Can gypsum mitigate eutrophication of the Baltic Sea?

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SYKE

Photo: Pasi Valkama

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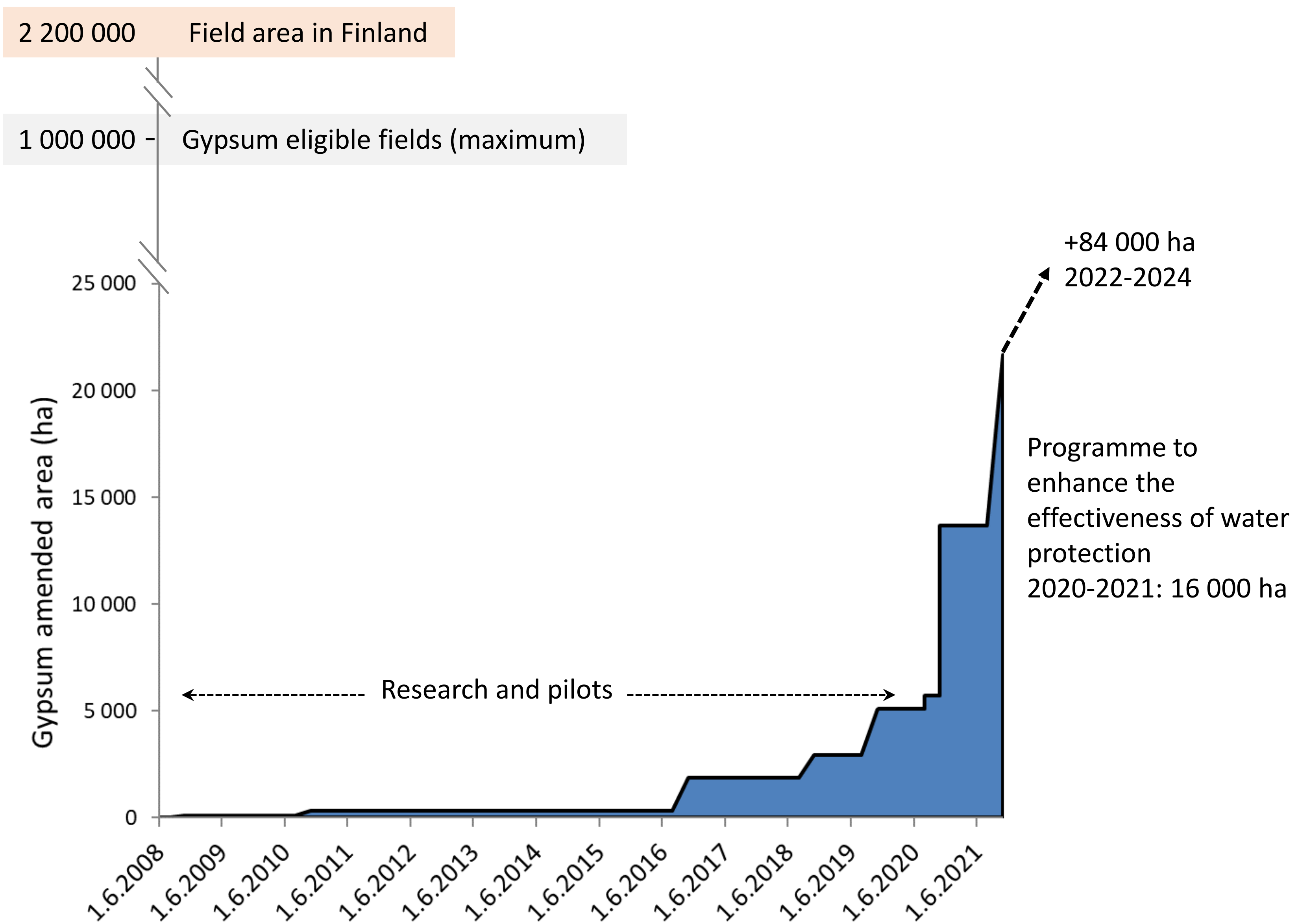
- Finnish perspective on gypsum
- How gypsum works
- Can gypsum work outside Finland

