Sustaining the productive capacity of our soils.

Source: Soils in the New Zealand Landscape - the Living Mantle, 2nd Edition", by Les Molloy
Solid phase

Non-labile
Absorbed by hydrous Fe and Al oxides
Apatite prim. min.

Labile $\text{H}_2\text{PO}_4^-$
Exchangeable ions

Inorganic

Non-labile

Labile $\text{H}_2\text{PO}_4^-$

Processes

Adorption, exchange
Dissolution, precipitation

Solution phase

Soluble ions $\text{H}_2\text{PO}_4^-$

Gas phase

P mainly on airborne dust

Processes

Very little leaching, in drainage water

Living organisms
Earthworms, nematodes, bacteria, fungi etc.

$\text{C-O-P} (\text{H}_2\text{PO}_4^-)$

Mineralisation, immobilisation

Solution phase

Soluble ions $\text{H}_2\text{PO}_4^-$

Litter/roots

Living organisms

$\text{C-O-P} (\text{H}_2\text{PO}_4^-)$

Earthworms, nematodes, bacteria, fungi etc.

Mineralisation, immobilisation

Soil

Processes

Adsorption, exchange
Dissolution, precipitation

Solid phase

Labile $\text{H}_2\text{PO}_4^-$
Exchangeable ions

Structural root

Fibrous root

Soil

Processes

Very little leaching, in drainage water

P mainly on airborne dust

Essential Components of Soils and phosphorus nutrition
Phosphorus transformations – maintaining P supply, replacing losses Gala apple block

Kg Phosphorus/hectare

Processes
- Very little leaching, in drainage water

Solution phase
- Soluble ions $\text{H}_2\text{PO}_4^-$

Solid phase
- Labile $\text{H}_2\text{PO}_4^-$
- Non-labile Absorbed by hydrous Fe and Al oxides
- Apatite prim. min.

Solid phase
- Non-labile C-O-P

Gas phase
- Soluble ions $\text{H}_2\text{PO}_4^-$

Living organisms
- Earthworms, nematodes, bacteria, fungi etc.
- C-O-P ($\text{H}_2\text{PO}_4^-$)

Mineralisation
- Immobilisation

Uptake
- 23
- Product loss
- 6
- Gain in framework
- 4

Processes
- 27
- 3
- 8

Fertiliser
- 23

Runoff
- 0.5

P mainly on airborne dust
Potassium (K) uptake and removals from a Gala apple block

Kg Potassium/hectare

Potassium sulphate 229

K in rainfall increases near coast 3

Product loss 83

Gain in framework 13

Uptake 178

Leaves/prunings 82

Living organisms

Earthworms, nematodes, bacteria, fungi etc.

K+ ion

Processes

Leaching, drainage

Dissolution, precipitation

Absorption, exchange

Feldspars, mica, illite

Non-labile

Exchangeable K+ ions

Labile

Inorganic

15

58

11
Field crops – take up and export large amounts of potassium and phosphate.

Nutrient uptake by Broccoli

Summary:
NZ primary industries depend upon significant inputs of:
Non-renewable Phosphate and Potassium
Where will our replacement P come from?

7 countries control 85% of Global phosphate rock resources

With whom should we trade?

Small Oceania fish in a large pond?
Where will our replacement K come from?

Minute Oceania fish in a large pond?

With whom should we trade?

6 countries control 85% of Global potassium chloride resources
Managing risks from contaminants - Cadmium derived from P fertiliser

NZ Cadmium Management Strategy

**Tiered Fertiliser Management System (TFMS)**
- 5 yearly screening of farmed soils
- Categorise soils into different Tiers
- Managed by Fertiliser companies

Example Cd conc. in soil samples, Waikato Region

<table>
<thead>
<tr>
<th>Tier</th>
<th>mg Cd/kg soil</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt; 0.6</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>0.6 &lt; 1</td>
<td>low Cd, P fertilisers, to maintain soil Cd below acceptable threshold for 100 y</td>
</tr>
<tr>
<td>3</td>
<td>1 &lt; 1.4</td>
<td>v. Low Cd P fertilisers, to maintain soil Cd below acceptable threshold for 100 y</td>
</tr>
<tr>
<td>4</td>
<td>1.4 &lt; 1.8</td>
<td>No application of Cd allowed Cd free fertiliser</td>
</tr>
</tbody>
</table>
Managing risks from contaminants - Cadmium derived from P fertiliser

Mean Cd concentration for different plant species. Values accompanied by the same letter are not significantly different (P >0.05) according to LSR analysis (After Gray et al., 1999).
### Plant availability of Cd

