Nitrogen

Efficient and effective use of nitrogen in pastures and cropping

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Why is nitrogen important?

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Why is nitrogen important?

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Why is nitrogen important?

- Nitrogen along with phosphorus is an essential nutrient for plant growth.
- Major component of chlorophyll
- N is used to form amino acids, the building blocks of protein, provides structure to plant
- Healthy plants contain 3-4% N in above ground tissues

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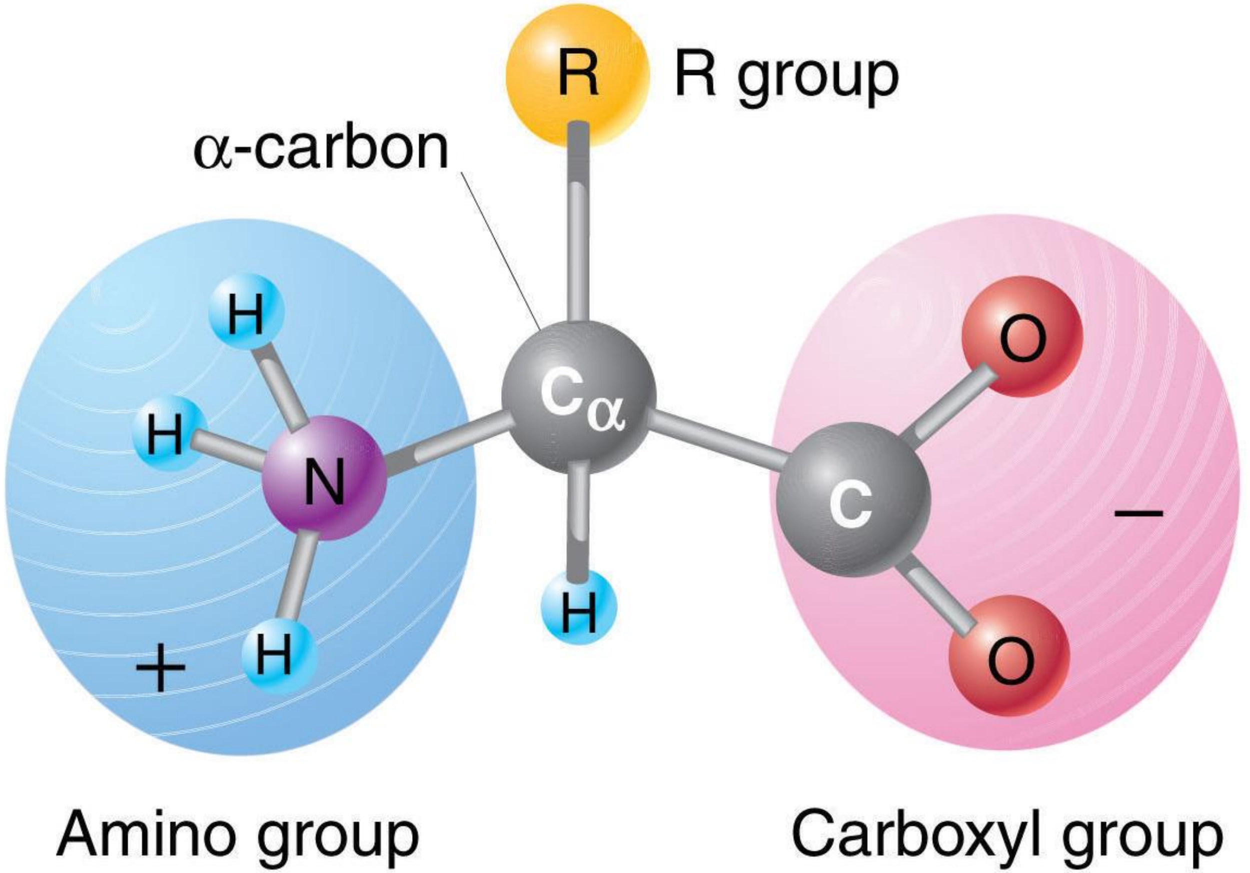
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α-carbon
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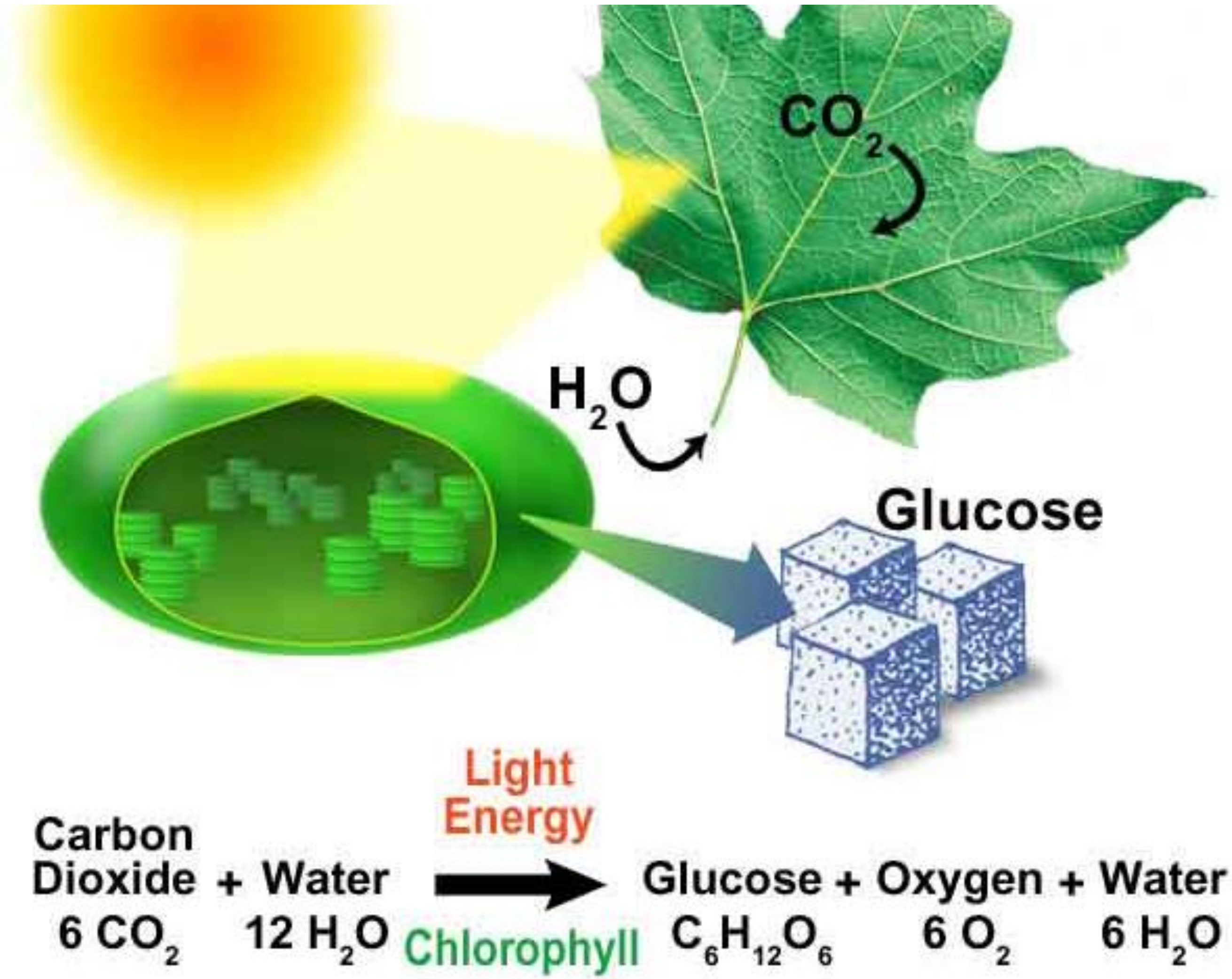
Amino group
Carboxyl group



