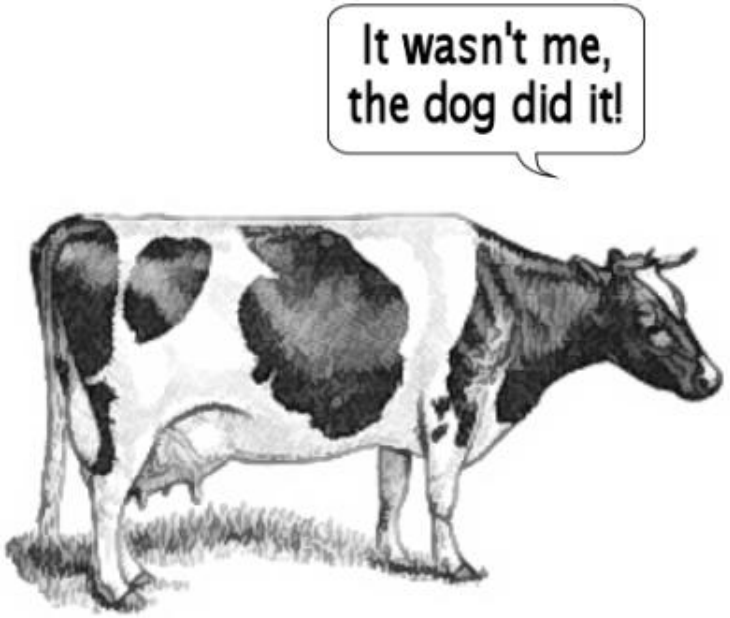
Nitrogen on dairy farms



- Nitrogen cycle & movements through soil
- Overseer model and a Nutrient Budget
- On farm mitigation options

Nitrogen (N)

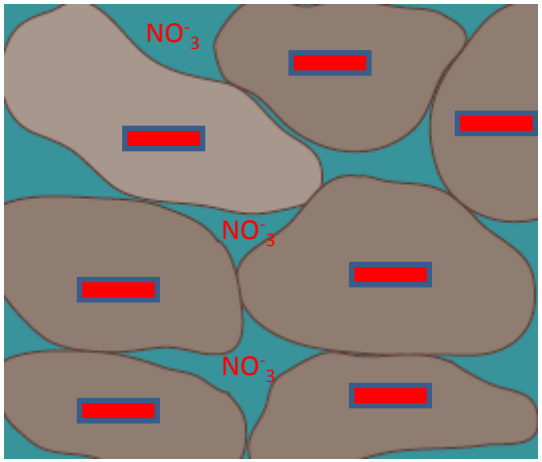
N is a chemical element which is present in all living cells and has a major effect on plant quality and growth potential.

However, when N is converted to nitrate in the soil it becomes mobile (active)

