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## Phosphorus retention into Nordic soils

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Plenty of iron hydroxides particularly in wet soils

Photo: Risto Uusitalo

About 8 g/kg aluminium and iron associated with oxides in clay soils

Acidic soils dominate around the Baltic sea

Phosphorus is retained mostly by aluminium and iron hydroxides by ligand exchange mechanism

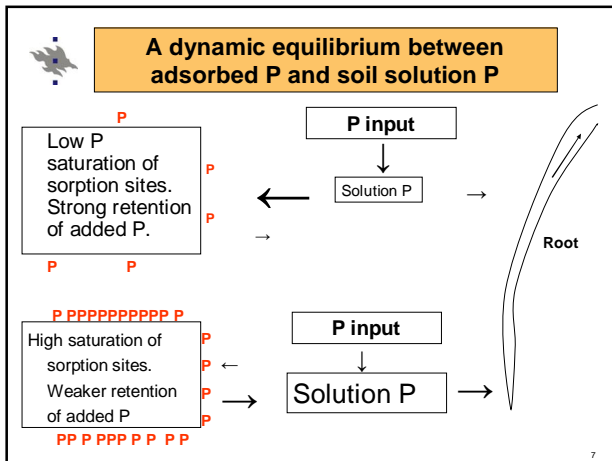
$$\begin{array}{c} \text{OH} \\ | \\ \text{Al}-\text{OH}_2 \\ | \\ \text{O} \\ | \\ \text{Al}-\text{OH} \\ | \\ \text{OH}_2 \end{array} + \text{H}_2\text{PO}_4^- \xrightleftharpoons[-\text{H}_2\text{O}]{+\text{H}_2\text{O}} \begin{array}{c} \text{OH} \\ | \\ \text{Al}-\text{O}-\text{P}=\text{O} \\ | \quad \quad | \\ \text{HO} \quad \quad \text{OH} \\ | \\ \text{Al}-\text{OH} \\ | \\ \text{OH}_2 \end{array}$$

...and in podzolic soils

In humid climate there are plenty of iron (and aluminium) hydroxides in the soil

About 4 g/kg aluminium and iron associated with oxides in sandy soils

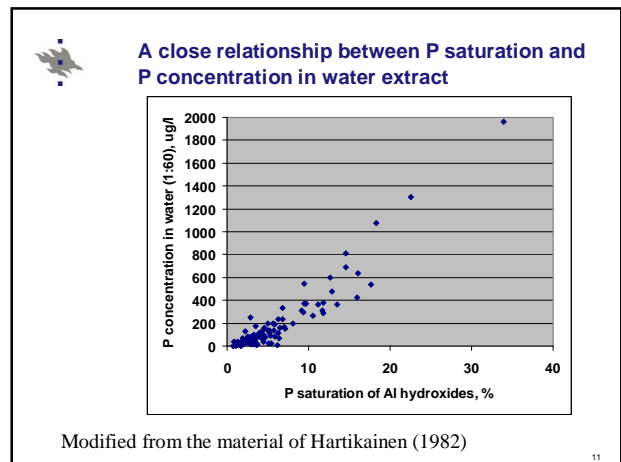
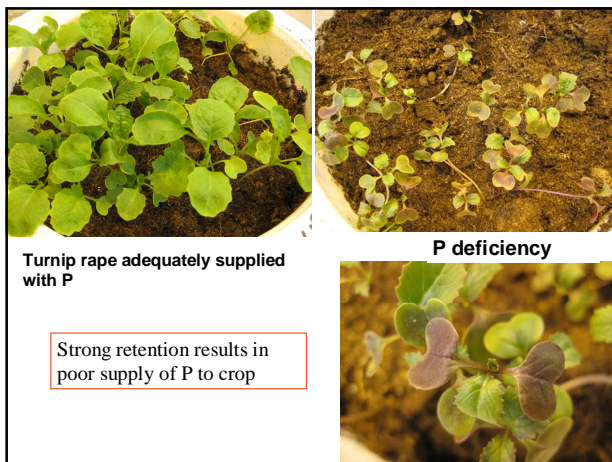
Iron hydroxide precipitates around soil pores



### Degree of P saturation

- n Calculate **molar** ratios
- n  $100 \times P_{\text{ox}} / (Fe_{\text{ox}} + Al_{\text{ox}})$
- n Lookman et al. 1995, Geoderma 66, 285
- n Not suitable for Nordic soils
- n  $100 \times (P_{\text{Al}} + P_{\text{Fe}}) / (Fe_{\text{ox}} + Al_{\text{ox}})$
- n Peltovuori et al. 2002, Geoderma 110;35
- n  $100 \times P_{\text{Al}} / Al_{\text{ox}}$  and  $100 \times P_{\text{Fe}} / Fe_{\text{ox}}$
- n Hartikainen 1982, J. Scient. Agric. Soc. Finl. 54; 537.
- n **Particularly  $100 \times P_{\text{Al}} / Al_{\text{ox}}$  explains the variation of soluble P**