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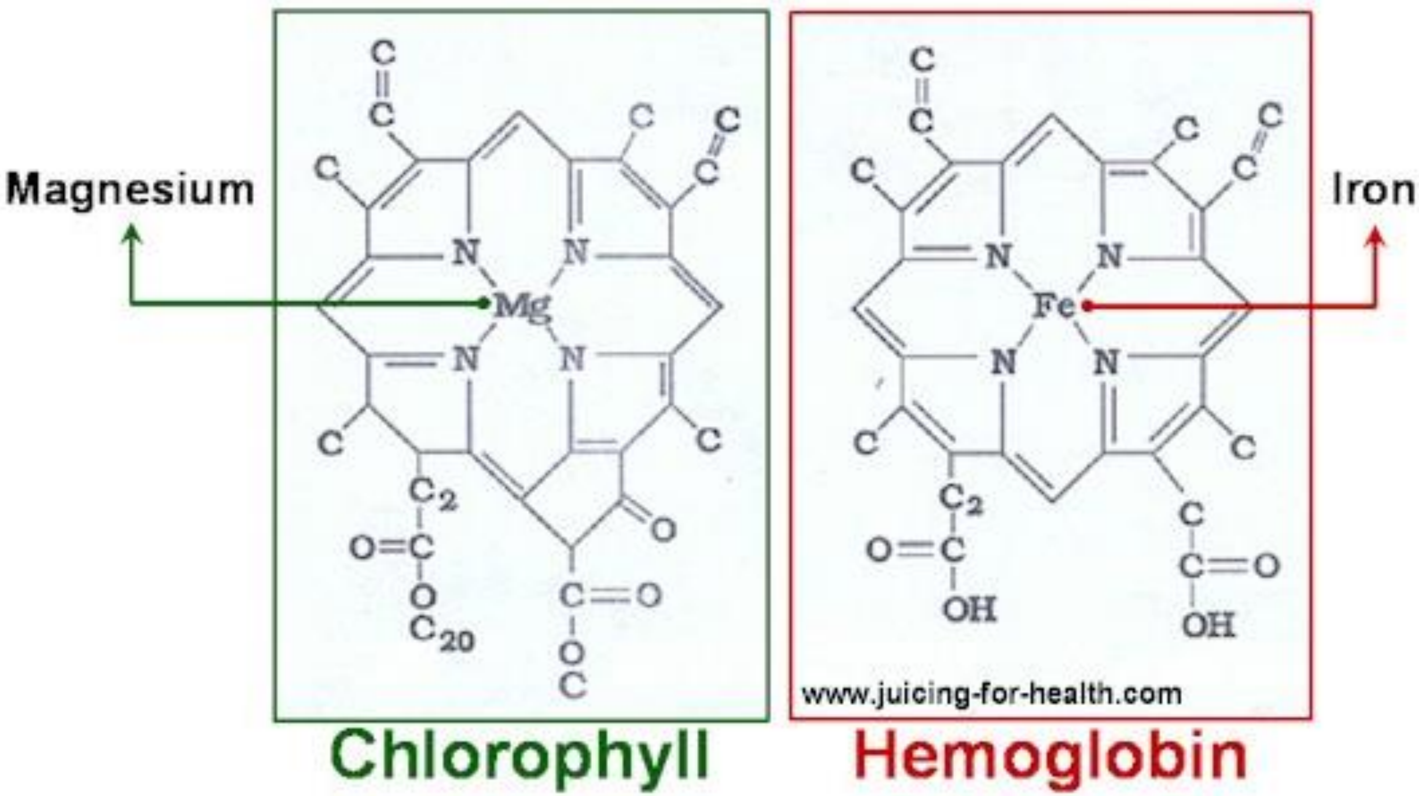

