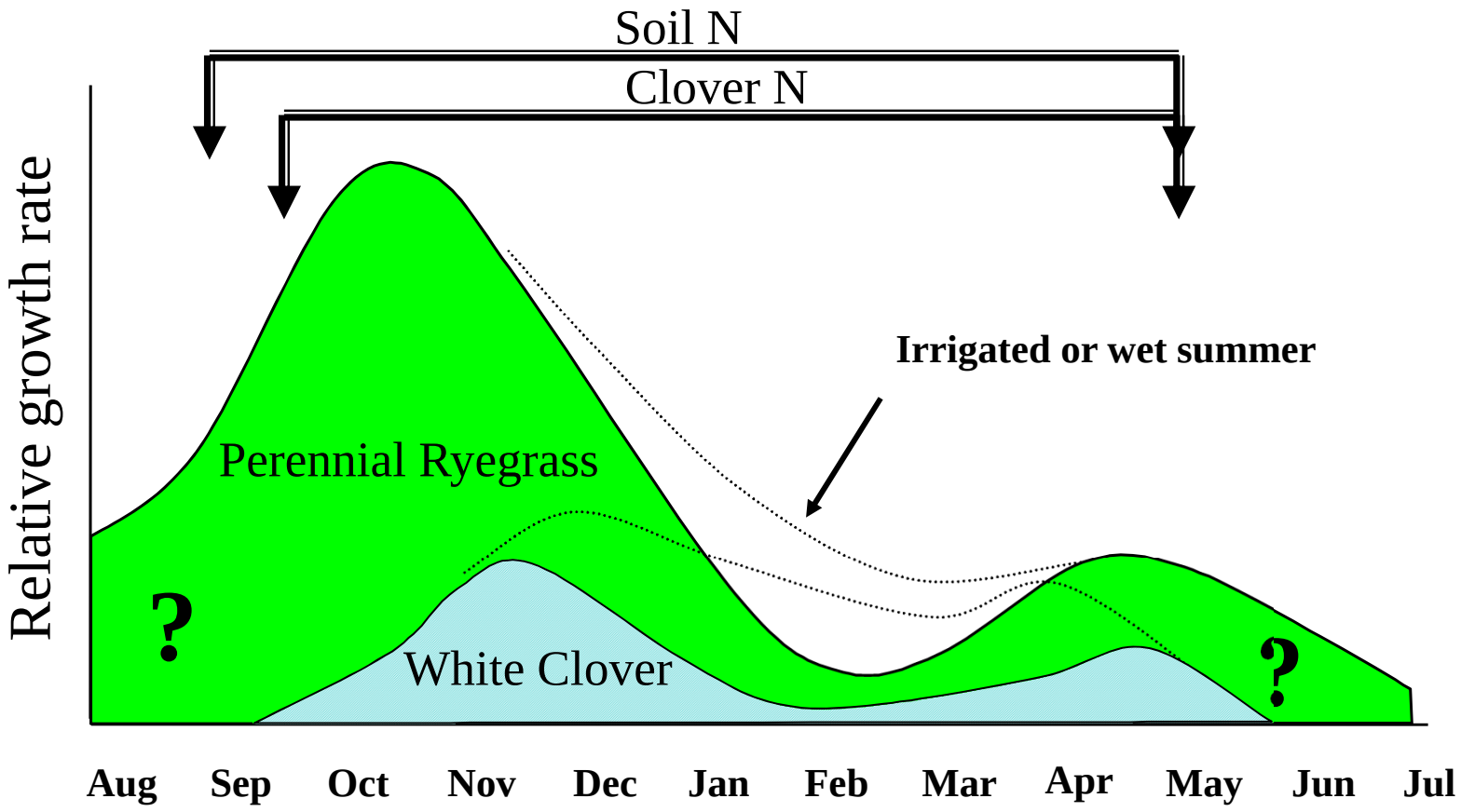
Clover dynamics



Ball & Field 1987

N fertiliser

The concept of strategic N inputs Perennial ryegrass/white clover



Eckard 2004

BMP for Nitrogen fertiliser

- Rate
- Source
- Timing
- Placement

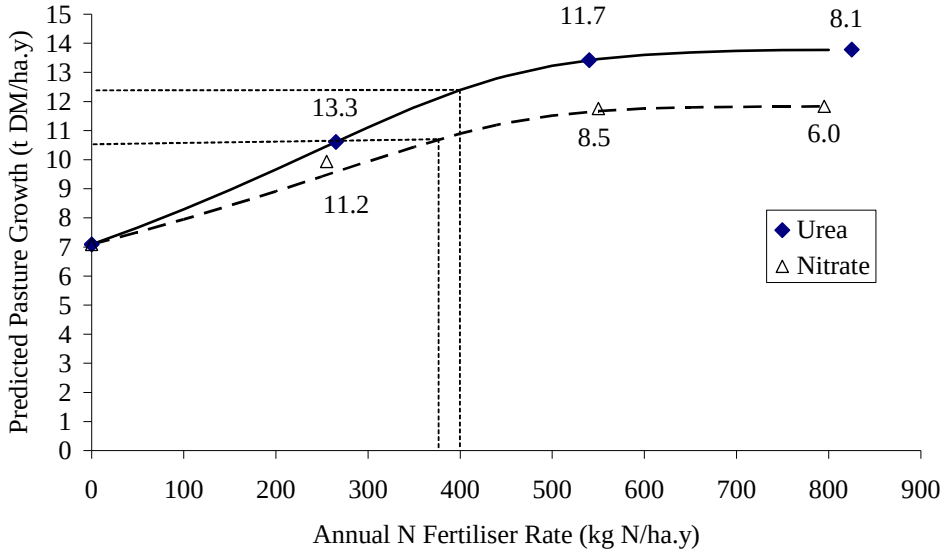
4 Rs

- Right Rate
- Right Source
- Right Time
- Right Place

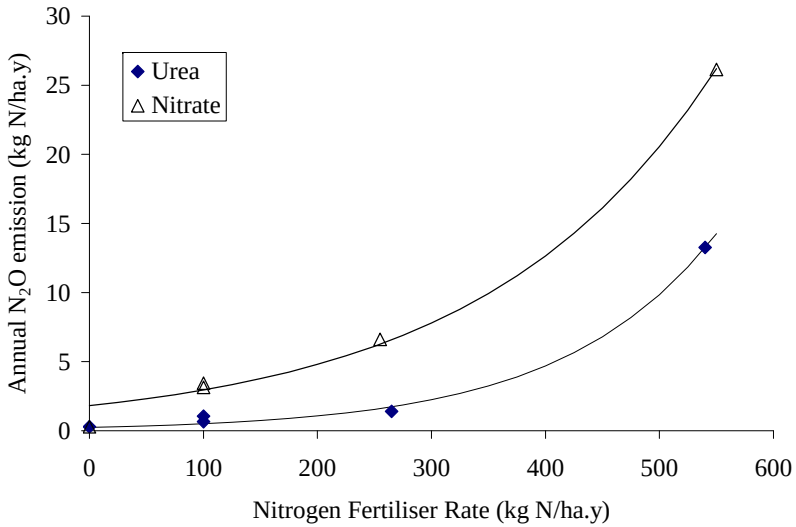
Nitrogen Rate

- Match rate & timing to plant demand

