Gypsum-based management practises to prevent phosphorus transportation

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Contents

1. Background
2. Introduction to the principles
   - Gypsum as soil amendment
   - Gypsum-based precipitate in manure treatment

3. Testing principles: preliminary studies 2006-2007
4. Testing principles in full scale 2008-2010
5. Conclusions

1. Background

- The eutrophication of the Baltic Sea is severe:
  - many efforts are currently underway to improve the situation.
    - **the phosphorus transportation from agricultural soils should be strongly limited**

- Hot spots for P losses from agriculture

  - **Erodible clayed fields:**
    - With slopes
    - Without slopes – during snow-melt period and rains
      - soil particles escape fields transporting P to waters

  - **Fields with high soil test P:**
    - Fields used for sugar beets, vegetables etc. (non-grains)
    - Fields where manure has been spread for years on N content basis
      - P surplus in manure use:
        - Pig manure P:N 1:3 vs. cereals 1:6 or grasses 1:9

1. Background

Farmers need **specific tools to control P losses** in addition to best management practises like drainage and liming

- Reduced tillage – direct sowing
- Constructed wetlands
- Buffer zones

  +
- **Chemical methods**
  - P absorption
    - **In-field – not out**
    - **For crop reuse** – no too strong precipitation mechanisms

Our targets

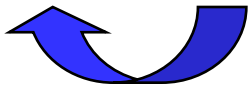
2. Introduction to the principles

- Approach to keep P in soil (root zone) as a part of ecological cycle for continuous use in agriculture by addition of Ca-based amendments
- Focus on gypsum –based products for environment tools in farming with two main applications:

1. **Gypsum as *soil amendment* enhancing phosphorus trapping**
   - by erosion / particle P –control via improved soil aggregation
   - by P leaching control via enhanced adsorption on particle surfaces

2. **Gypsum in liquid *manure treatment* for phosphorus fractioning**
   - P-free effluent after solid removal and settling of phosphates
   - P-rich solids at the bottom of farm pit

I Soil application **II Manure application**



Both tools base on utilization of Siilinjärvi phosphogypsum

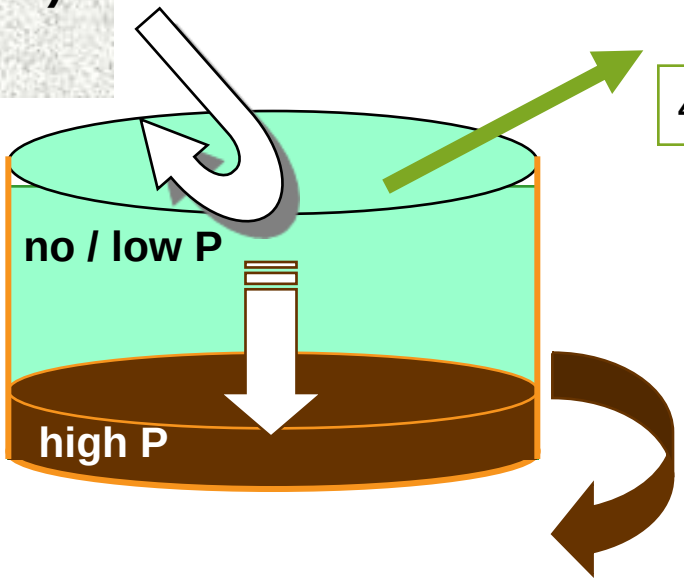
- $CaSO_4 \cdot 2H_2O$ is by-product produced by wet process phosphoric acid by the reaction of phosphate rock with sulphuric acid
- Originates from Siilinjärvi phosphate rock

Figs: Asko Kinnunen

PRINCIPLE 1. Liquid Manure treatment
- P fractioning on focus

Precipitate (0,2-0,5 %)