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Symptoms of N deficiency

- Pale green or yellowish from lack of chlorophyll
- Small
- Slow growing
- Limp, lack of structure
- Low protein, low energy
- Urine patches

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How do you test for nitrogen?

- Plant tissue testing can be used to diagnose potential deficiencies
- Deep N soil testing
  - Soil cores taken to a depth representative of the rooting zone (often 60 cm)
  - Analysed for nitrates, ammonium and organic carbon
  - Taken early in the growing season to allow for N budgeting
  - Due to the volatile nature of N, samples should be analysed without delay

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Supply and demand

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Nitrogen demand

- Plant demand for nitrogen increases with plant size and yield.
- Calculating plant demand:
  - Potential yield – grain or dry matter / ha
  - Nitrogen requirement – how many kg N / unit of product

Plant demand (kg N/ha) =	Yield potential (t/ha)	x Nitrogen requirement (kg N/t)

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Potential yield

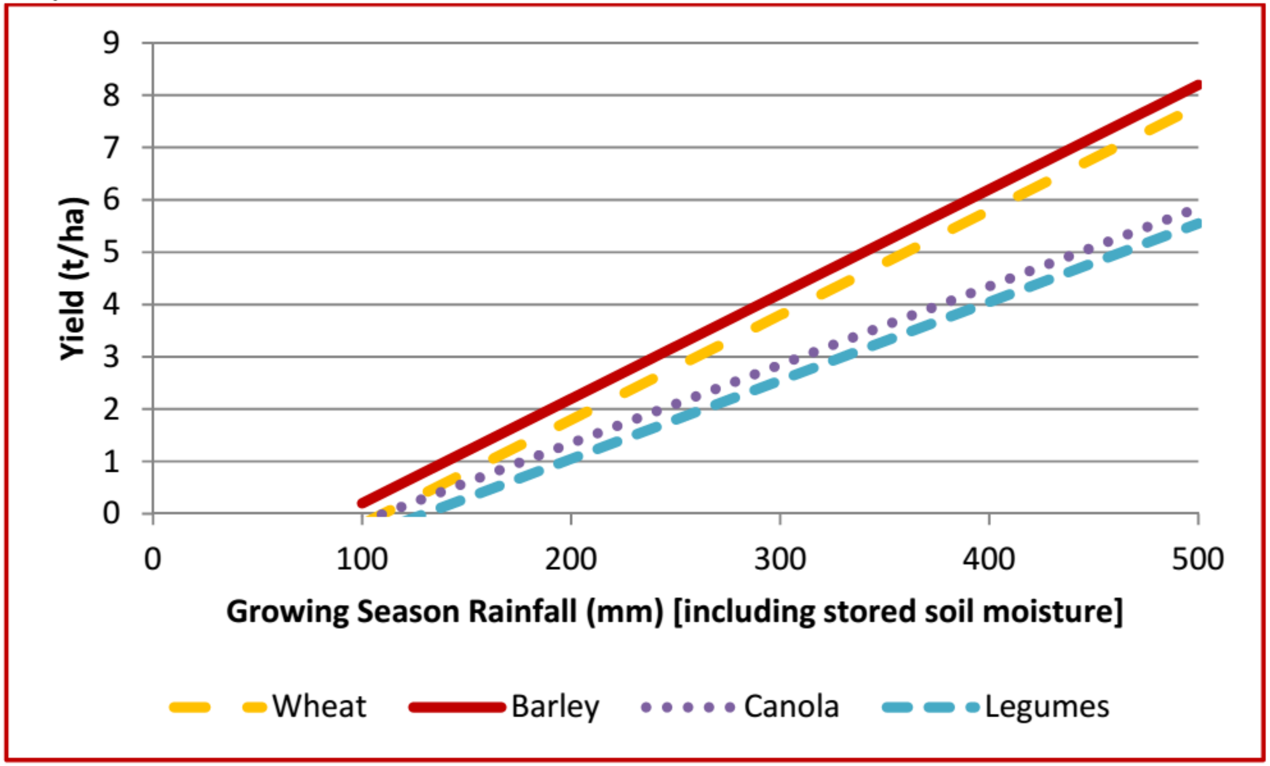
- French and Schultz equation

Yield Potential (kg/ha) =	Stored Soil Moisture (mm) + Growing Season Rainfall (mm) - Evaporation (mm)	x Water Use Efficiency (kg/mm)

- Wheat
  - Evaporation (110mm) & WUE (20kg grain/ha/mm or 55kg total DM/ha/mm)
  - Eg 300mm GSR = 3.8t grain/ha or 10.45t total DM/ha
- Pasture
  - Evaporation (30mm) & WUE (30kg total DM/ha/mm)
  - Eg 300mm GSR = 8.1t DM/ha

Potential yield

Crop Potential Grain Yield



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Nitrogen demand

Crop Nitrogen Requirement for 1 t of grain

Crop	kg N/ha
Wheat	40
Barley	40
Oilseeds	80

- Wheat demand
  3.8 t grain/ha x 40 kg N/t
  = 152 kg N/ha

- Pasture demand
  3-4% Nitrogen/t DM = 30 – 40kg N/t
  @ 8.1 t DM/ha
  = 283 kg N/ha