Productivity



Environment



Eckard, Johnson , Chapman (2006)

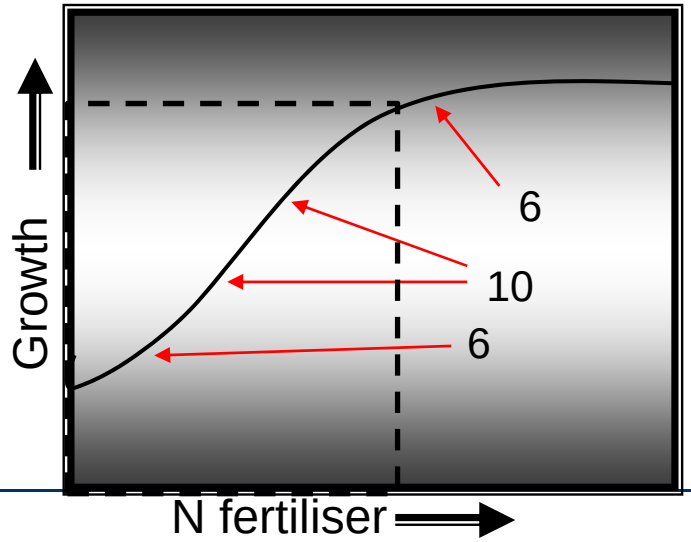
Nitrogen Efficiency – what is it?

N Efficiency = the slope of the response curve

OR = kg 'extra' DM produced/kg N applied

Using an N efficiency of 10:1 as an example:

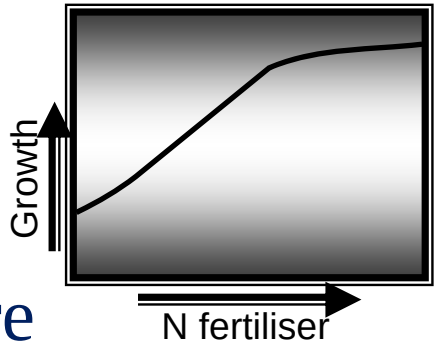
- If you are short 5 t DM
- 50 kg N/ha @10:1 = 500 kg DM/ha
- Apply 50 kg N to 10 ha



How do you use this?