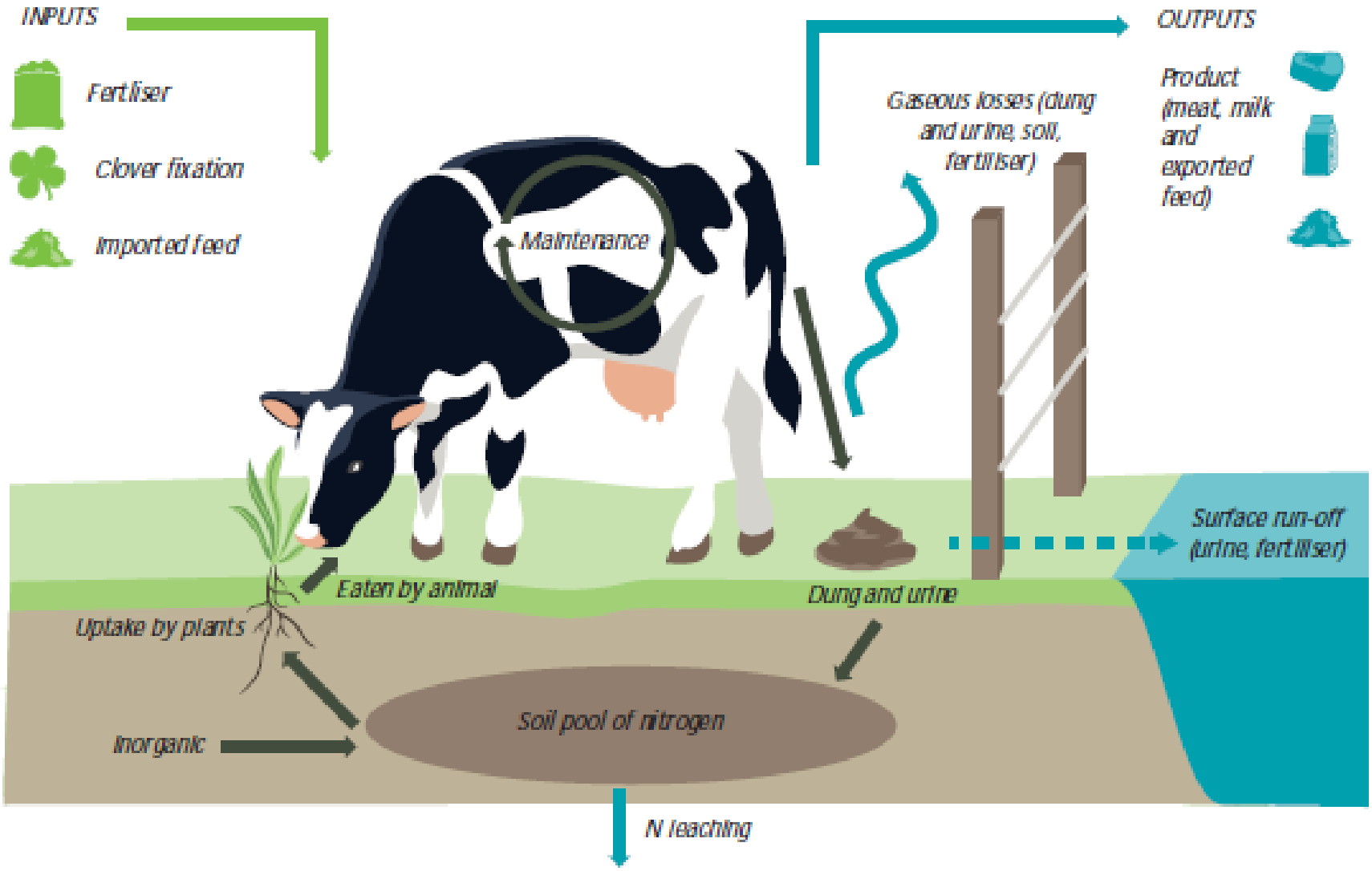
Nitrate:

NO^-_3

Soil

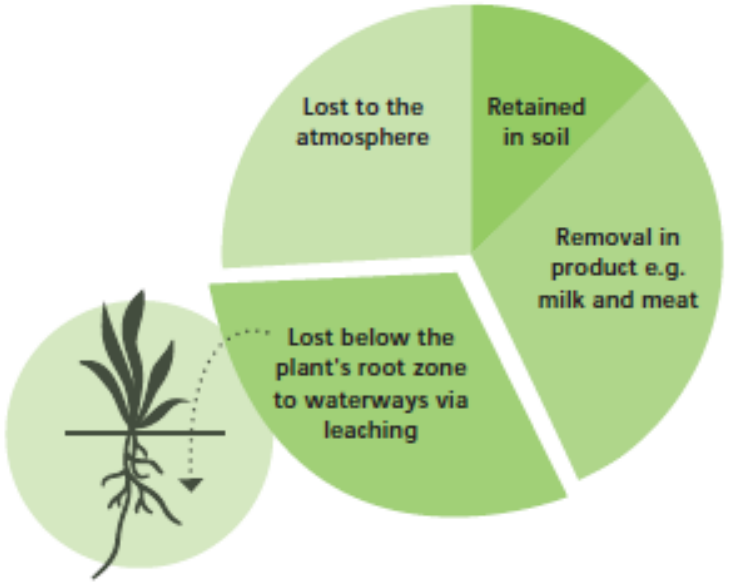


How does N enter and move through a dairy farm



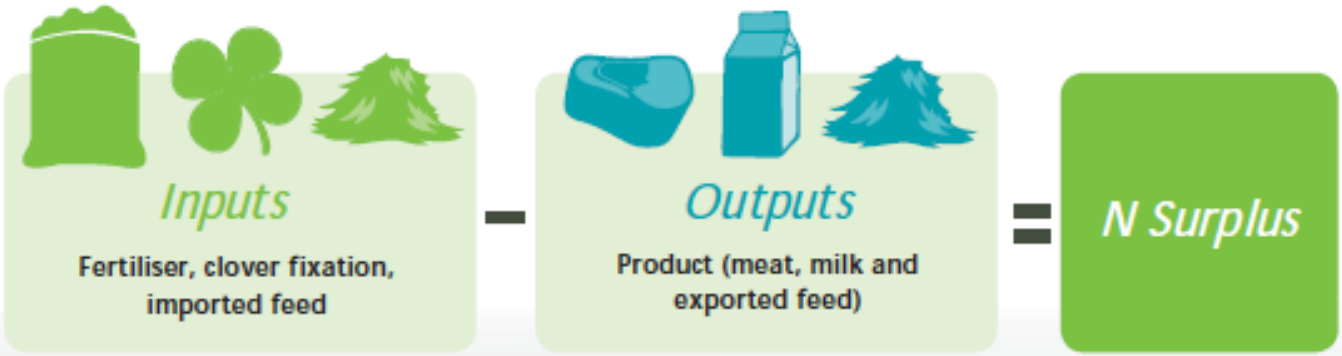
Where does Nitrogen end up after entering a farm system

The exact breakdown of where N goes after it enters a farm system will vary between farms and paddocks. A large proportion is lost beyond the root zone to water via a process called 'leaching'. Urine patches are a significant source of N leaching.