1. Precipitate powder/fine granules
2. Stirring
3. Sedimentation by settling



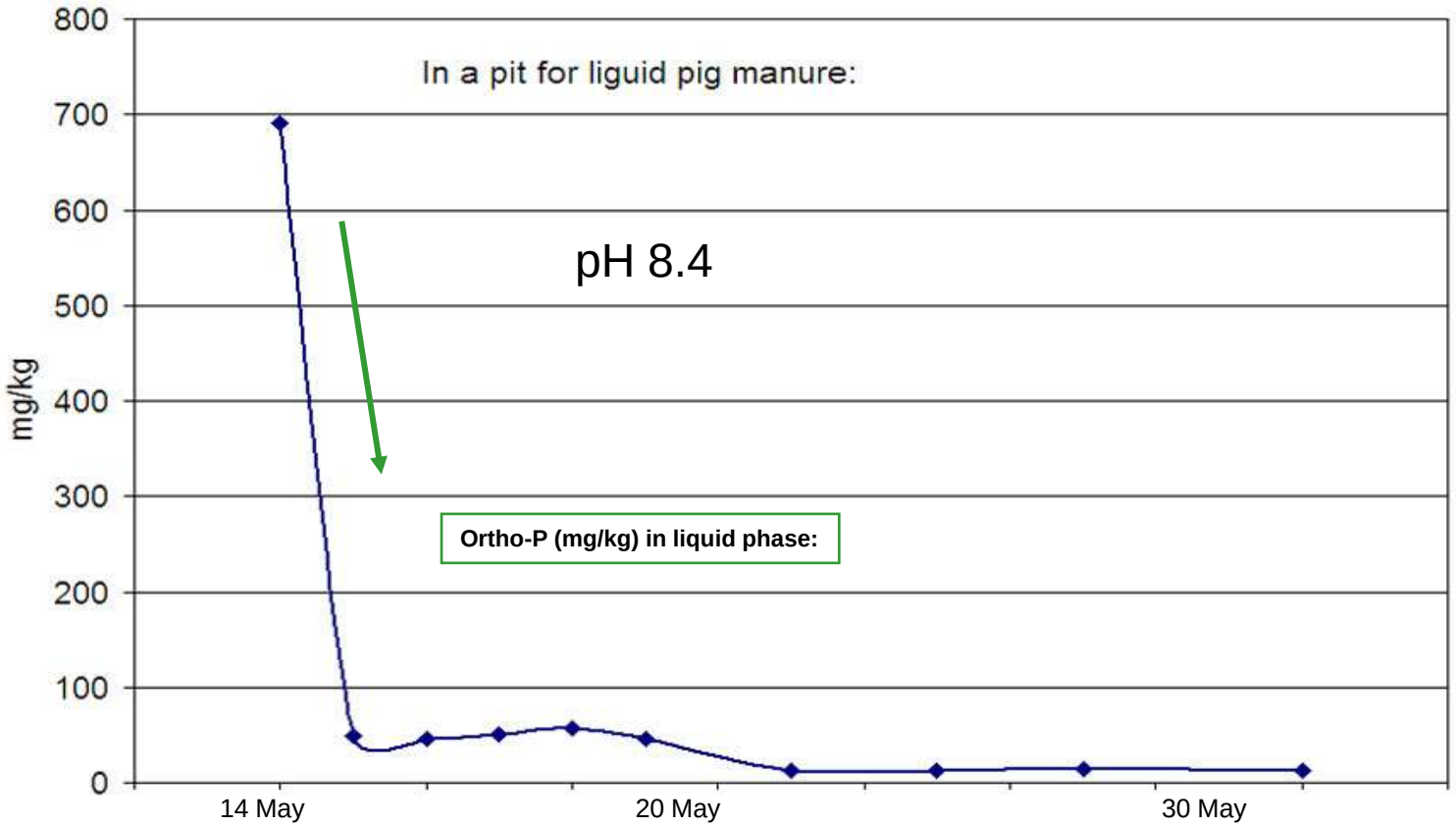
4. For NK-fertilizer use

5. For NPK-fertilizer or energy production

P available for crops

Ca-phosphates
$MgNH_4$-phosphate

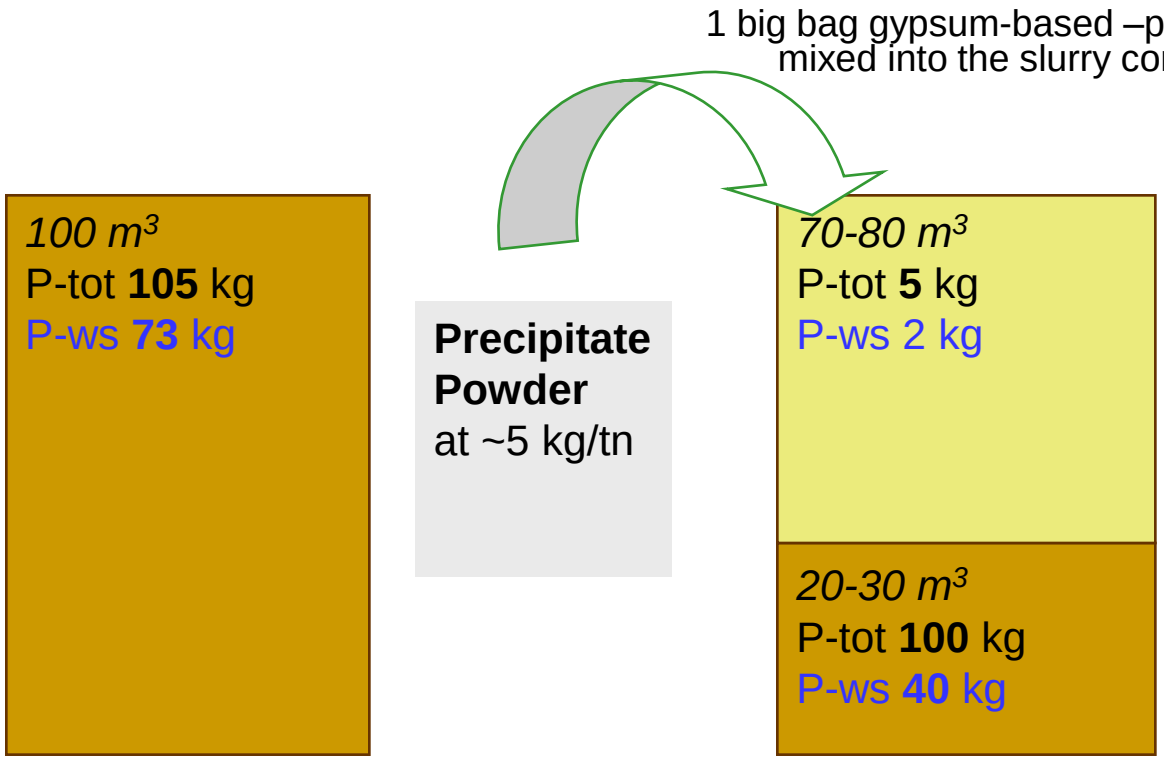
Testing principle
ws P concentration in upper part of the manure



Sampled from 0-10 cm, May 21 and 30 also from 30 cm (no differences between depths)

Testing principle 2006-07:
Application with liquid pig manure

(at 15-20 degrees C, after 1-2 days)



P

- P-free effluent after solid removal by settling
  = NK fertilizer
- P-rich solids*
  = P-fertilizer/for energy

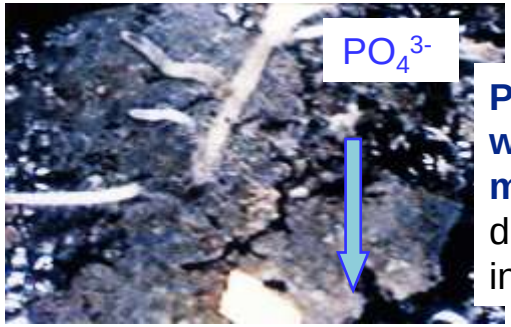
* Ca-phosphates
  $MgNH_4$-phosphate → *P available for crops*

(unlike Al- or Fe-phosphates)

PRINCIPLE 2. Soil treatment
-P trapping into soils on focus

- By controlling P transportation through
  - runoff / erosion: typically **particle P**
  - or drainage water: typically **soluble P**

- Aiming to keep P usable for crops:
  - Chemical treatment on **Ca-based compounds**
  - **Ca-sulphate** dissolves readily and
    - Increases soil Ca and EC
      - Which enable P trapping

