LOWE Environmental Impact

Biosolids

Nutrient Use and Accumulation *in* Soil from Biosolids Application to Land

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Outline

Biosolids Nitrogen

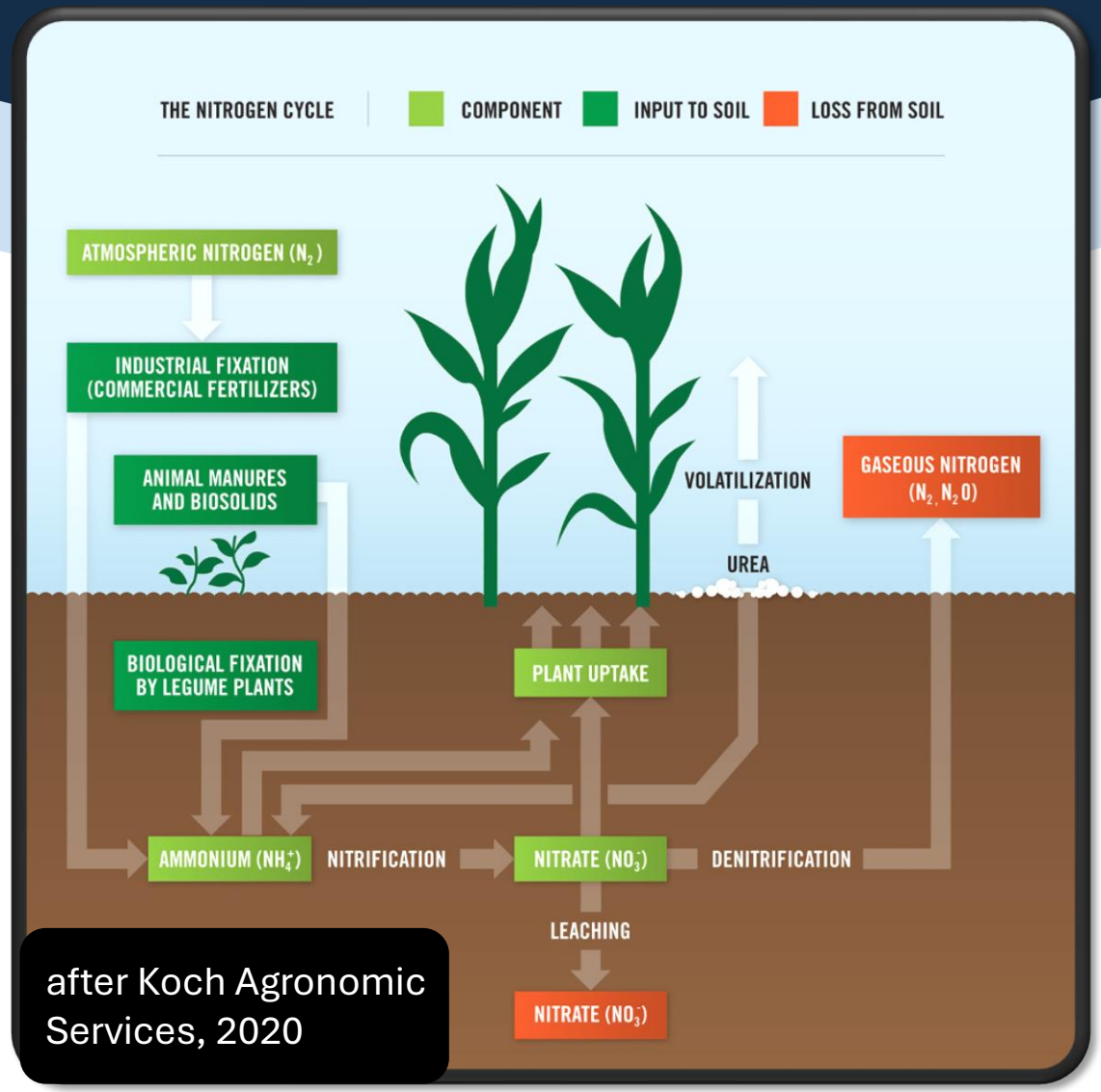
- Nitrogen in the environment
- Nitrogen in biosolids and mineralisation
- Guidelines repeat biosolids application
- Cumulative N loading and potential risks