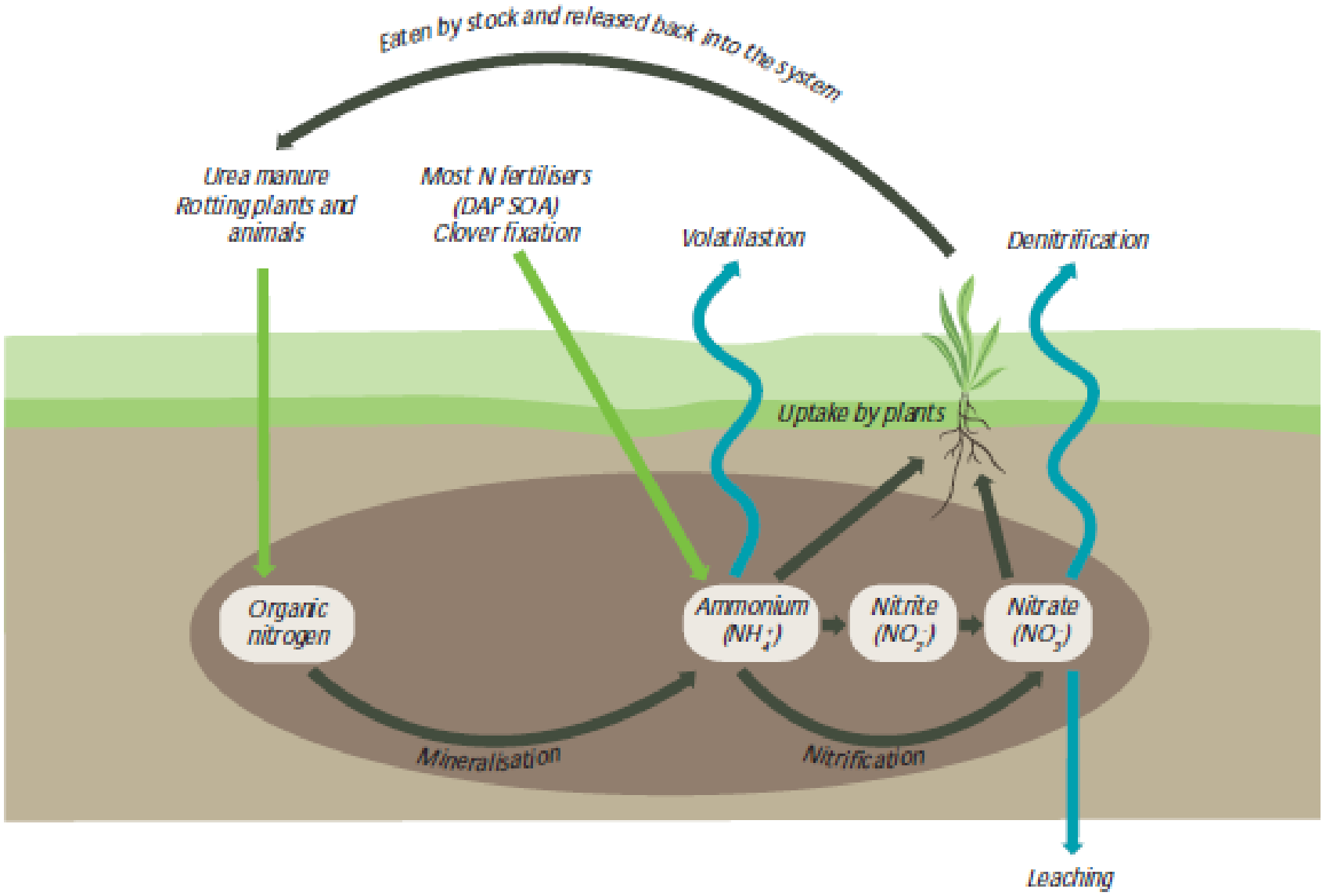


N surplus

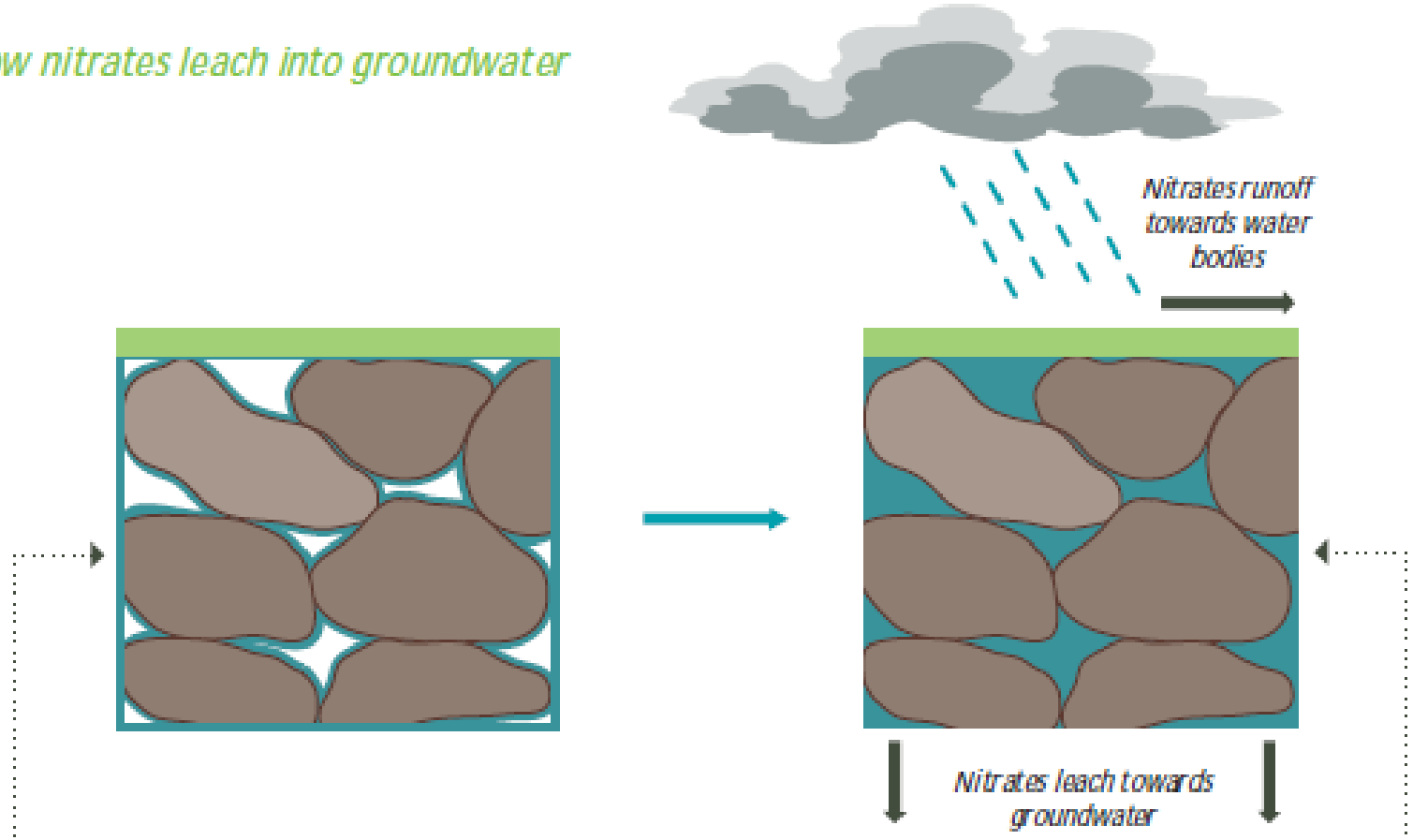
N surplus is what remains after the conversion of N inputs to saleable product e.g. milk, meat or feed.