Photos: Eliisa Punttila

Gypsum amendment in Finland

From laboratory to catchments



A need to reduce **P** load into the Baltic Sea

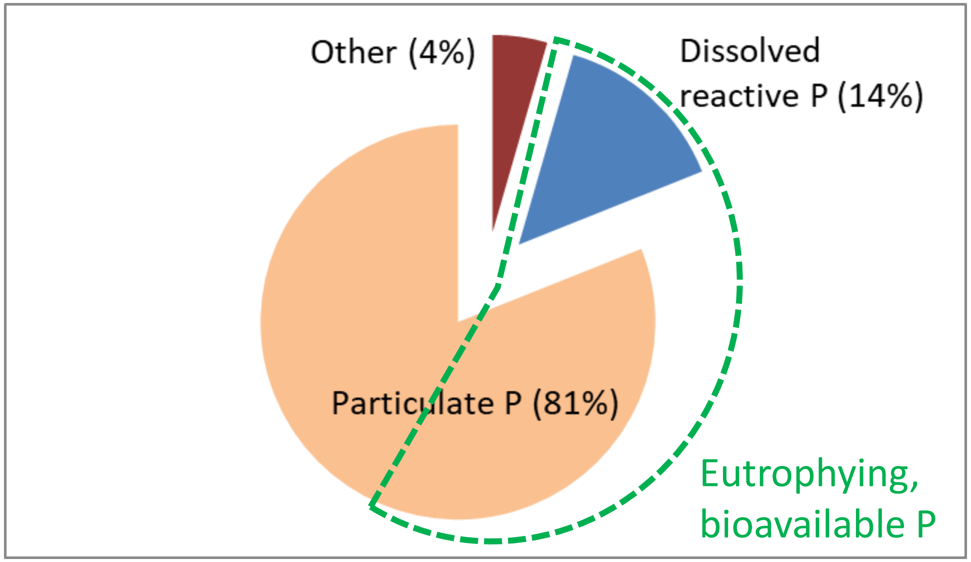
"… no significant reduction of input from diffuse sources … in the last two decades … Agriculture, which has the highest reduction potential, is currently the main contributor to the diffuse load of nutrients to the Baltic Sea." HELCOM (2021)

- Phosphorus load from Finland to the Baltic Sea should be decreased by about 13% to meet the goals of marine strategy
    - Gypsum could (help to) fix the challenge

A need to reduce **bioavailable P**

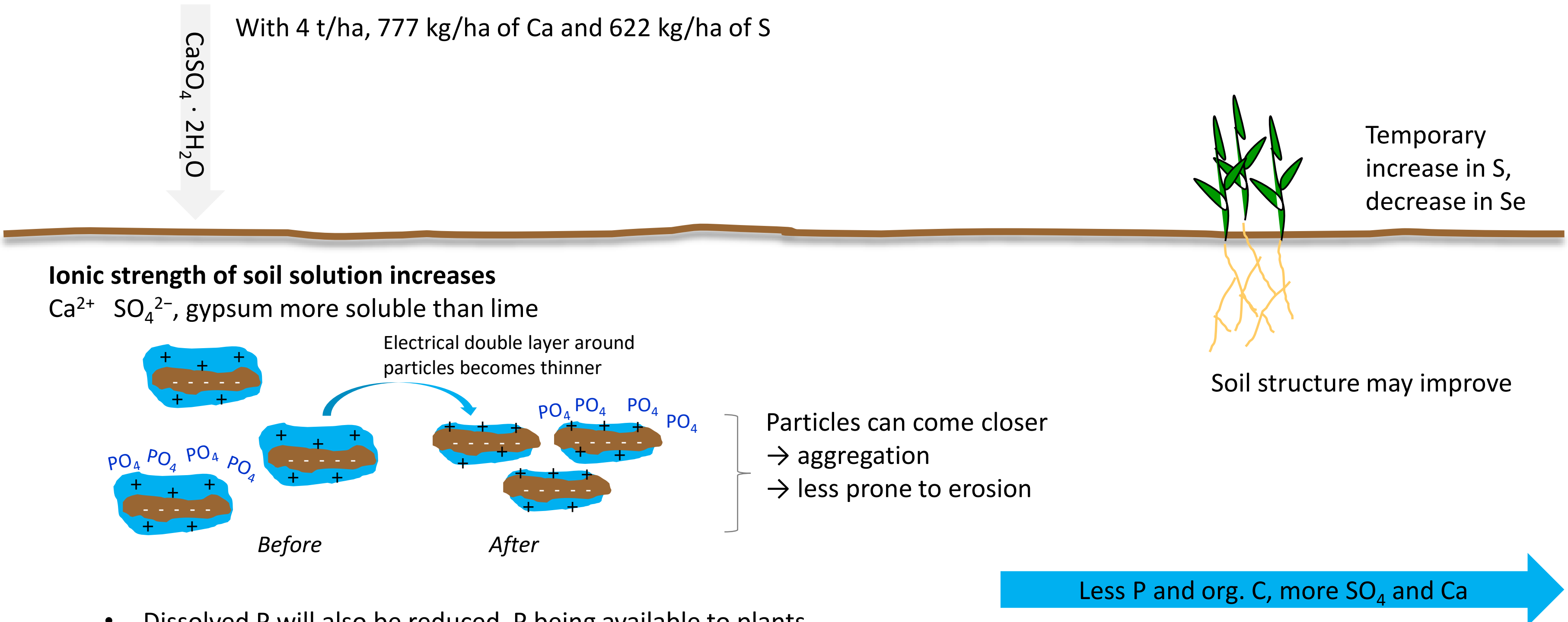
Typical agricultural river (the Paimionjoki)