Average N response – Gippsland (kgDM/kgN)												
Pasture potential	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Low	7	3	4	7	5	5	6	8	9	9	8	7
Medium	8	4	6	10	9	7	10	13	16	13	12	9
High	9	5	8	14	12	10	15	18	22	18	16	12

Nitrogen Rate



- Depends on additional growth required:
  - e.g.
  - 25 kg N => 8 – 20 kg DM/ha.day more
  - 50 kg N => 16 – 40 kg DM/ha.day more
- So it follows that (at 10:1):
  - 25 kg N/ha on 100 ha = 50 kg N/ha on 50 ha

BUT

  - 40 kg/ha on 100 ha > 80 kg/ha on 50 ha
- ALSO
  - N over the whole farm is 7 – 10% less efficient than following the cows

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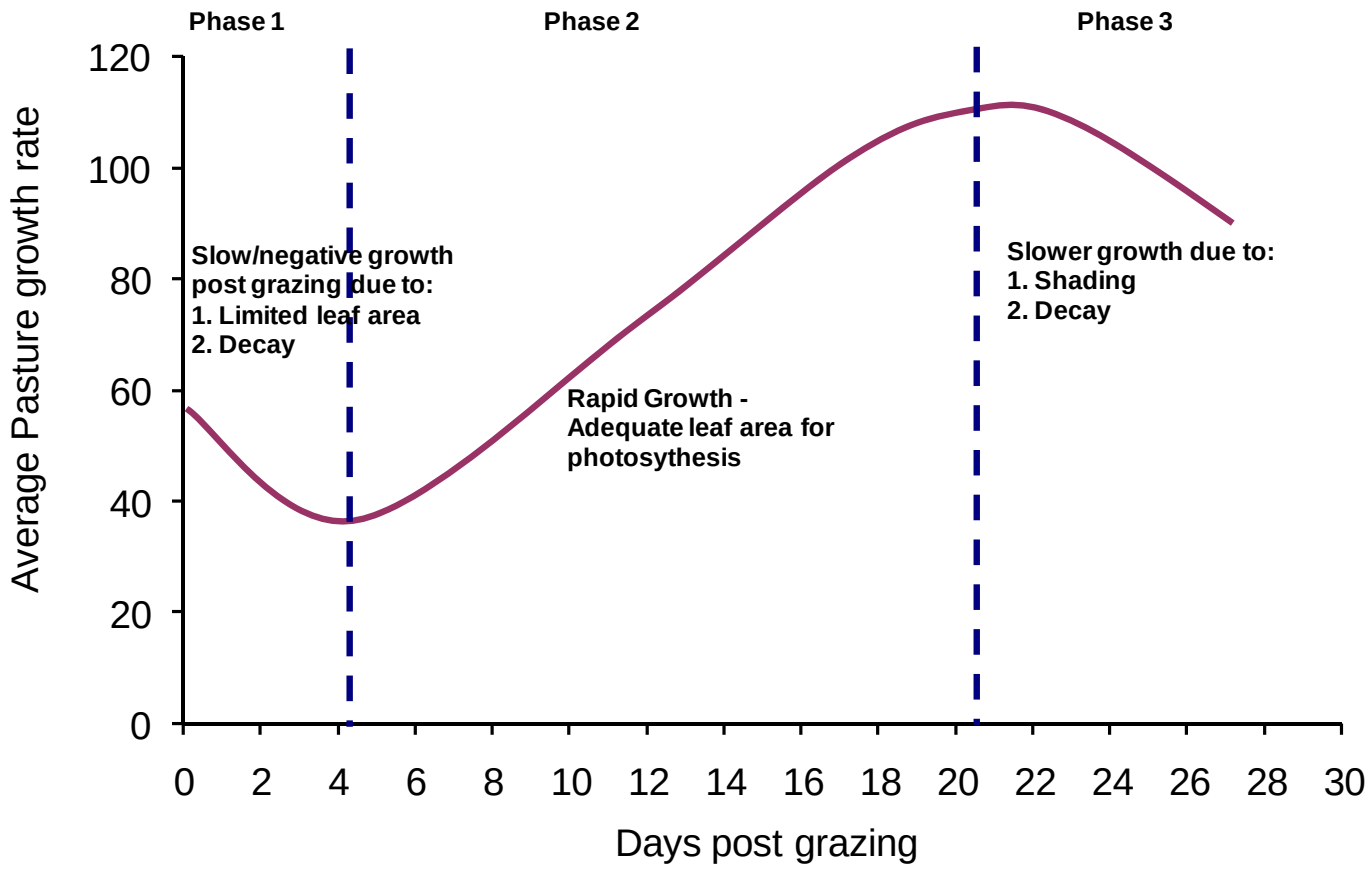
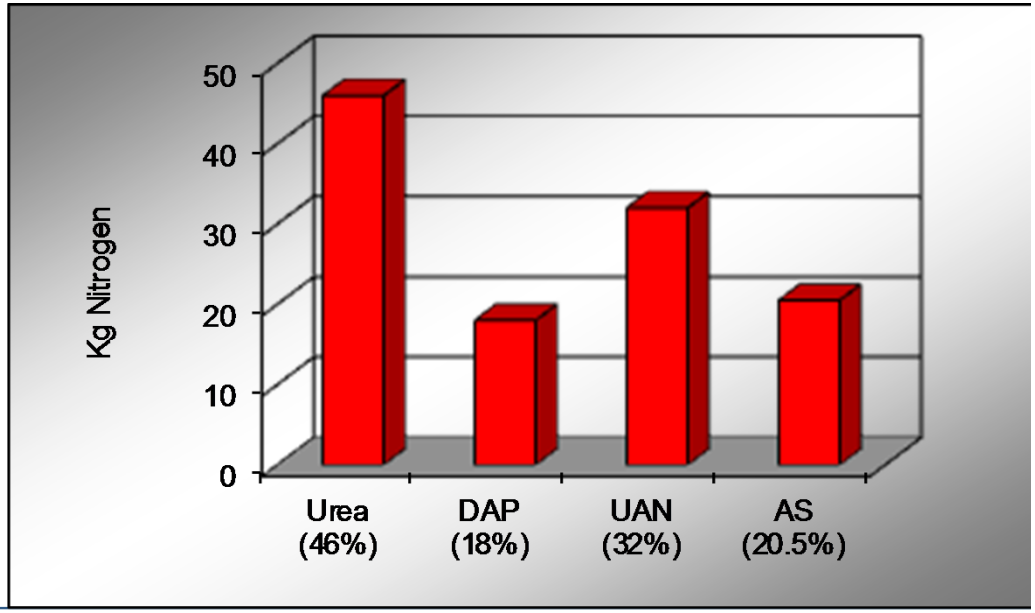
Nitrogen Timing