<table>
<thead>
<tr>
<th>Description</th>
<th>Factor affecting Cd uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil factors</td>
<td>Amount of Cd present in soils</td>
</tr>
<tr>
<td></td>
<td>pH (increase pH = decrease Cd uptake)</td>
</tr>
<tr>
<td></td>
<td>CEC (increase sorption = decrease Cd uptake); adsorption onto oxides, organic matter</td>
</tr>
<tr>
<td></td>
<td>Competition with micronutrients, especially Zn</td>
</tr>
<tr>
<td></td>
<td>Salinity (CdCl complexes) promotes Cd uptake</td>
</tr>
<tr>
<td>Crop factors</td>
<td>Species and cultivars; weeds &gt; grass &gt; clover</td>
</tr>
<tr>
<td></td>
<td>Plant tissues; leaves &gt; grain, fruit, roots</td>
</tr>
<tr>
<td></td>
<td>Leaf age; old &gt; young</td>
</tr>
</tbody>
</table>
Reduce Cd accumulation in plants

Crop management
- use cultivars with low Cd concentration (e.g. Wheat and potato)

Soil/land management:
- Liming
- Maintaining high soil organic matter
- Alleviating Zn deficiency
- One off deeper cultivation

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Are we managing risks from cadmium?

Data from the soil quality survey of Wellington regional council

Drewry, et al. FLRC, 2017
Are we managing risks from cadmium?

Data from the soil quality survey of Waikato regional council

Decline in soil organic matter will increase Cd bioavailability if soil pH also declines.

M.Taylor, 2013
Sustaining productive capacity will require:

- Education on soils and landuse
- Farm mapping: soils and landuse

With particular emphasis on:
- Physical management
- Water supply
- Securing essential Nutrients
- Avoiding Soil contamination
- Managing environmental risk
Nutrient Management Plans – Cost effective nutrient use, minimising nutrient loss to the environment and primary product quality assurance

Rural Environmental Compliance Loan.

The farming sector is the driving force of the New Zealand economy, and to ensure it stays that way, it’s important that New Zealand’s farmers get the balance right between productivity and sustainability.

We want to help you succeed in meeting your local council’s environmental by-laws by minimising the cost to your business through a low interest Rural Environmental Compliance loan.

ASB’s Floating Base Rate of just 3.80%*

Maximum loan amount of $200,000 to be used to fund environmental compliance initiatives
No establishment fee
Maximum term is 5 years

Contact your Rural Manager
6. Think about the trade-offs of the proposed management regime, and the likely impacts and opportunities (both environmental and economic).

5. Decide on what limits need to be set and what management options are required to achieve the chosen band, given the current state and how the resource is currently being used.
Nutrient Management for the Farm, Catchment and Community

Professional development and decision support

Discharge limits: (nutrients etc)

Time to adjust

Water take limits: Water out (flows, levels etc)

Other management options: Catchment mitigation, shade

8. Council implement planning and management regime

Forever discovering
Who is capable of Nutrient Management Planning?

Trained in Sustainable Nutrient Management plus Industry Experience

Intermediate SNM course
2093 enrolments since 2002

- Fertiliser Companies: 752
- Farm Consultants (inc. Fonterra & DNZ): 875
- Research Organisations: 58
- Regional/District Councils: 240
- Postgraduate students: 87
- Other (eg QCONZ, MPI etc): 81

Advanced SNM course
856 enrolments since 2002

- Fertiliser Companies: 379
- Farm Consultants (inc. Fonterra & DNZ): 229
- Research Organisations: 17
- Regional/District Councils: 53
- Postgraduate students: 44
- Other (eg QCONZ, MPI etc): 32
Distribution of Advanced SNM Certificates in 2013
Distribution of Advanced SNM Certificates in 2015
Distribution of Advanced SNM Certificates in 2018

- Auckland Region: 200
- Manawatu-Wanganui Region: 114
- Wellington Region: 54
- Hawke's Bay Region: 10
- Taranaki Region: 29
- Waitakere: 27
- Northland: 33
- Gisborne: 171
- Otago: 60
- Marlborough Region: 17
- West Coast: 14
- Canterbury: 34
- Southland: 67

Nutrient Management Adviser Certification Programme Ltd
What will the nutrient management plan include?

- Farm/Block description – farm property map
- Soil and Land Use Capability Map at paddock scale
- Soil, plant test information
- Crop management plan, irrigation plan
- Nutrient budget, fertiliser recommendations
- Compliance Checklist
- Mitigation Plan – if required to reduce loss of nutrients, sediment and reduce contaminant accumulation.
- Communicate implementation to – staff and contractors.
- Describe a monitoring programme to re-evaluate plan periodically