How is N converted to nitrate



How nitrates leach into groundwater



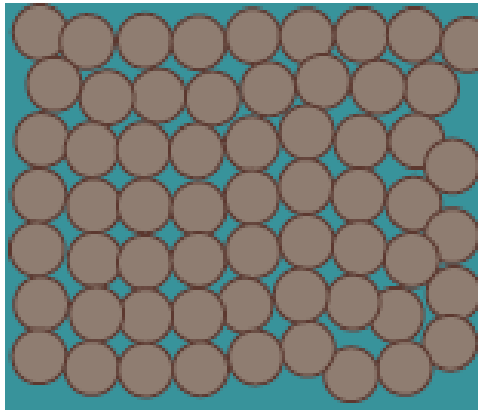
- Soil is not at water holding capacity. There is a mix of water and air in the soil pores.
- Nitrates are dissolved in soil water but not moving.
- Nitrates are available for plant uptake.

- Water (rain, irrigation) increase soil water above the soil water holding capacity. This means the soil cannot hold any more water.
- Gravity causes the soil water (and the dissolved nitrates it contains) to leach towards groundwater.

The influence of soil type on N loss

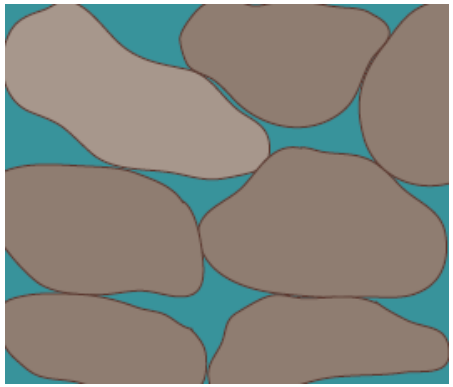
Soils vary greatly in the amount of water they can store in the gaps between individual soil grains (water holding capacity)

Clay soil



- Very small pores
- Hold onto water tightly
- Can not hold a lot of water
- Poorly drained soil
- Lower risk of leaching
- Higher risk of runoff

Sandy soil



- Have bigger pores
- Hold onto water less tightly
- Can hold more water
- It is easier for water to infiltrate
- Higher risk of leaching
- Lower risk of runoff

How do we measure individual farm N loss
The Overseer Nutrient Budget Model

- Overseer is a computer model tool
- It estimates nutrient flows through the animal, pasture, crop and soil.
- Nutrient budgets for eight nutrients including N are calculated.
- It was first developed in the 1990s and has undergone repeated revisions to improve the model
- It is developed in NZ and calibrated against NZ research farms
- It predicts long term annual average nutrient losses on major soil types