- Mean total P concentration 250 µg/l

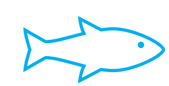


“Ideal” P controlling measure	Gypsum
Reduces both particulate and dissolved P	About 50% reduction in particulate P, some in dissolved P and organic C
Applicable to large areas	Clay soils, possibly other mineral soils, some local restrictions
Does not interfere with farming practices, take productive area from farming or negatively affect yield	Does not Farmers reacted mainly positively
Performance tested Mechanism known	Yes
No / manageable side-effects	Soil and plant analyses & river monitoring revealed no concerns
Fixes the root cause	Effects lasts from 3 to more than 5 years, allowing time for slower measures (e.g. depleting legacy P)
Available	Several sources of gypsum
Cost-effective	Prof. Ollikainen will tell us soon

How gypsum works?



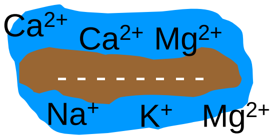
- Dissolved P will also be reduced, P being available to plants
- Organic C losses decrease
- No effect on pH (unlike lime, $CaCO_3$)

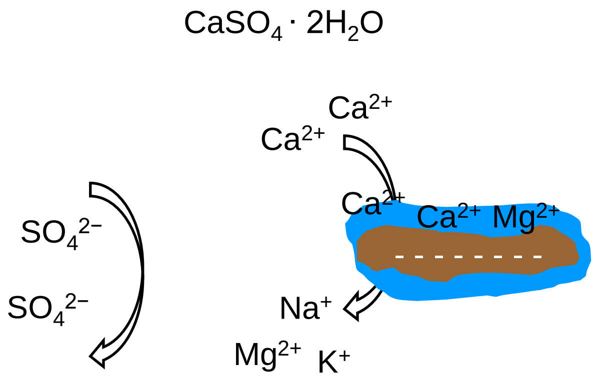


Local restrictions

! **Should be used with care in**

- Catchments upstream of lakes
    - Sulfate may accelerate eutrophication of lakes and reservoirs
- Soils low in magnesium or potassium
    - Cation exchange reactions
- Ground-water areas (if leaky soils)
    - Groundwater legislation
    - Moderate increase in sulfate harmless to humans and structures
- Natura 2000 sites





Impact of sulfate

Photos: Rami Laaksonen/Nixplore, Matti Leppänen

The increase in sulfate concentration does not affect river ecology (Rantamo et al. 2021)

Can gypsum work in other Baltic Sea countries?

Tattari et al. 2012. Mapping erosion- and phosphorus-vulnerable areas in the Baltic Sea Region – data availability, methods and biosecurity aspects. MTT Report 65.