Biosolids Phosphorus

- Phosphorus in the environment
- Phosphorus accumulation from biosolids

Conclusions

N Cycle / N Mineralisation



after Koch Agronomic Services, 2020

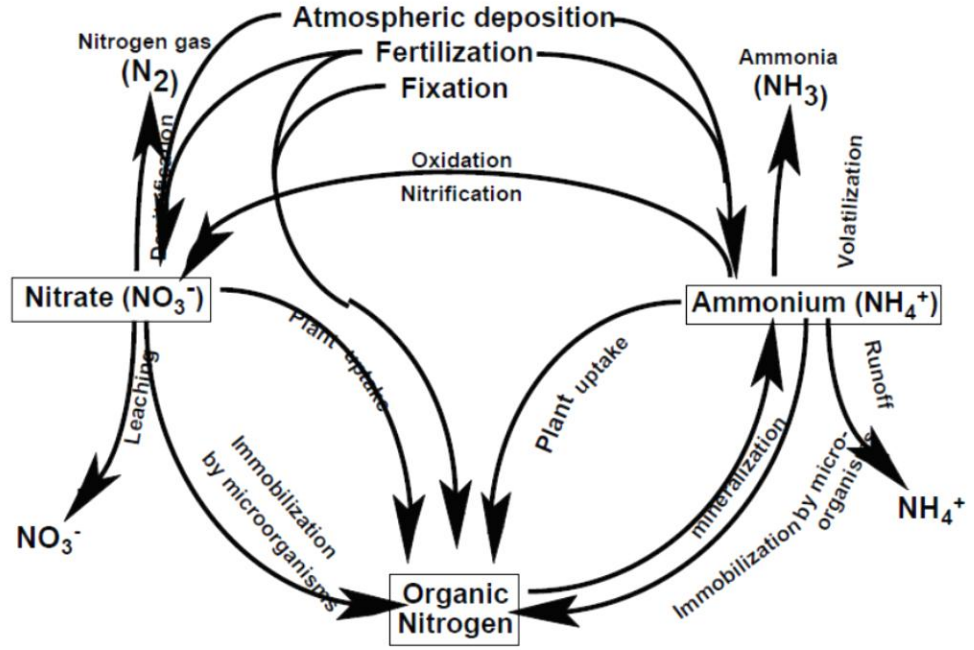


Figure 2.2. The nitrogen cycle: inputs to soil, nitrogen transformations, and losses from soil.

after Henry *et al.*, 1999

Biosolids N and N Release

Factors that influence mineralisation of N from biosolids:

Biosolids

- Origin / treatment process
- Age

Environmental

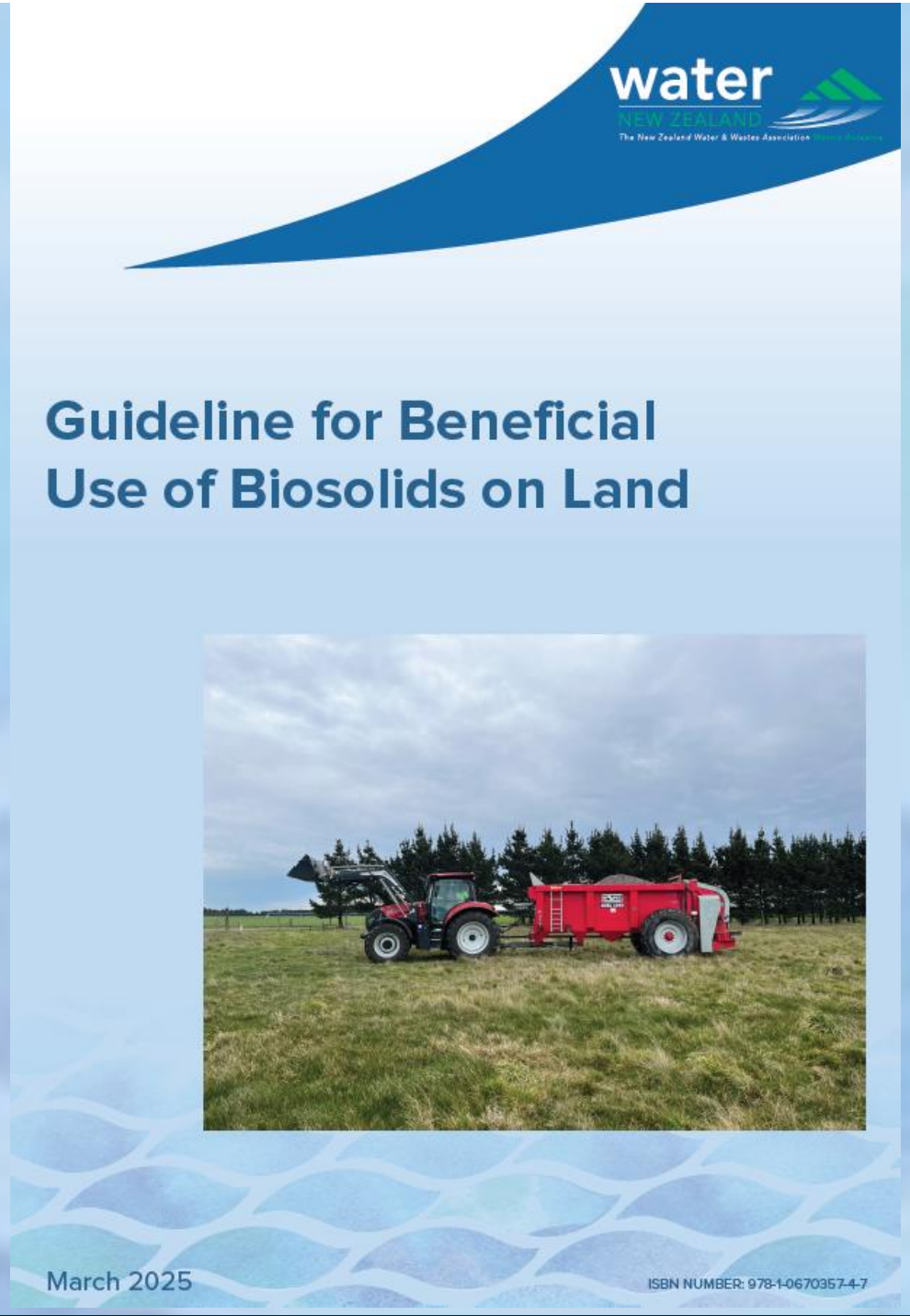
- Soil type/texture
- Soil pH
- Microbial health
- C:N
- Temperature
- Soil moisture

Guideline Rules Around Application

- Guideline recommends 200 kg N/ha/y
- Can be applied as 400 kg N/ha every two years
- [150 PAN for one-off and soil rehabilitation]

But:

- Concern over cumulative N release for repeat applications
  - Leaching potential
- Aim to evaluate risk from the Guideline loading



Rate of N release from Biosolids

Biosolids Treatment Method	Mineralization Rate (% of initial organic N)
Anaerobically digested - Liquid	20 – 40
Anaerobically digested - Dewatered	25 – 45
Anaerobically digested - Heat-dried	24 – 45
Aerobically digested	30 – 50
Lagooned	10 – 30
Lime-stabilized	30 – 60
Composted	0 – 30
Drying bed	15 – 40
Oxidation ditch	30 – 50