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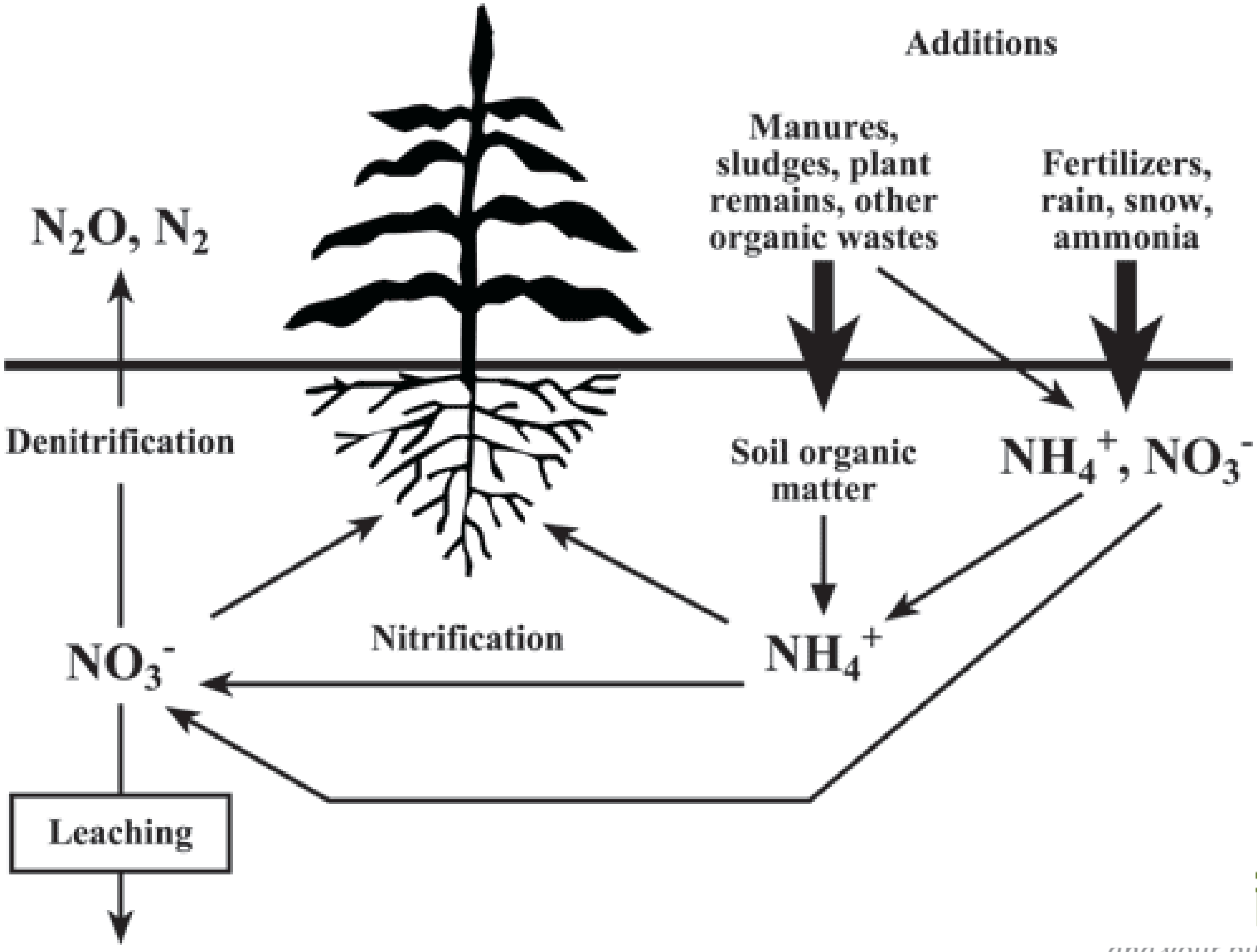
Nitrogen supply



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Plant available nitrogen

Crop Total Available Nitrogen (kg/ha) = Soil Test N (kg/ha) + Mineralised N (kg/ha)

Soil Test N (kg/ha) = [nitrate (ppm) + ammonium (ppm)] x bulk density x depth (cm) ÷ 10

Example Soil Test N

Depth interval (cm)	Soil texture	Layer thickness (cm) [A]	Bulk density (g/cm^3) [B]	Total soil nitrate (ppm) [C]	Ammonium (ppm) [D]	Available Soil N (kg/ha) [E = (C+D) x B x A ÷ 10]
0-10	Clay Loam	10	1.35	3.3	1.7	6.75
10-40	Clay Loam	30	1.35	8.3	0.5	35.64
40-70	Clay Loam	30	1.35	3.3	0.5	15.39
70-100	Clay Loam	30	1.35	4.6	0.5	20.66
Total Soil Test Nitrogen (kg/ha)						78.44

Mineralised Nitrogen (kg N/ha) = GSR (mm) x Organic Carbon % x 0.15 (kg N/ha)

= 300 x 0.96 x 0.15

= 43.2 kg N/ha

Crop Total Available Nitrogen (kg/ha) = Soil Test N (kg/ha) + Mineralised N (kg/ha)

= 42.39 + 43.2

= 86 kg N/ha (in top 40cm)

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Nitrogen budgeting - Wheat

- Plant demand (kg N/ha) = Yield potential (t/ha) x Nitrogen requirement (kg N/t)

  = 3.8 (t/ha) x 40 (kg N/t)

  = 152 (kg N/ha)

- Fertiliser N (kg N/ha) = Plant demand (kg N/ha) – Plant available nitrogen (kg N/ha)