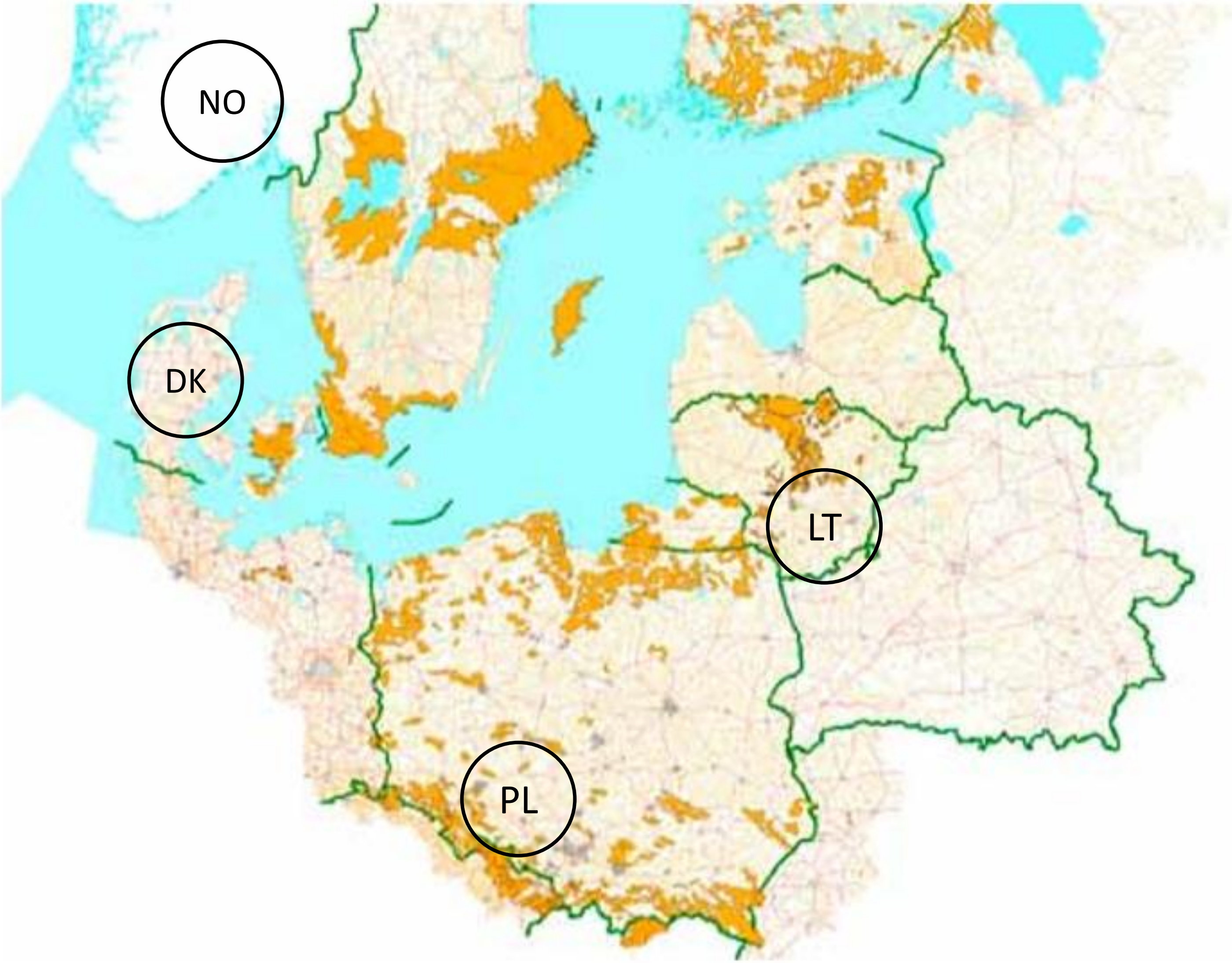


Figure 4. Clayey areas identified as FAO soil class Cambisol with EU soil map.

Pot experiment in Poland

- Flue-gas desulfurisation gypsum from Kozienice Power Plant
- COVID-19 prevented face-to-face instructions
- Pre-test with Finnish soil showed sensitivity of the method on gypsum effect
- 12 soils, 3 waterings (0, 17, 34 d), 3 replicates
- Responsible scientist: Dominika Bar-Michalczyk, Institute of Technology and Life Sciences, Kraków, Poland