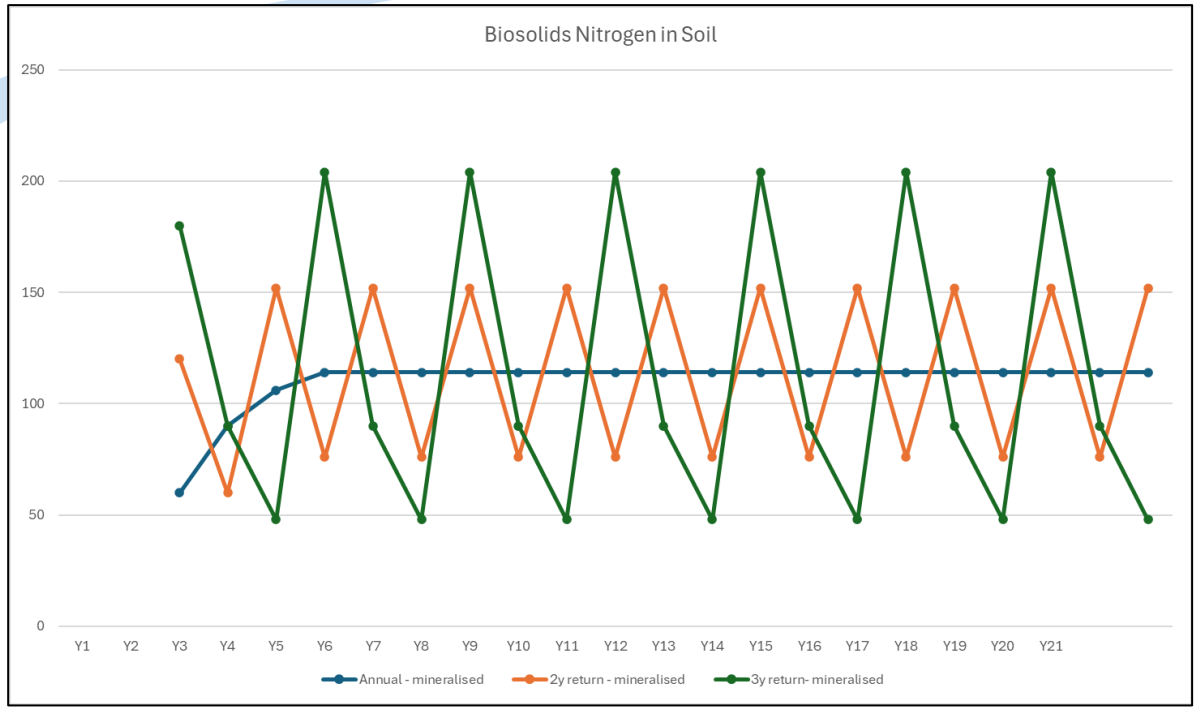
Table 1. Estimated N mineralization rates range for biosolids treatment methods in the first year of application (percentage of initial organic N).
Source: Henry et al., 1999.