Limitations:

- Data entered into Overseer must be as accurate as possible
- Its a long term annual average model
- It assume that the farm system is in balance
- It assume on farm best practise such as for effluent and fertiliser applications and irrigation water use

Example of an Overseer Nutrient Budget

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phos

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | F

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	220	0	15	22	0	0	0
Rain/clover N fixation	93	0	5	9	9	20	121
Irrigation	1	0	1	1	4	1	5
Supplements	14	3	14	2	3	2	1
Nutrients removed							
As products	83	14	19	5	20	2	5
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	84	0	0	0	0	0	0
To water	100	0.8	13	23	107	27	80
Change in farm pools							
Plant Material	0	0	-2	1	2	0	0
Organic pool	60	10	2	6	0	0	0
Inorganic mineral	0	14	-26	0	-2	-3	-3
Inorganic soil pool	1	-36	28	0	-112	-3	44

Nitrogen report

Nutrient Budget | Nitrogen | Phosphorus | Comments | Summary | Nitrogen overview | Phosphorus overview

Energy | Footprint units | Footprint product | Effluent | Pasture production | Other values | Full parameter report

Block name	Total N lost kg N/yr	N lost to water kg N/ha/yr	N in drainage * ppm	N surplus kg N/ha/yr	Added N ** kg N/ha/yr
Effluent Areas	2132	71	4.8	176	165
Main pasture	13917	109	7.0	332	296
Fodder crop - Kale	1766	252	**15.3**	388	131
Lucerne	264	29	2.0	65	46
Other sources	406				
Whole farm	18485	100			
Less N removed in wetland	0				
Farm output	18485	100			

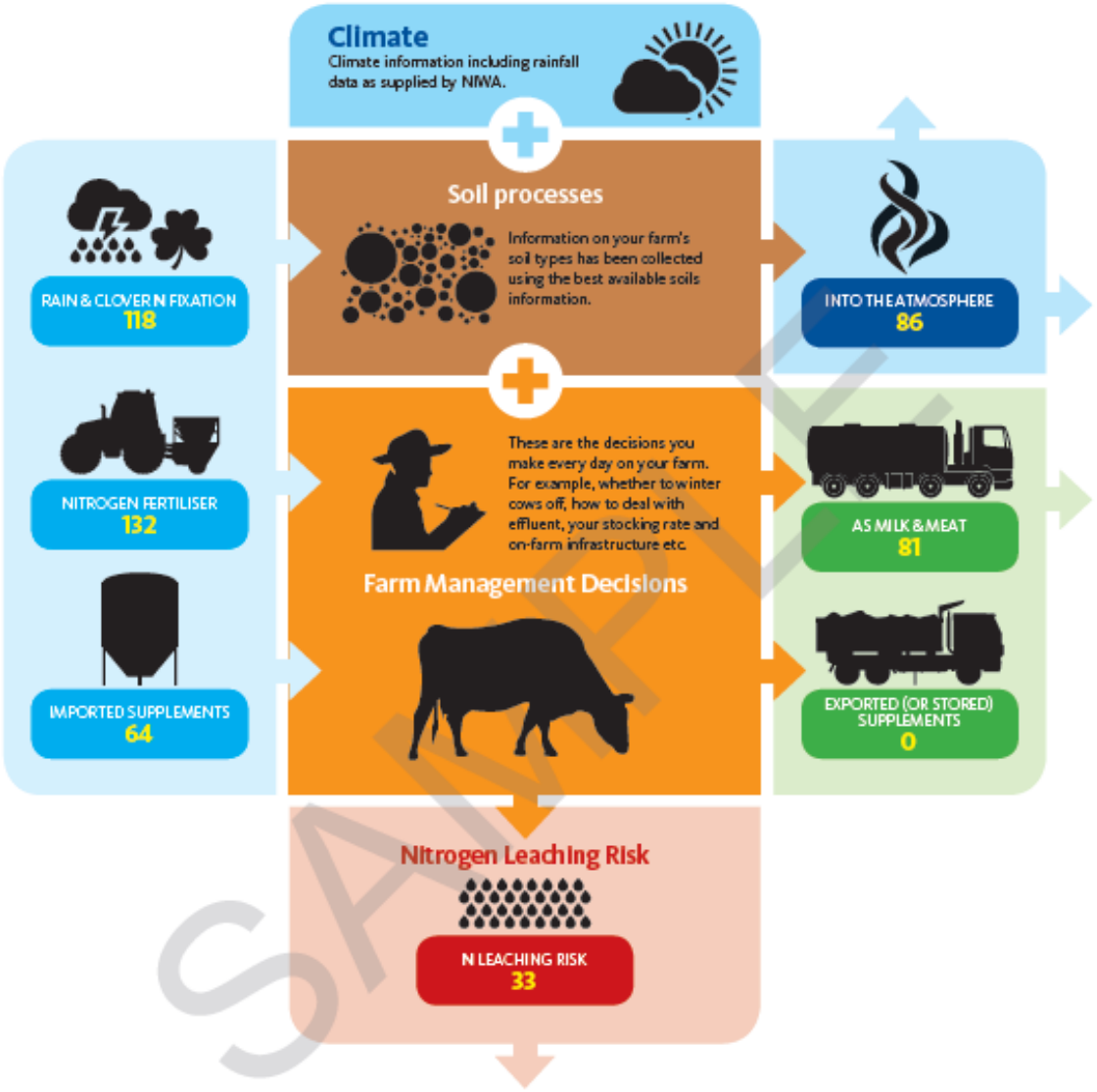
* N concentration due to leaching in drainage water at the bottom of the root zone. Maximum recommended level for drinking water is 11.3 ppm (note that this is n quality standard).