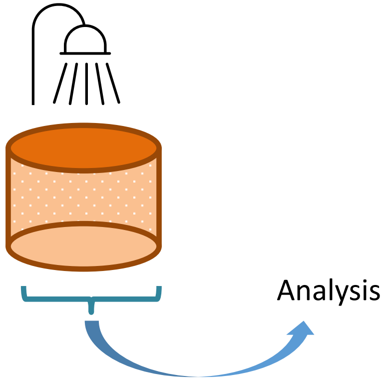
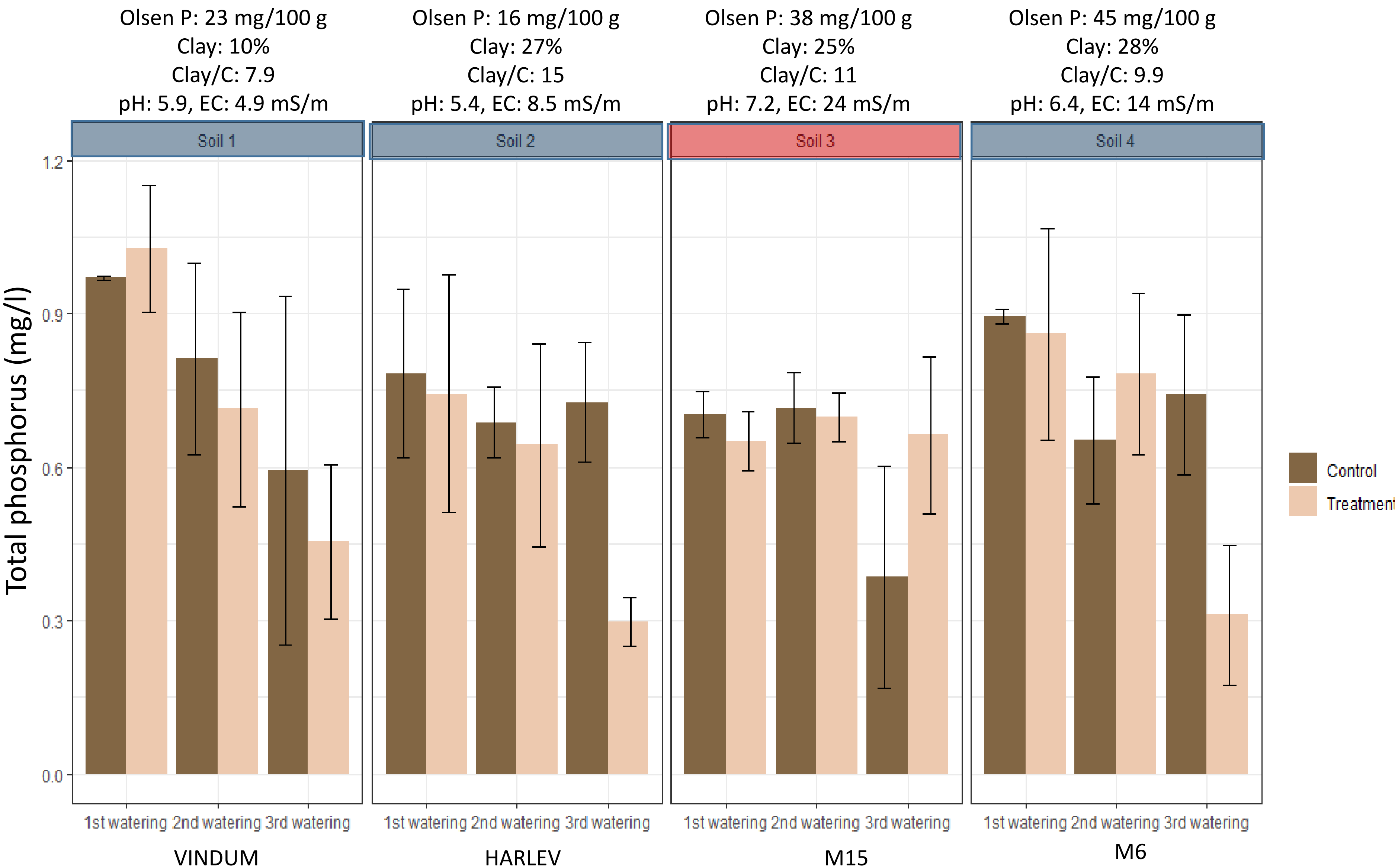