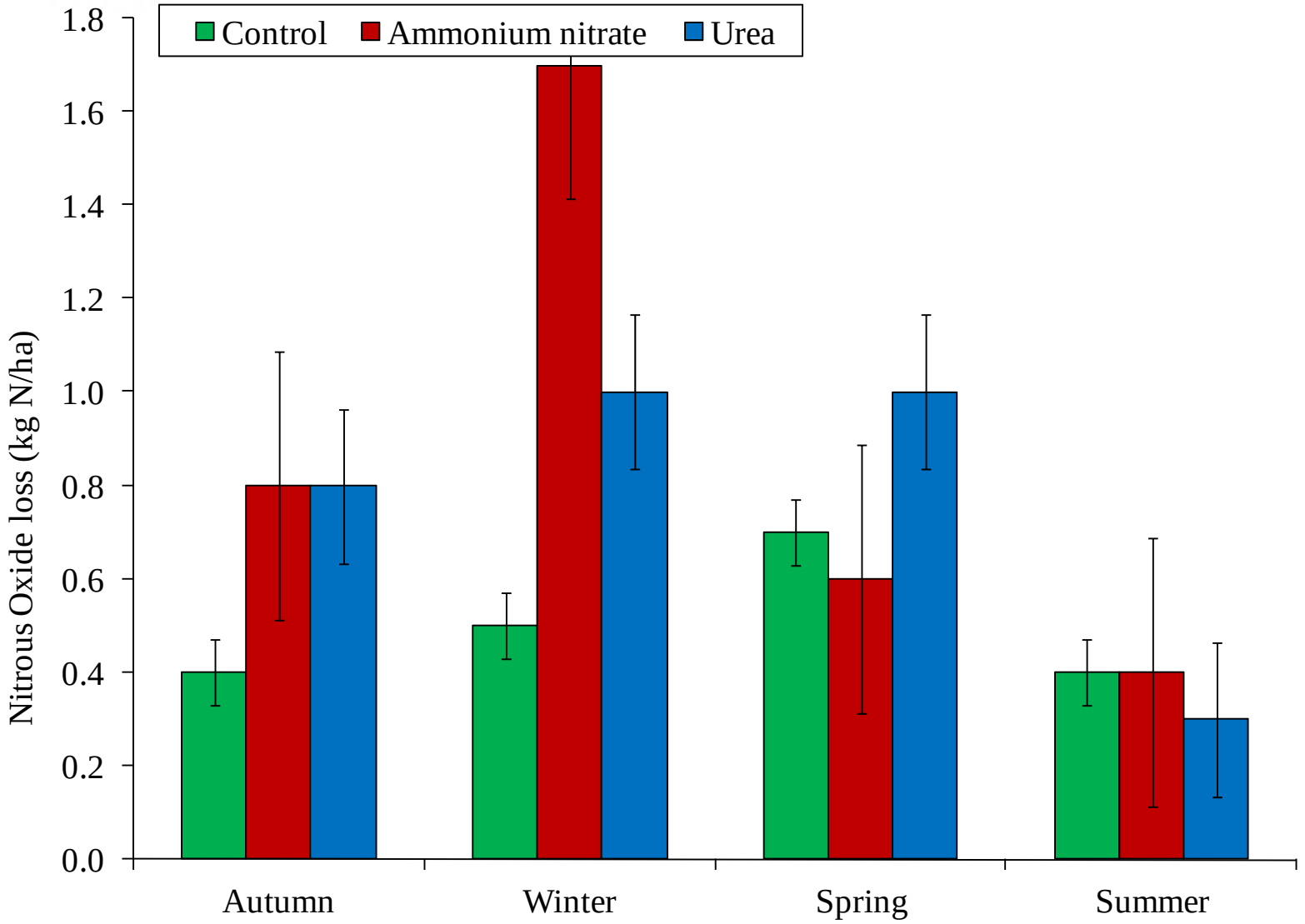
Nitrogen Source

- No difference between sources in yield
  - As long as the same N rate is applied
  - N losses do differ