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### Degree of P saturation of Al and Fe hydroxides

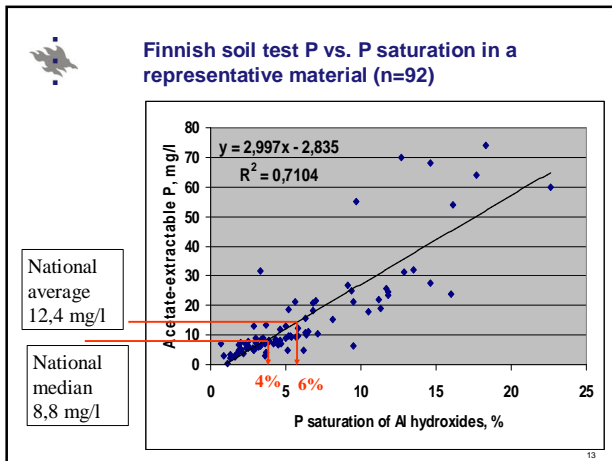
- n A practical way to illustrate the filling of sorption sites with P
- n Different methodologies may create confusion
  - n Oxalate extraction of Al and Fe oxides
  - n Oxalate extraction of P
    - not good for Nordic soils
- OR
- n Extraction of P adsorbed by Al and Fe oxides
  - more laborious

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### Are the Nordic soils saturated with P?

- n Degrees of P saturation have not been commonly determined
- n They can be roughly estimated from soil test P
- n Different methods of soil testing make it difficult to do cross-border comparisons of the actual P concentrations
- n Distribution of soils into the soil test classes may be a more reasonable approach

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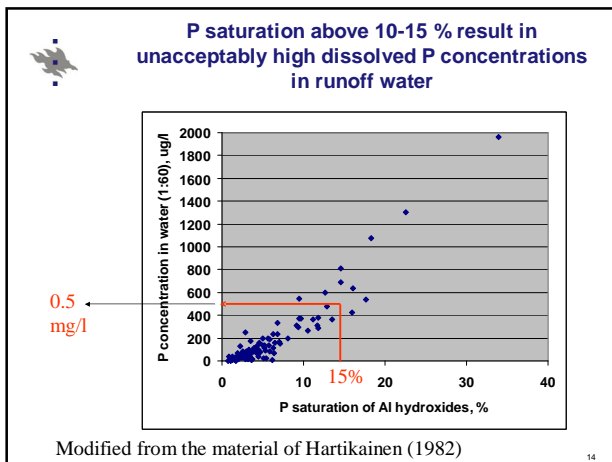


### Distribution of soil test P classes in various countries

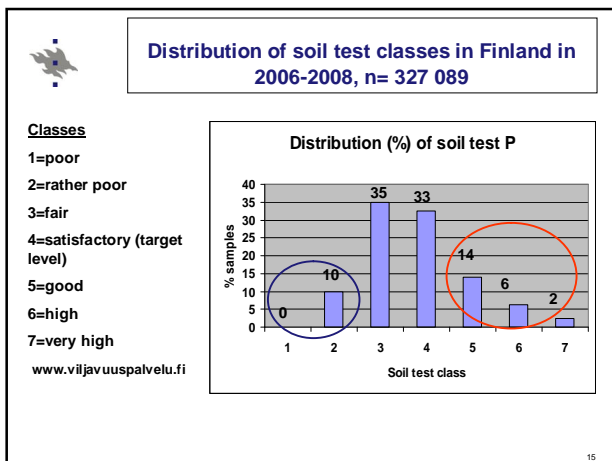
Country	Low	Medium	High
Estonia	29	47	24
Latvia	37	35	28
Lithuania	63	20	16
Poland	38	27	35
Finland	10	68	22

Csatho et al. 2007. Soil Use and Management 23, Suppl. 1, 36. (except Finland)

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- ### Trends of P saturation around the Baltic Sea
- Strongly positive P balances particularly from the 1970's to 1990's have increased P saturation
  - High values common in
    - areas of intensive animal production
    - nurseries
    - intensive vegetable production
    - soils receiving plenty of topdressing
  - Most soils still have P saturation less than 10 %
  - All countries have also soils of high P saturation
  - Degrees of P saturation are only slowly changed
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- ### Conclusions
- Degree of P saturation is a practical illustration of P retention characteristics of a soil
  - Environmental measures should be directed to sites of high degrees of P saturation ("hot spots"), revealed by high soil test P levels.
  - Soils of low P status must not be neglected. Deficiency of P in crop production should not be promoted.
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