  = 152 (kg N/ha) – 86 (kg N/ha)

  = 66 (kg N/ha)

- Urea (kg/ha) = Fertiliser N (kg N/ha) / Nitrogen % of fertiliser

  = 66 (kg N/ha) / 0.46

  = 143 kg Urea/ha

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Nitrogen budgeting - Pasture

- Plant demand (kg N/ha) = Yield potential (t/ha) x Nitrogen requirement (kg N/t)

  = 8.1 (t/ha) x 35 (kg N/t)

  = 283 (kg N/ha)

- Fertiliser N (kg N/ha) = Plant demand (kg N/ha) – Plant available nitrogen (kg N/ha)

  = 283 (kg N/ha) – 86 (kg N/ha)

  = 197 (kg N/ha)

- Urea (kg/ha) = Fertiliser N (kg N/ha) / Nitrogen % of fertiliser

  = 197 (kg N/ha) / 0.46

  = 428 kg Urea/ha

But what is different in pastures?

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Role of clovers

- In a typical ryegrass/clover pasture, 50 to 250 kg N/ha/year can be fixed by the clover, depending on such factors as the clover content of the pasture, soil fertility, and moisture availability.
- This is equivalent to applying urea (which is 46% nitrogen) at a rate of 109 to 543 kg of urea/ha/year.
- At a price of $500/tonne spread for urea, the contribution by clover is equivalent to about $55 to $270/ha/year worth of nitrogen fertiliser.
- Hence, clover is a valuable component in the pasture sward for its nitrogen-fixing ability, as well as for its nutritional value.

Soil organic carbon

- Total organic carbon is a measure of the carbon contained within soil organic matter.
- Continuous pasture builds organic carbon quicker than other rotations.
- Plant residue removal and constraints to crop growth reduce organic inputs.
- Erosion events remove topsoil which contains the bulk of a soil's organic matter. This can take years of good management to replace.
- Micro-organisms breakdown soil organic carbon as an energy source – this occurs faster when the soil is moist and warm.
- Cultivation can also enhance breakdown as soil aggregates are disrupted; making protected organic matter available to micro-organisms to decompose and because better soil aeration increases microbial activity.
- Gravel in soils will 'dilute' the total carbon in your paddock when total organic carbon is calculated on a per hectare basis.

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Nitrogen losses

- Nitrogen fertiliser can be lost from the system in four main ways: by leaching, denitrification, volatilisation and plant removal.
  - Leaching occurs when water draining through the soil profile carries dissolved N downwards, but N not leached beyond the root zone is still recoverable by the roots later in the season.
  - Denitrification occurs in wet soils when the oxygen concentration falls and microbes use nitrate instead of oxygen to support their growth. In denitrification, nitrate is converted to oxides of N and are lost to the air.

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Nitrogen losses

- Volatilisation is the loss of N from the soil as ammonium gas. Volatilisation losses are affected by:
  - Weather conditions: warm soils and windy conditions are conducive to high losses from volatilisation
  - Soil pH: volatilisation losses are higher in alkaline soils
  - Form of N: ammonium-based fertilisers are more susceptible than nitrate-based fertilisers. Losses from urea can be high, while losses from UAN and ammonium sulphate are considerably lower.
  - Recent work from Victoria suggest losses of N from volatilisation of up to 1% per day with urea and about half that for UAN and ammonium sulphate.
  - The degree of incorporation: N left on the surface is more susceptible than N incorporated, banded or washed into the topsoil.
  - Soil moisture: Losses tend to be greater when fertiliser is applied to dry soil.