- Urea (46% N)
  - Cheapest ‘pure’ N source
  - Ammonia Losses <10% (May-Nov)
  - Summer losses may be 14 - 20 %
- DAP (18%)
  - Cheapest ‘mixed’ N source
  - Top up with Urea



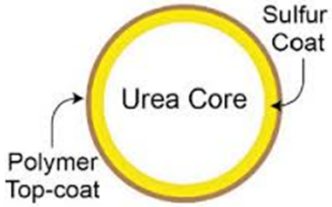
Nitrogen Source - losses



Eckard *et al.* 2002`

Enhance Efficiency Fertilisers

- Nitrification inhibitors
  - DMPP
    - Entec (3,4-dimethyl pyrazole phosphate)
  - Nitrapyrin
    - eNTrench (liquid)
  - DCD (?)
    - Eco-N (Dicyanciamide)
- Urease inhibitor
  - Agrotain
    - Green urea (NBPT)
- Polymer Coated Urea (PCU)



- Not cost-effective in grazing systems?

Nitrogen losses

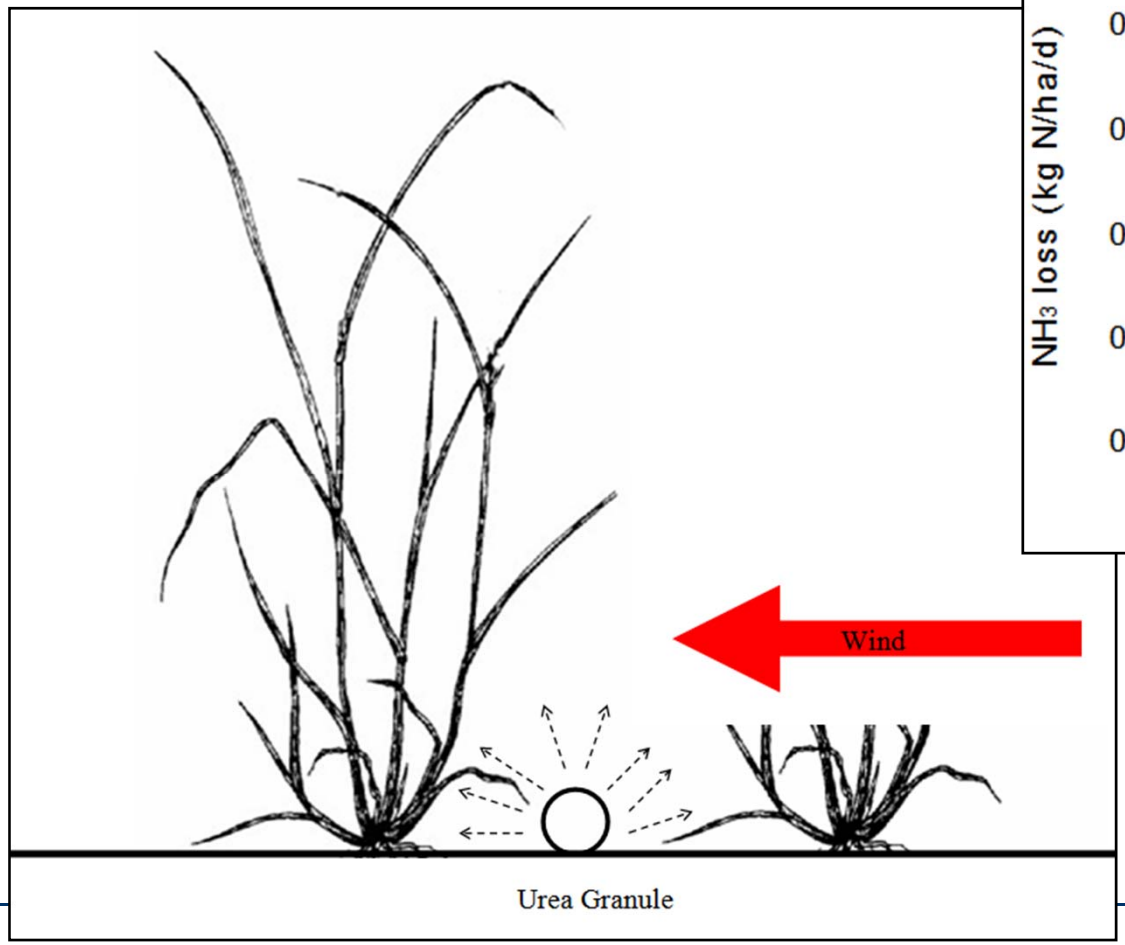