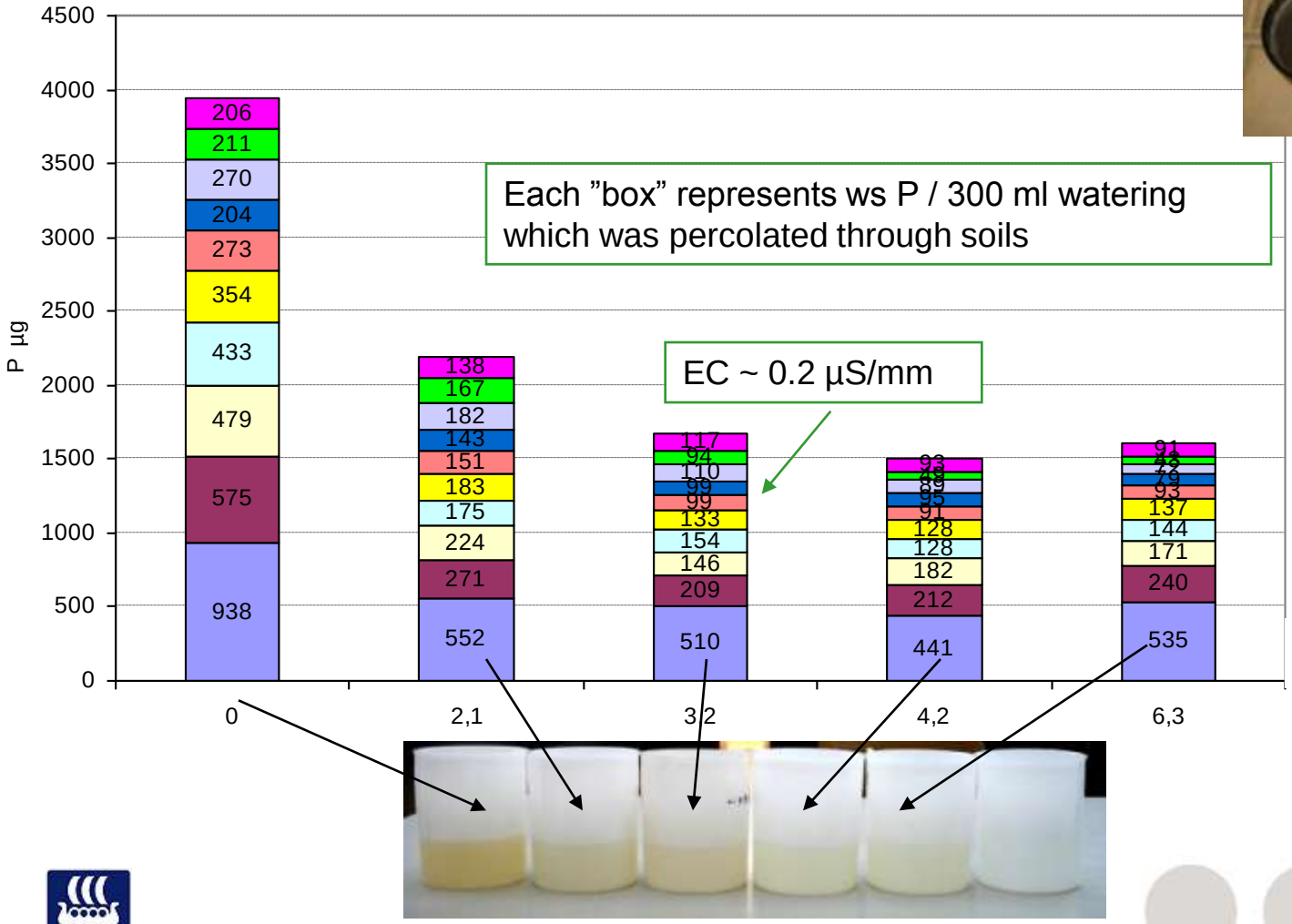


P in particles in runoff:
decreases by **aggregation**
by increased **Ca**

P in leaching water by in mass flow:
decreases by increased **EC**

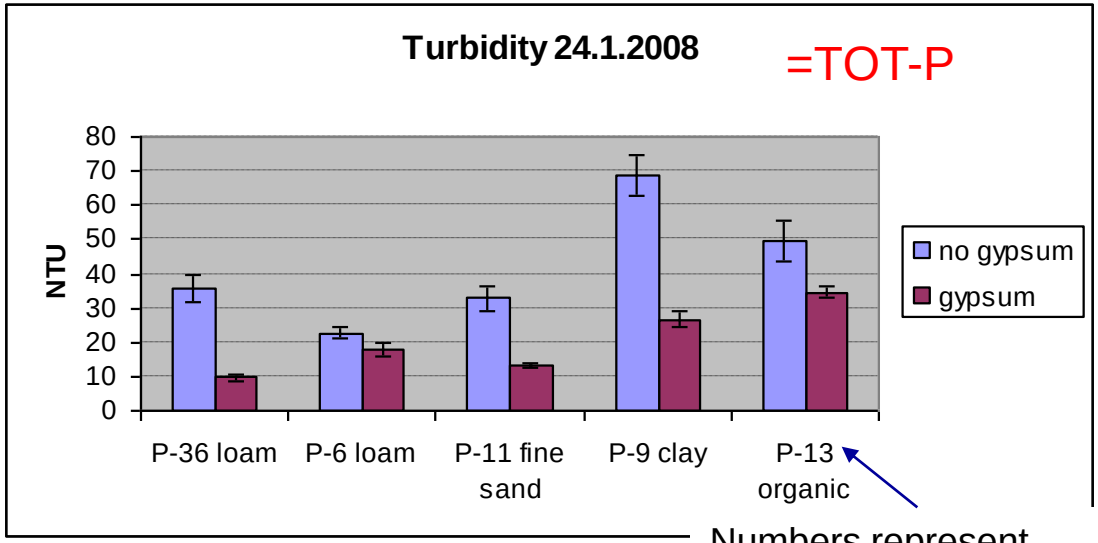
Testing principle 2008:
Laboratory results from incubation-leaching tests