** Fertiliser, organic and effluent inputs.

N/A: N in drainage not calculate for easy and steep pastoral blocks, or for tree and shrubs, riparian, wetland or house blocks.

Download this report

What do the numbers mean



Mitigating N loss

Animals

On a dairy farm, the cow's urine is the greatest source of nitrogen

- Urine from a cow applies 600-1000 kgN/ha in the urine patch (much more than fertiliser)
- A typical dairy cow urination deposits 2 litres of urine on just 0.2 m^2 of land (this increase the chance of leaching)
- Lighter breeds of cow deposit less urine nitrogen (only if SR is not increased to compensate for loss of production)
- Higher stocking rates are associated with more nitrate leaching
- Higher protein feeds are associated with higher levels of nitrogen in urine

Effluent

The way effluent is used impacts its contribution to N leaching

- Effluent applies nitrogen to the land along with water (how much N depends a lot on season and feed type
- Applying effluent too heavily can increase N leaching by increasing the depth of the effluent in the soil
- Applying effluent to wet pastures can increase N leaching

Fertiliser

Nitrogen fertiliser only has a small direct impact on N leaching

- Following good agricultural practise for n fertiliser reduces the chance of losing N through leaching or direct entry into water
- Small, regular applications of N fertiliser mean the nitrogen is much more likely to be used by plants than lost by leaching
- Applying N fertiliser when soils are overly wet or plants are not growing will increase the chance of N leaching
- Nitrogen fertiliser indirectly affects N leaching as it allows for an increase in stocking rate

Feed

Feed is an easily overlooked source of N that can contribute to N leaching

- Fodder crops and imported supplement both affect the amount of N leaching that will occur on farm
- The higher the protein content of consumed feed the higher the N content of the urine
- Winter grazed crops increase leaching more than other crops
- Strip grazing fodder crops means urine is concentrated in a small area, so N leaching risks increase

Drainage

N is leached from soil when water moves below plant roots (drainage event)

- *Soil type dictates how much water can be held before drainage starts*
- *Stony soils, sands, gravels and pumice soils drain easily so are more prone to N leaching*
- *Areas that get more rainfall also experience more drainage regardless of the soil type*
- *When drainage occurs, N can enter rivers, streams and lakes*

Mitigation options - controls and impacts