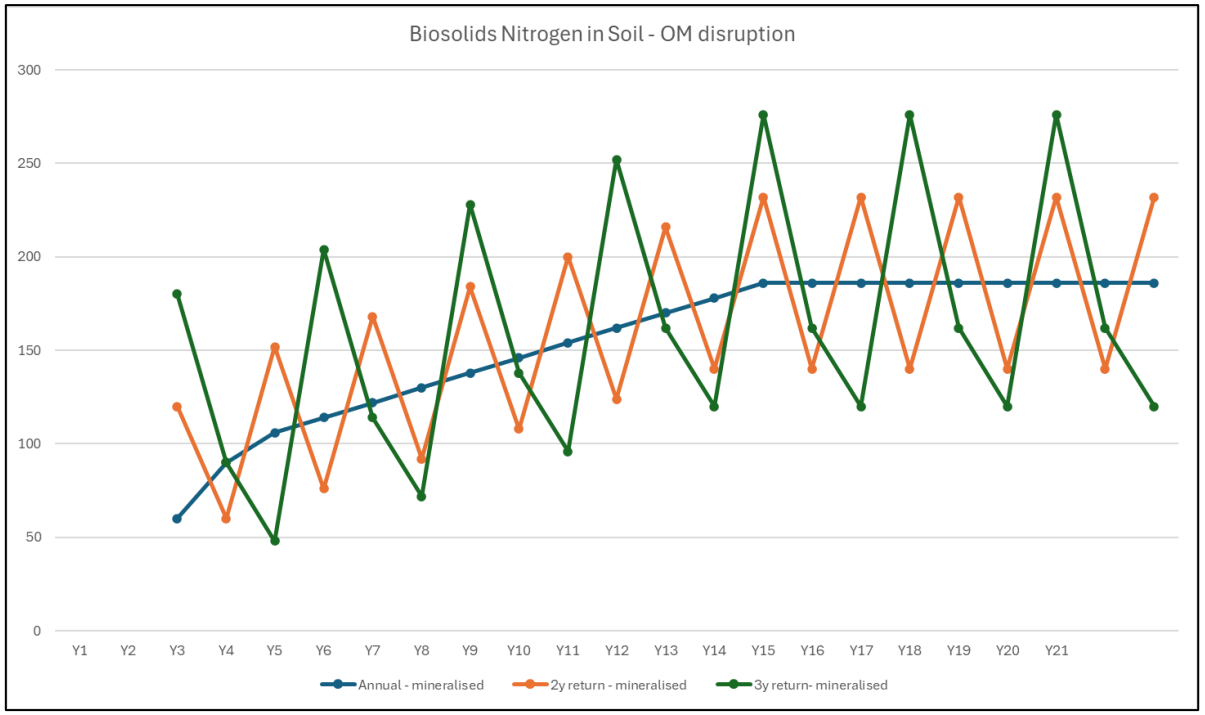
Time after biosolid application (Year)	Unstabilized and Waste Activated Sludges	Lime Stabilized or Aerobically Digested Biosolids	Anaerobically Digested Biosolids	Composted biosolids
0 – 1	40%	30%	20%	10%
1 – 2	20%	15%	10%	5%
2 – 3	10%	8%	5%	
3 – 4	5%	4%		

Table 2. Estimated N mineralization rates from field applied biosolid by year.
Source: USEPA, 1995.