Ammonia Losses from Urea

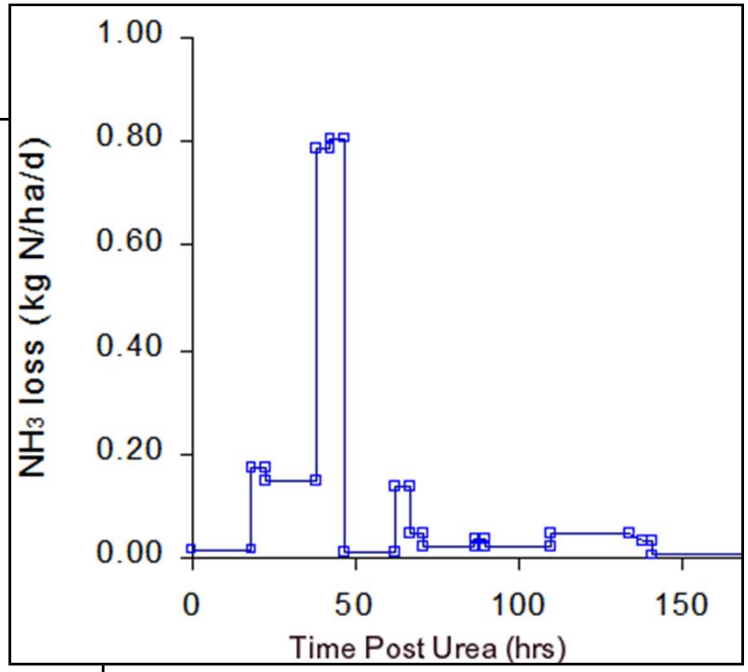
- Comes back down in rain
  - 5 to 8 kg N/ha from deposition
  - But can form N_2O
- Autumn break to Nov
  - 3 to 6% of Urea-N lost
    - No specific management needed
- Summer months
  - 6 to 14% of urea N lost
  - 25% max recorded in Gippsland
  - Urea still cheapest N source
  - DAP & AN – minimal loss

Eckard *et al.* 2003

Ammonia Loss
Grazing Management

- Apply N 3 days before grazing
- Only during warmer months



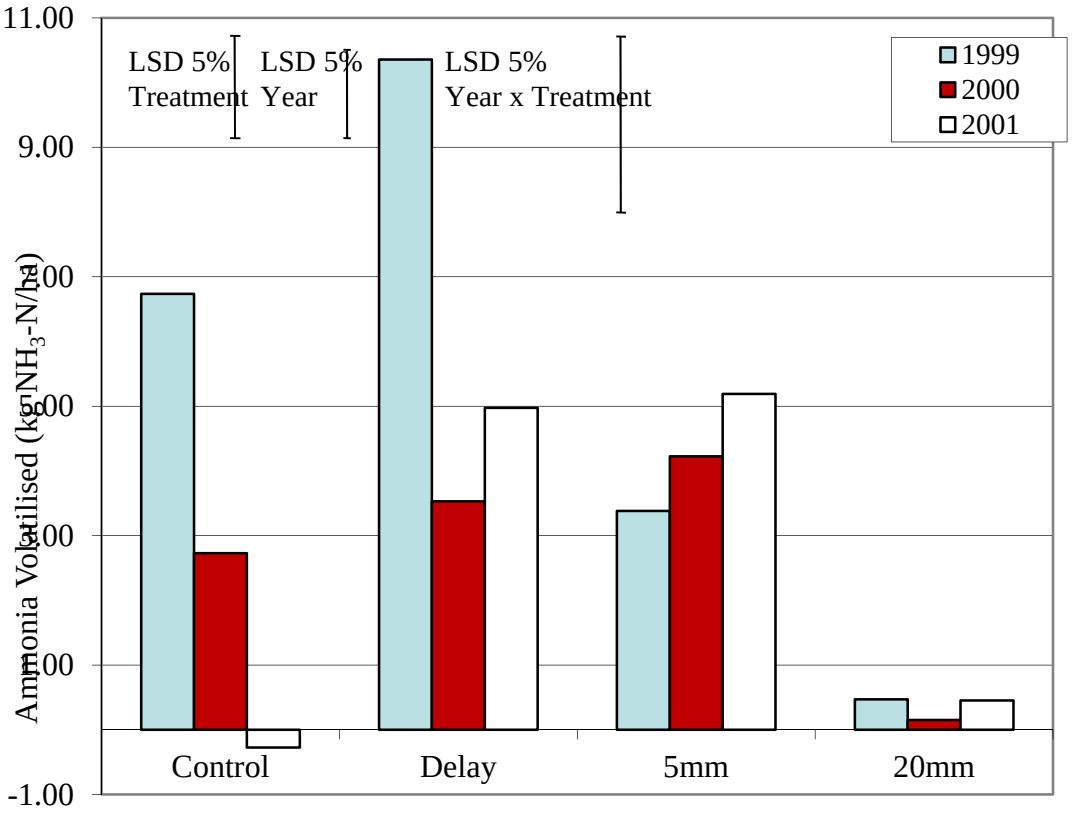


Ammonia Volatilisation
Summer Rainfall or Irrigation

50 kg **Urea-N** applied in Feb:

- No Rain: 0 –13% loss

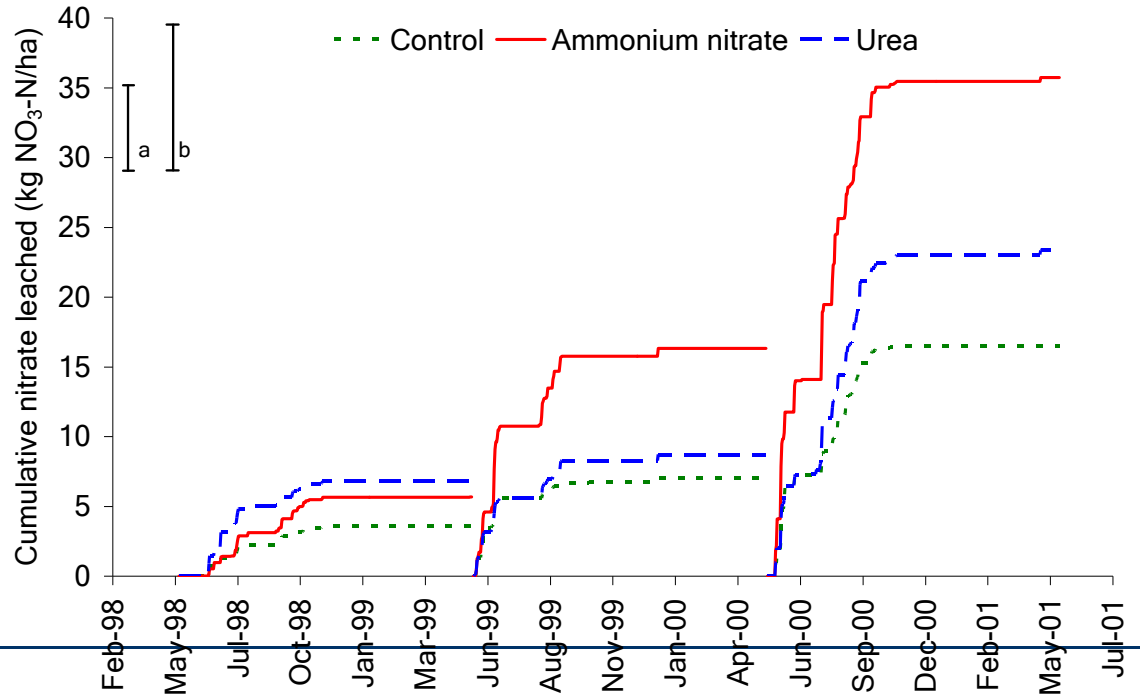
- Rainfall within 24hrs of N:
  - 5 mm: 7 – 10 % loss
  - **20 mm: 0 – 1% loss**
- Rainfall 24 hrs before N:
  - 20 mm: 7 – **21**% loss



Eckard *et al.* 2008

Nitrate Leaching

- Free draining soils lose more nitrate
- Impacts accumulate over years
  - <10 kg N/ha through to >40 kg N/ha