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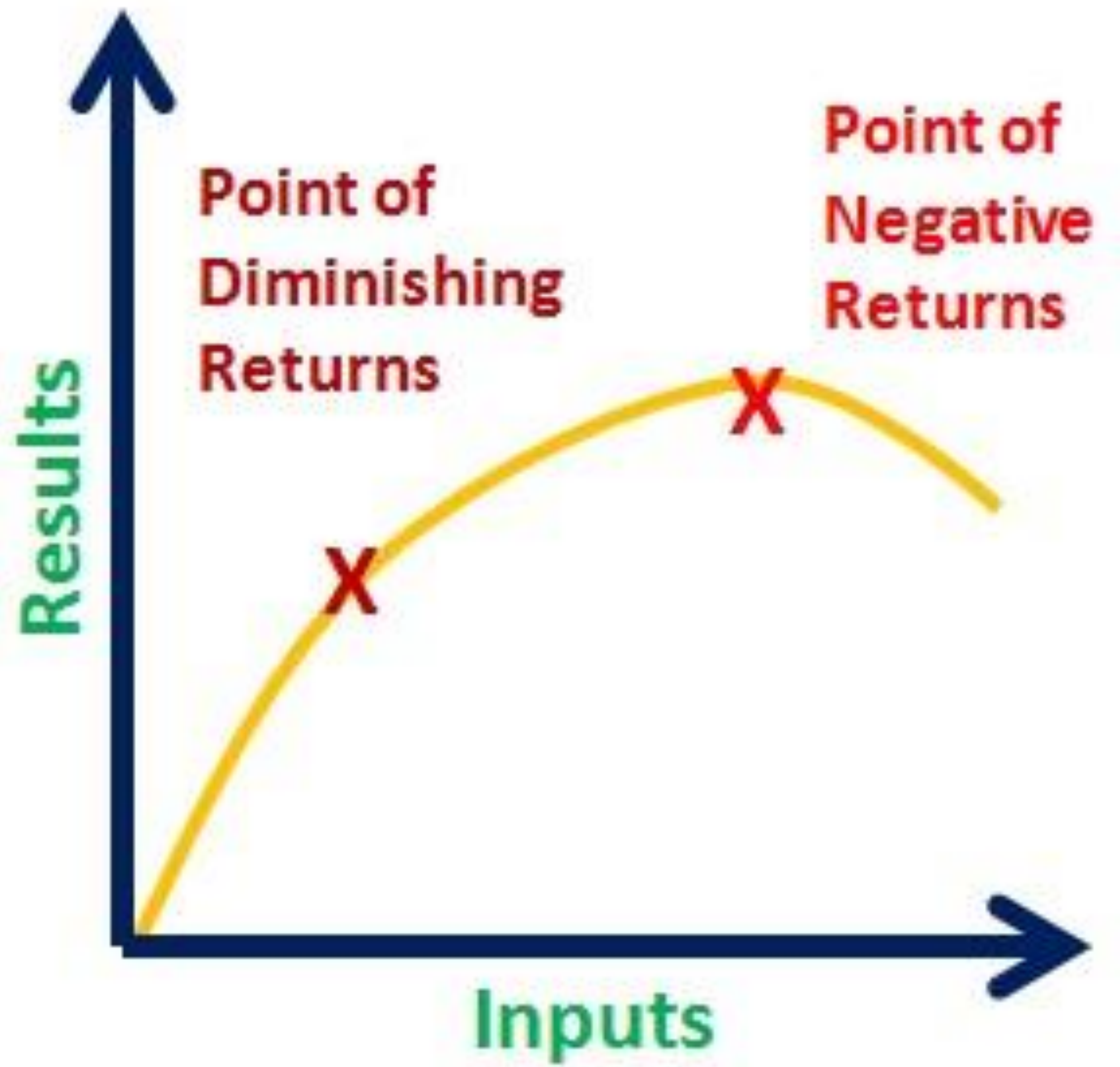
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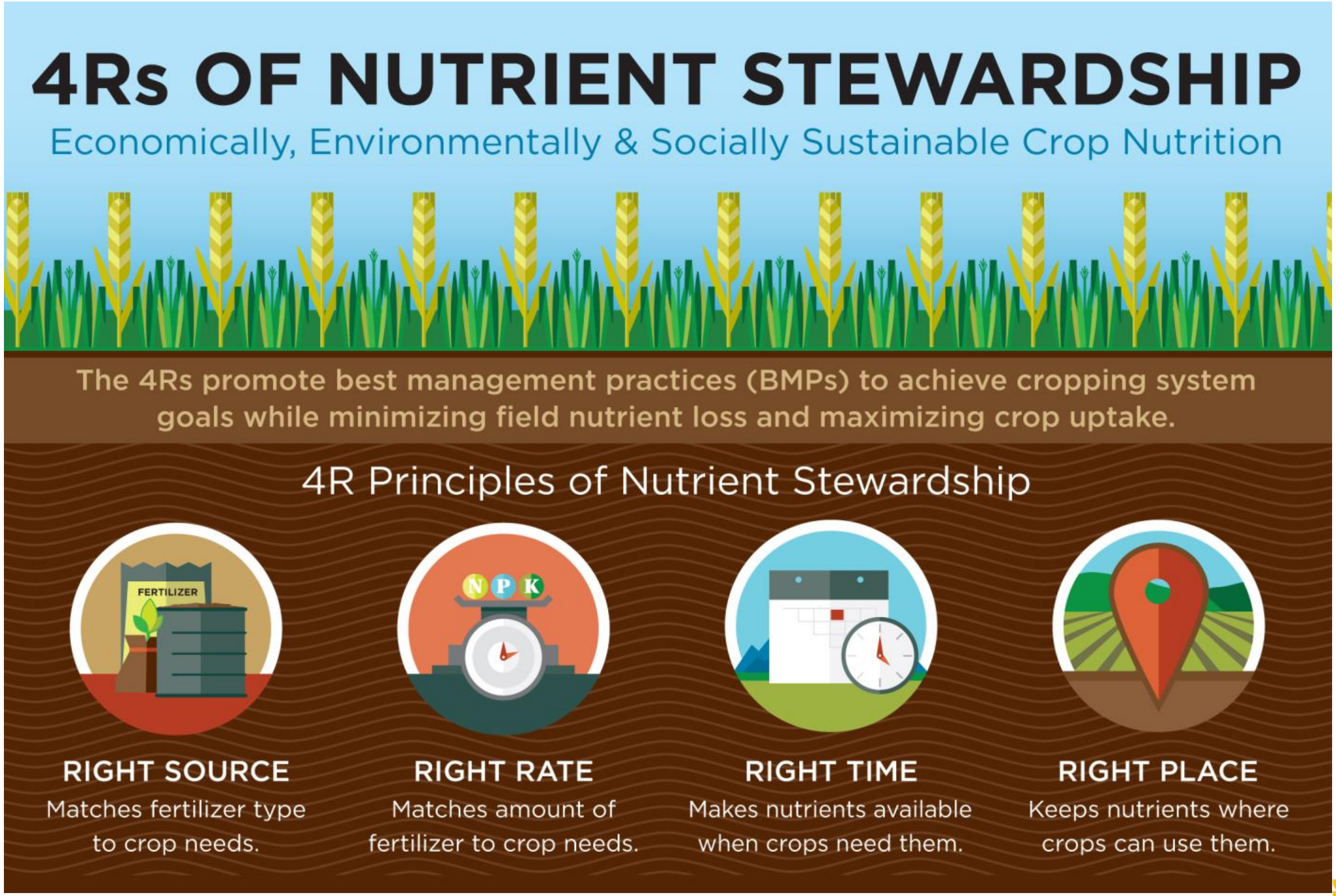
Nitrogen management