Soil N dynamics Under Repeat Biosolids application

For Aerobically Stabilised Biosolids



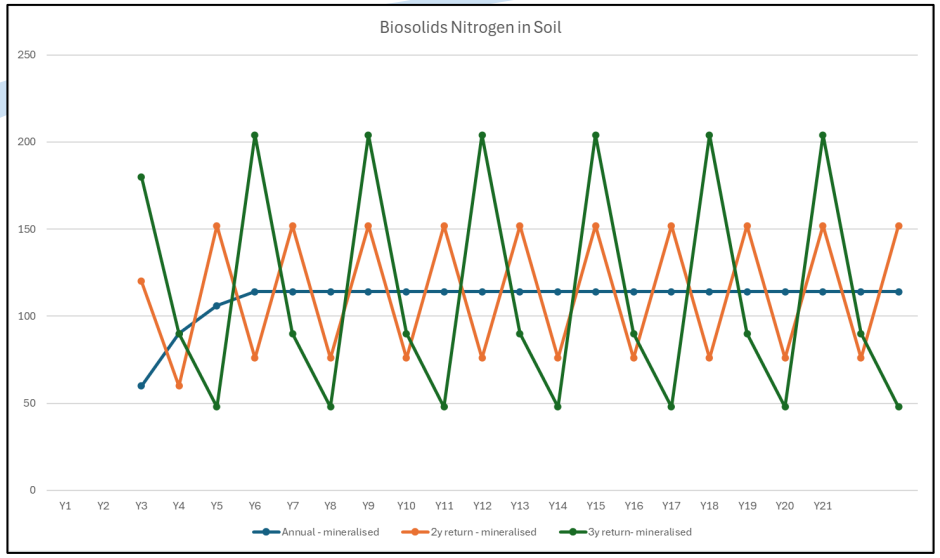


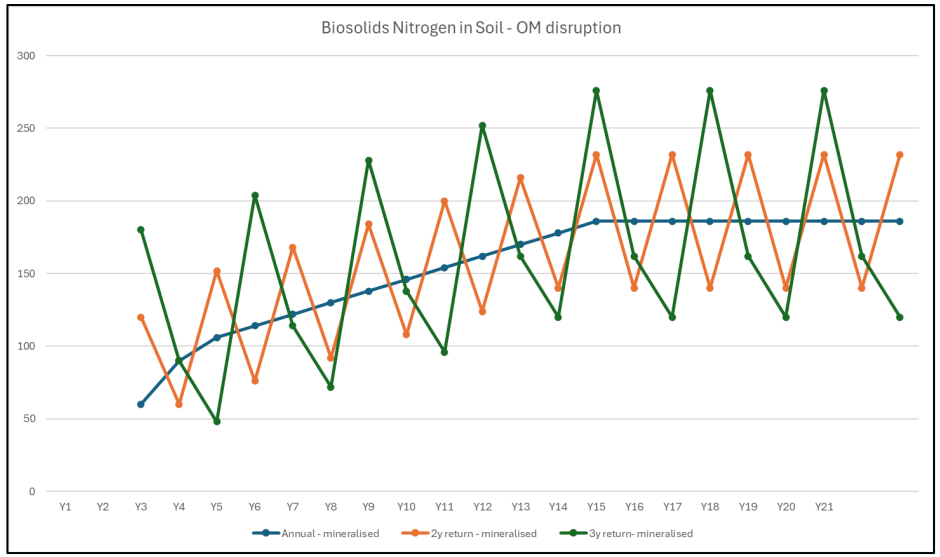
Steady state is reached where the OM pool is stable