Photo: Dominika Bar-Michalczyk

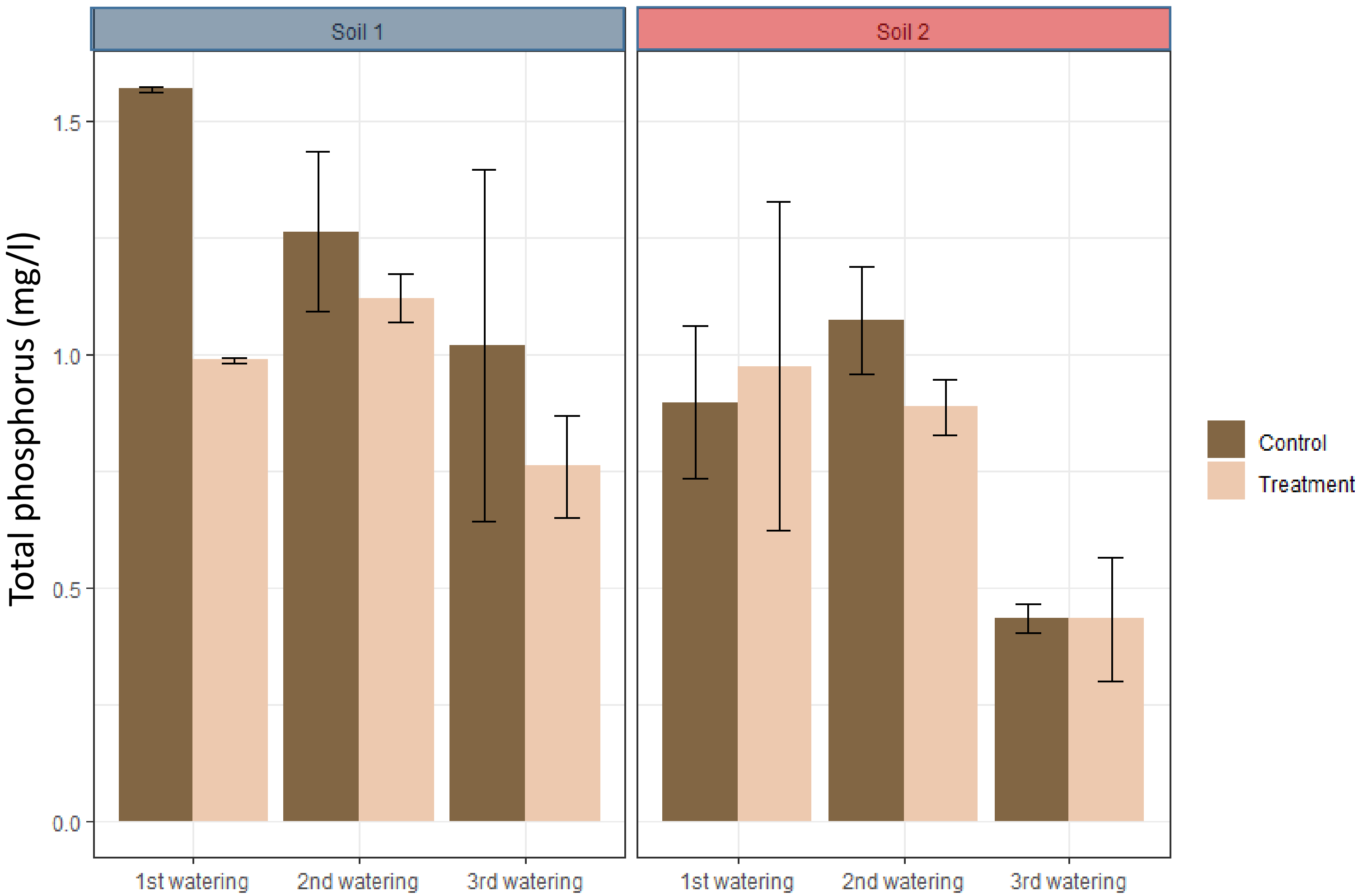
Denmark

3 out of 4 samples reacted on gypsum



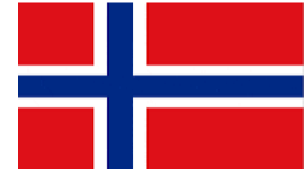
Lithuania

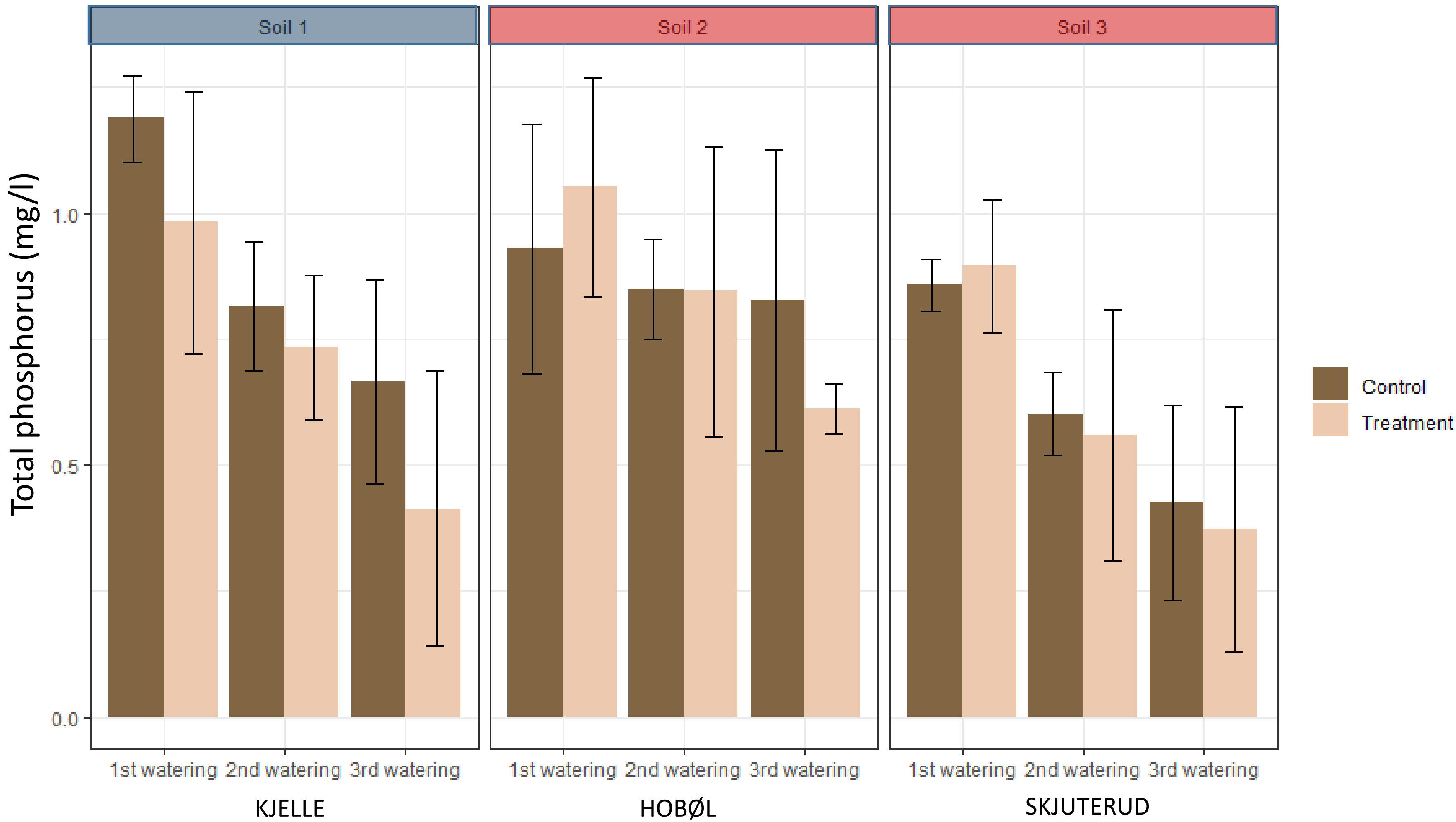
1 out of 2 samples reacted on gypsum



Norway

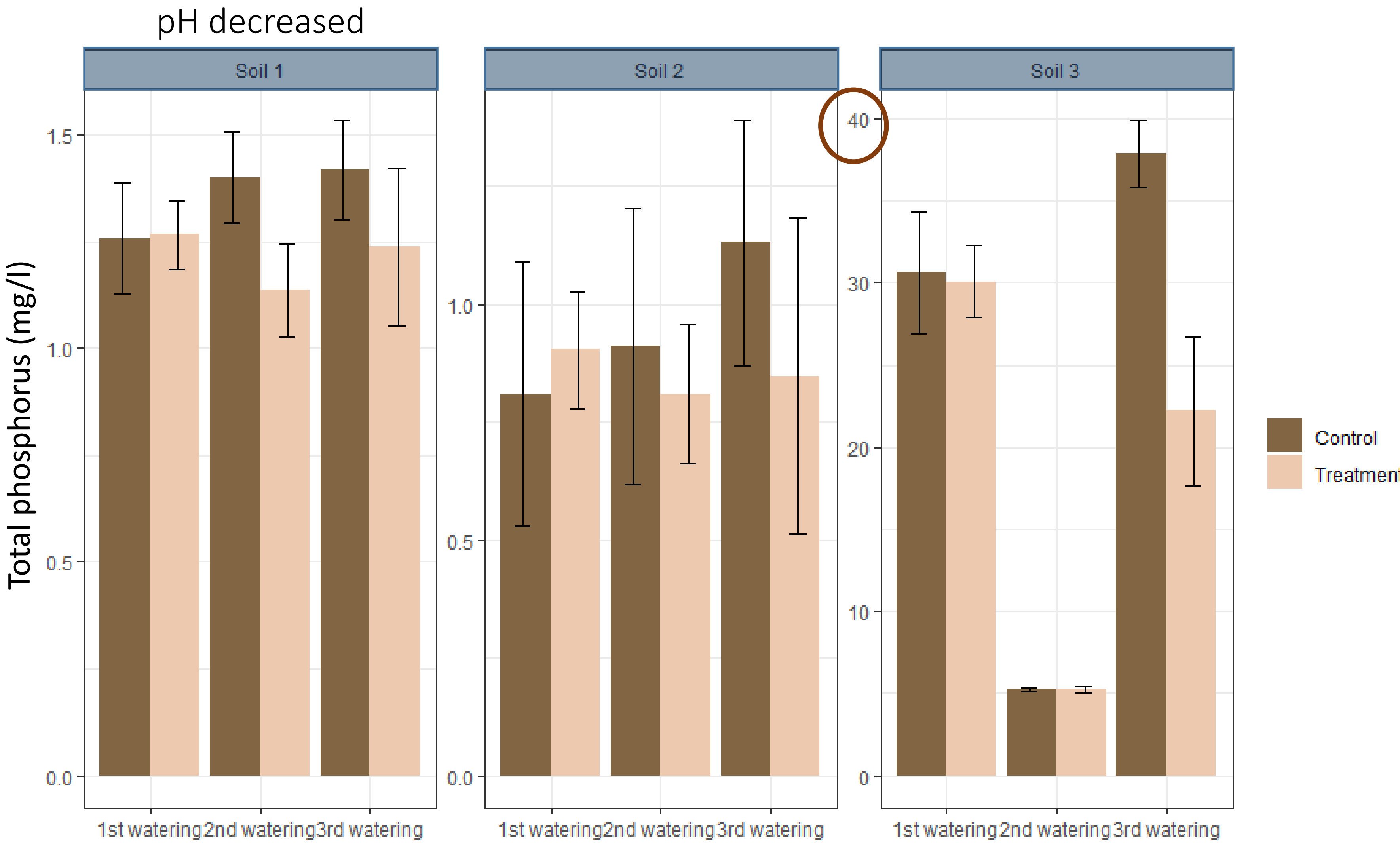
1 out of 3 of reacted on gypsum





Poland

3 out of 3 reacted on gypsum



Conclusions

- Finnish government finances gypsum amendment by 35 M€ in 2020-2024
- International collaboration projects ongoing and at planning stage
- Scientific evidence on gypsum amendment on the increase
- Pot tests suggested that gypsum works in some other Baltic soils
    - Why the performance of gypsum varies?
- A need to develop a simple pretest showing the gypsum effect

Finnish studies on gypsum in English

Ekholm P, Jaakkola E, Kiirikki M, Lahti K, Lehtoranta J, Mäkelä V, Näykki T, Pietola L, Tattari S, Valkama P, Vesikko Lj, Väisänen S. 2011. The effect of gypsum on phosphorus losses at the catchment scale. The Finnish Environment 33.