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General recommendations

- Target a yield potential at the start of the season, whether it is based on average yield or calculated using average growing season rainfall
- Estimate the amount of N available from the soil, based on soil testing or on guidelines established from a number of years of paddock histories and local experience.
- Calculate the amount of N required to reach your target
- Apply 70-80% of the N required between mid tillering and mid stem elongation. Adjust the timing of the application depending on initial soil N and factors such as time of sowing and climate events
- The remaining N can be applied later, up to flag leaf emergence, to maintain or boost grain protein depending on seasonal conditions and soil moisture availability. The rates of N can be adjusted in response to seasonal conditions.
- Monitor yield potential throughout the season and adjust your strategy accordingly to minimise losses and maximise profit
- Consider the value of legumes in pastures or as break crops to reduce reliance on fertilisers and minimise losses

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Thankyou

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	Depth	0-10	10-20	20-30	30-50	50-70
Phosphorus Colwell	mg/Kg	11	4	3	2	12
Potassium Colwell	mg/Kg	187	141	146	172	222
Sulphur	mg/Kg	1.4	0.9	0.7	1.0	3.4
Organic Carbon	%	1.03	0.19	0.11	0.11	1.04
Conductivity	dS/m	0.020	< 0.010	< 0.010	< 0.010	0.026
pH Level (CaCl2)	pH	4.4	4.5	5.2	5.8	5.5
pH Level (H2O)	pH	5.3	5.6	5.9	6.5	6.3
Exc. Aluminium	meq/100g	0.549	0.395	0.104	0.124	0.156
Exc. Calcium	meq/100g	1.72	0.97	1.82	3.65	4.80
Exc. Magnesium	meq/100g	0.20	0.10	0.28	0.83	1.69
Exc. Potassium	meq/100g	0.48	0.36	0.37	0.44	0.57
Exc. Sodium	meq/100g	0.01	< 0.01	0.01	0.03	0.10
Phosphorus Olsen	mg/Kg	5.0	1.7	1.1	1.4	5.2
PBI		40.7	34.5	32.5	50.5	103.6

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