Cumulative mineralised N higher with disturbance e.g. cultivation

Soil N dynamics Under Repeat Biosolids application

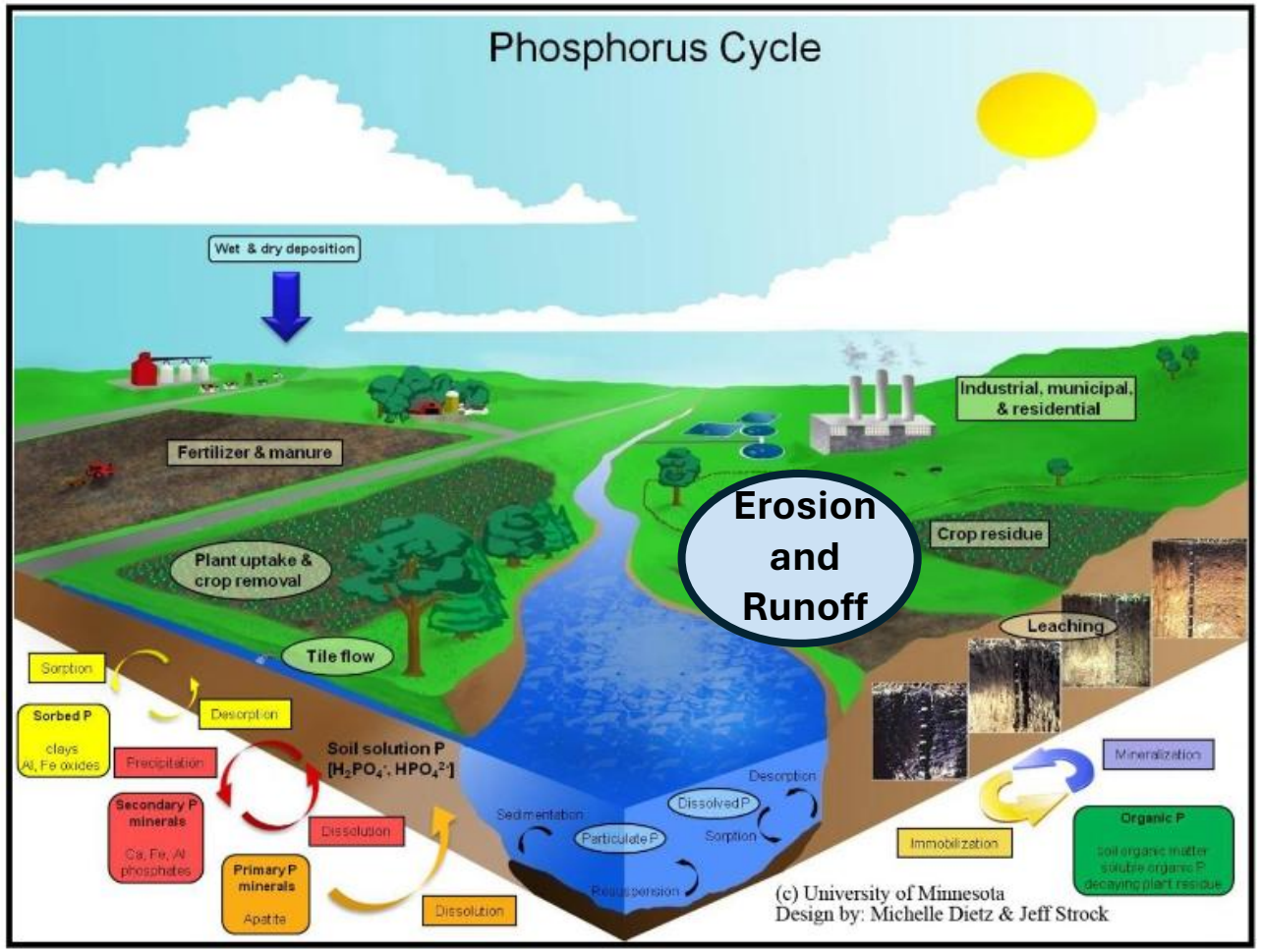
For Aerobically Stabilised Biosolids

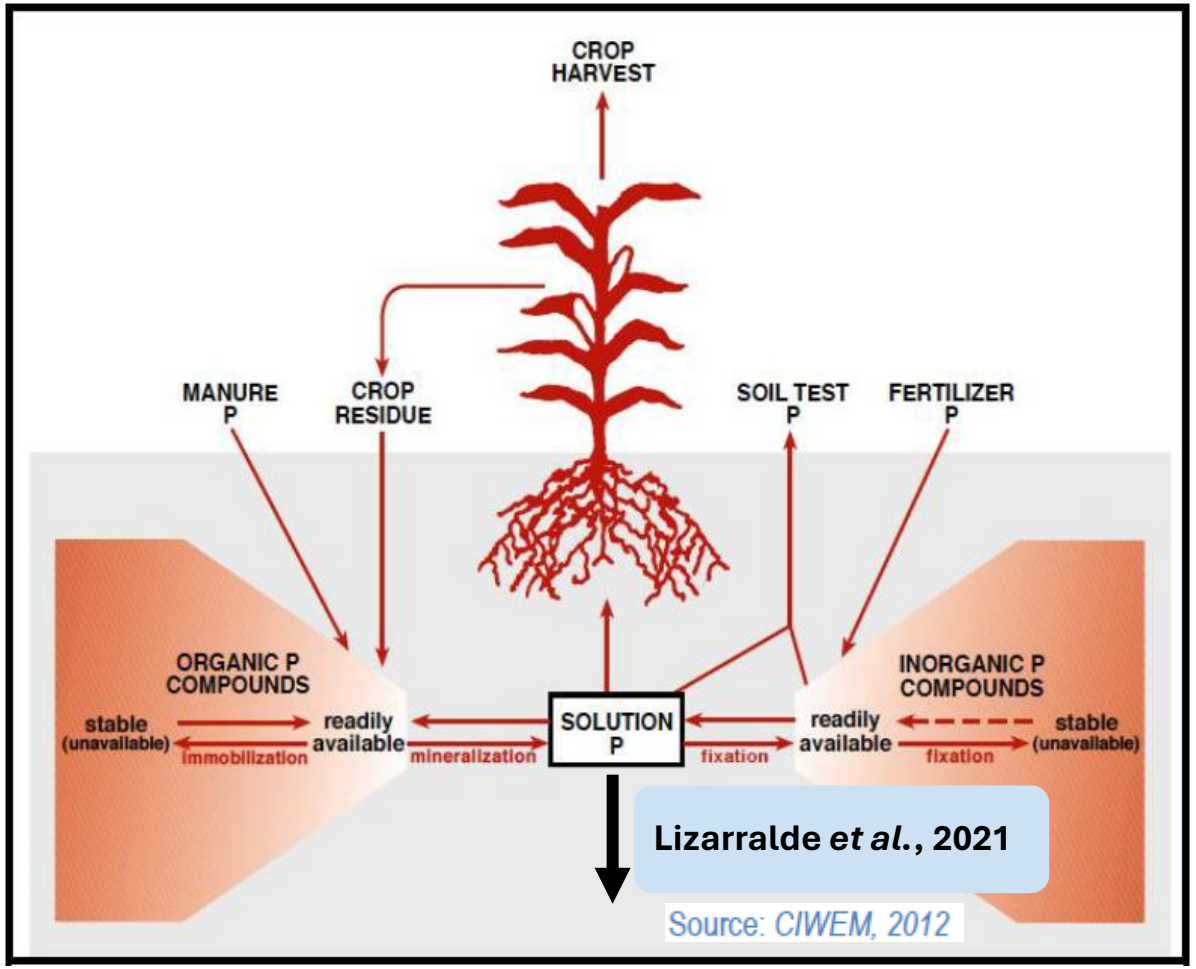




- Annual and 2-yearly application now recommended
- Around 114 kg N/ha/y (yearly) to 152 kg N/ha/y (2-yearly) released under optimum soil conditions, minimal disturbance
- Around 186 kg N/ha/y (yearly) to 232 kg N/ha/y (2-yearly) released after Y15 under optimum soil conditions, soil disturbance
- Loading expected to result in mineralised N less than or similar to fertiliser for crops under these management types. Advice adjusted to 10 y of repeat application for high input crops

Phosphorus in the Environment





Biosolids P and Cumulative Application

- No guideline limit for P

  (controlled by N in same way as contaminants)
- NZ biosolids data – average 1.47% P (range 0.02-3.46% P)
- At 200 kg N/ha, P application is ~77 kg P/ha
- Biosolids contain a much higher P:N ratio than what plants require
- Leads to accumulation in soil

Risks from Cumulative P Application

Risk — Risk associated with P is (mostly) due to transfer to water (dissolved, adsorbed, precipitated)

Effect — Effect on risk from accumulation is not well understood

Difficult — Difficult to determine evidence based loading limits

Conclusions

About N

- Understanding of biosolids N release advanced since 2003 Guideline
- Effects of cumulative N release more under > yearly application
- Soil OM disturbance
- Guideline recommendations adjusted to address

About P

- P is applied at rates higher than plants require
- Accumulation in soil is a concern
- Research is needed to better understand P loss risk (of soil quality indicators)

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Extra Info

- About N
- About P

Concluding remarks

- We aren't much further advanced in our ability to develop thresholds/quantitative interpretations than early 2000s!
  - But we do have some better understanding of some processes – consequence often 'depends' on factors other than measured soil properties
  - **Targeted** research is required to better quantitatively link indicators to function and environmental responses