Ekholm P, Valkama P, Jaakkola E, Kiirikki M, Lahti K, Pietola L. 2012. Gypsum amendment of soils reduces phosphorus losses In an agricultural catchment. Agricultural and Food Science 21:279–291.

Iho A, Laukkanen M. 2012. Gypsum amendment as a means to reduce agricultural phosphorus loading: an economic appraisal. Agricultural and Food Science 21:307–324.

Iho A, Lankoski J, Ollikainen M, Puustinen M, Lehtimäki J. 2014. Agri-environmental auctions for phosphorus load reduction: experiences from a Finnish pilot. Agricultural and Resource Economics 58:205–222.

Kosenius A-K and M. Ollikainen 2018. Drivers of participation in gypsum treatment of fields as an innovation for water protection. Ecological Economics: 157:382-393.

Ollikainen M, Kosenius A-K, Punttila E, Ala-Harja V, Puroila S and Ekholm P. 2020. Gypsum Amendment of Arable Fields – Farmers' Experience from a Large Scale Pilot. Agricultural and Food Science.

Pietola L, 2008. Gypsum-based management practices to prevent phosphorus transportation. NJF Report, Vol 4, Nr 4.

Rantamo K, Arola H, Aroviita J, Hämälainen H, Hannula M , Laaksonen R, Laamanen T, Leppänen M, Salmelin J, Syrjänen J, Turunen J, Taskinen A, Ekholm P. 2021. Risk assessment of gypsum amendment on agricultural fields: Effects of sulfate on riverine biota. Environmental Toxicology and Chemistry (Accepted).

Suojala-Ahlfors T, Laamanen T-L. 2014. Effect of Calcium Amendment on the Calcium Content and Storage Quality of Carrot (Daucus carota L.). Europ. J. Hort. Sci. 79:278–282.

Uusitalo R, Ylivainio K, Rasa K, Kaseva J, Pietola L, Turtola E. 2012. Gypsum effects on the movement of phosphorus and other nutrients through undisturbed clay soil monoliths. Agricultural and Food Science 21:260-278.





Photos: Janne Artell, John Nurminen foundation, Eliisa Punttila, Pasi Valkama, a local farmer

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Gypsum Initiative project
https://johnnurmisensaatio.fi/en/projects/gypsum-initiative/

SAVE project
SAVE – Saaristomeren vedenlaadun parantaminen peltojen kipsikäsittelyllä (helsinki.fi)

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