Loamy soil, test P **6** mg/l; pH **6,9**; EC 0.1
(P-fertilization 10 mg/l)

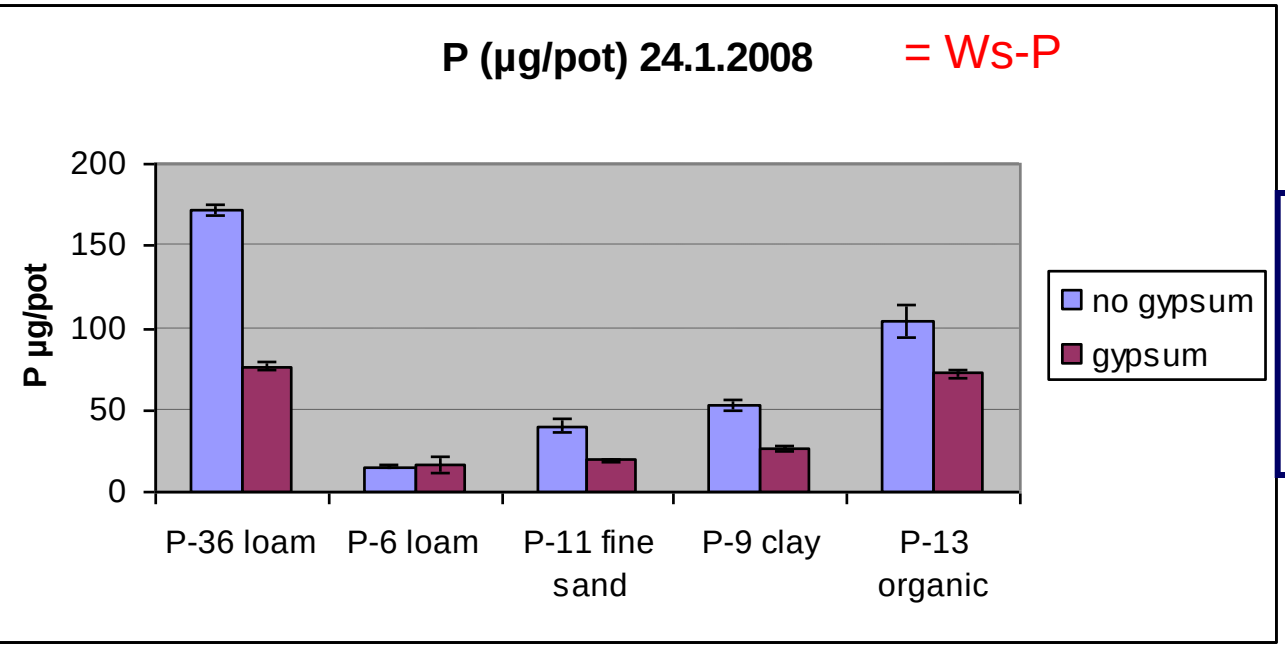


Testing principle 2007-08:
Laboratory results for different soils

after 5 months incubation with wetting-drying cycles, **no P fertilization**



Numbers represent soil test-P (mg/l soil, with acid AAc extraction)



Phosphorus in percolated water from **gypsum treated** (4 g per soil litre) soil columns, **control** (no gypsum) (n=3)

4. Testing principles in full scale 2008-2010 by TraP project / Yara's environmental research on water quality

In-field P trapping

= "TraP and Recycle"

TraP - Novel gypsum-based products for farm scale phosphorus trapping

- Under farm conditions & at catchment scale
- With Finish Funding Agency for Technology (Tekes) – support

- Yara coordinates and purchases research from partners
  - **SYKE** Finnish Environment Institute
  - **MTT** Agrifood Research Finland
    - Plant production
    - Economics
  - **TTS** Work Efficiency Institute
  - **Luode** Consulting Ltd.
  - Yara focus on R&D on product recipes, quality control, manufacturing and logistics:

In co-operation with other partners:

- Water Protection Association of The River Vantaa and Helsinki region
- Uusimaa Environment Centre, local farmers

Conclusions / Project mission

Significant agricultural P load decrease on waters is observed

1. In accordance with the goals set by the Government of Finland in national water protection policy
2. HELCOM

& Practical methods to achieve the load decrease is developed

1. Provide solutions for farmers
   - to be used in ***hot spots of P-loading***:
     - **erodible** soils
     - high P status soils;

       by better **manure management**
2. Are included into the Finnish agri-environmental support scheme

Practical methods includes:

- Gypsum as soil amendment for **erosion** and soluble P control
- Gypsum-based precipitate in **manure treatment** to fractionate P

Thanks

for audience and Trap-partners