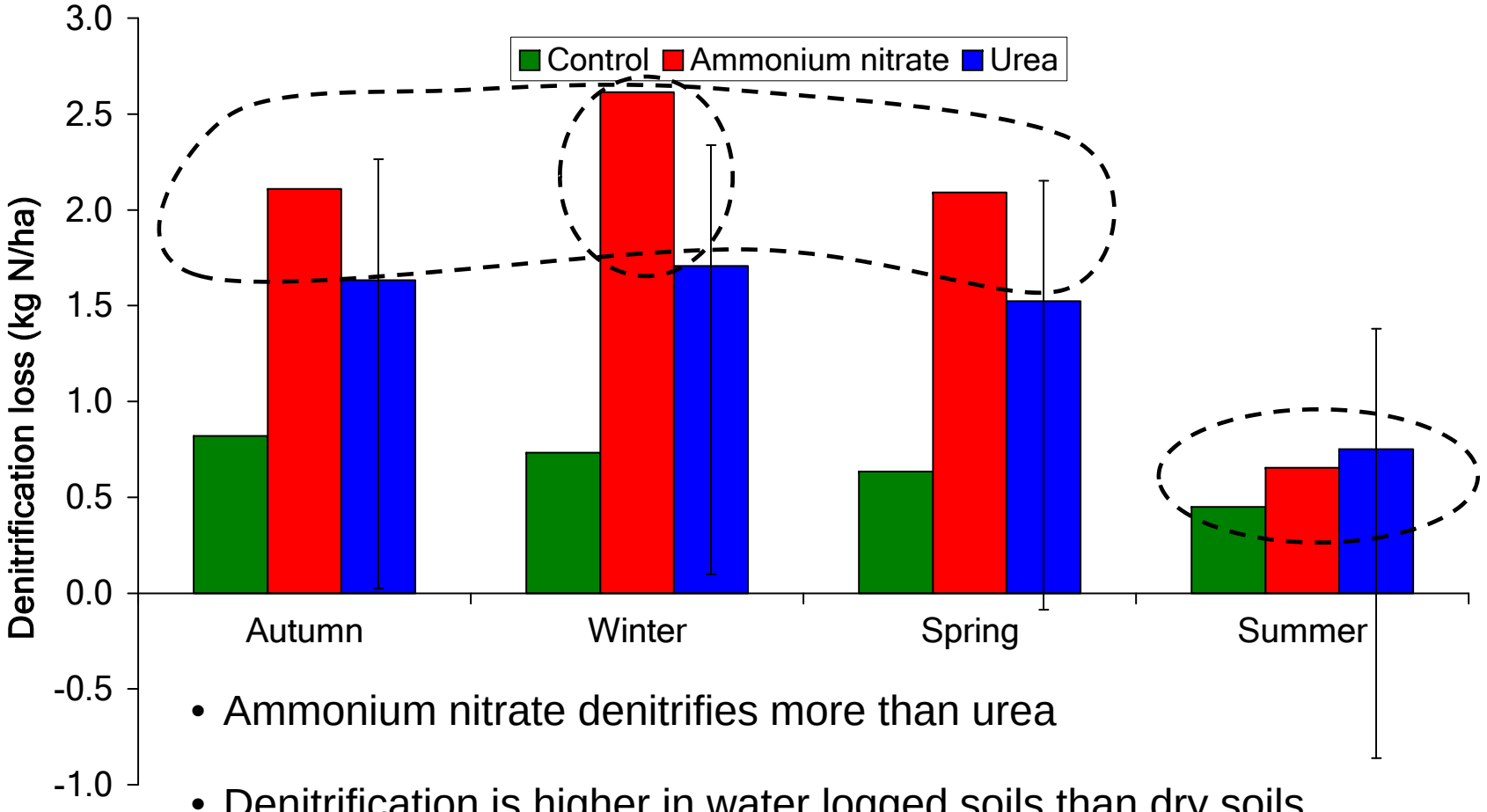
Eckard *et al.* 2004

Denitrification

- Warm and waterlogged soils
- Actual losses are low
  - 1 to 5% of N applied
- BUT
- Nitrous oxide is a powerful greenhouse gas
  - 310 times to GWP of carbon dioxide

Eckard *et al.* 2003

Denitrification



- Ammonium nitrate denitrifies more than urea
- Denitrification is higher in water logged soils than dry soils
- Higher denitrification with higher N and stocking rate

Eckard *et al.* 2003

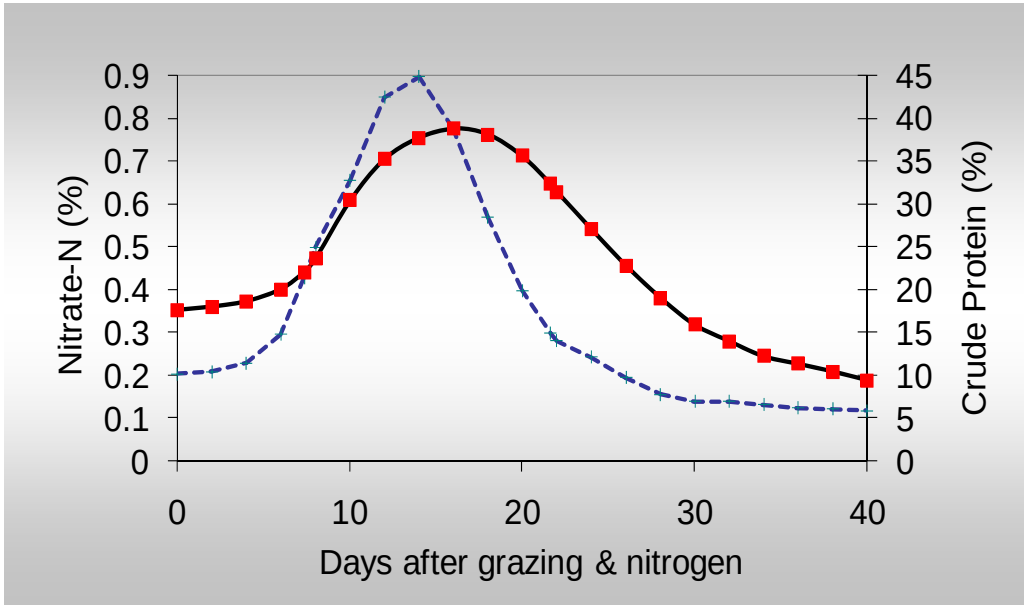
Animal Health Effects

- Nitrate Toxicity
  - Annual ryegrass
  - Capeweed
  - Brassicas

NOT

  - Perennial ryegrass
  - Clover

- Ammonia toxicity/bloat
  - sad-cow syndrome
  - 'belly-ache‘
  - Urine scalds /ammonia smell



Eckard *1994; 1999*

In Summary

- N fertiliser can be a useful management tool
- Only apply N when pasture is actively growing
  - No closer than 28 days apart
- Apply Urea or DAP between 25 and 50 kg N/ha
  - The N rate depends on the extra growth rate required
- Avoid high rates of N on wet soils
- Stocking rate is the biggest influence on
  - N input demand
  - N loss to the environment