1st EU/North-African Conference on Organic Agriculture (EU-NACOA)
11-12th November 2019, Marrakech-Morocco
www.eu-nacoa2019.bio

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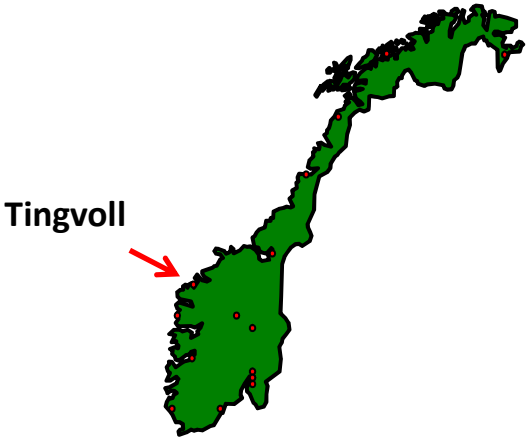
Farm level management of phosphorus: organic farmers need recycled fertilisers

Anne-Kristin Løes, Tatiana Rittl

Norwegian Centre for Organic Agriculture (NORSØK): Hub for agronomic research since 1986, location Tingvoll



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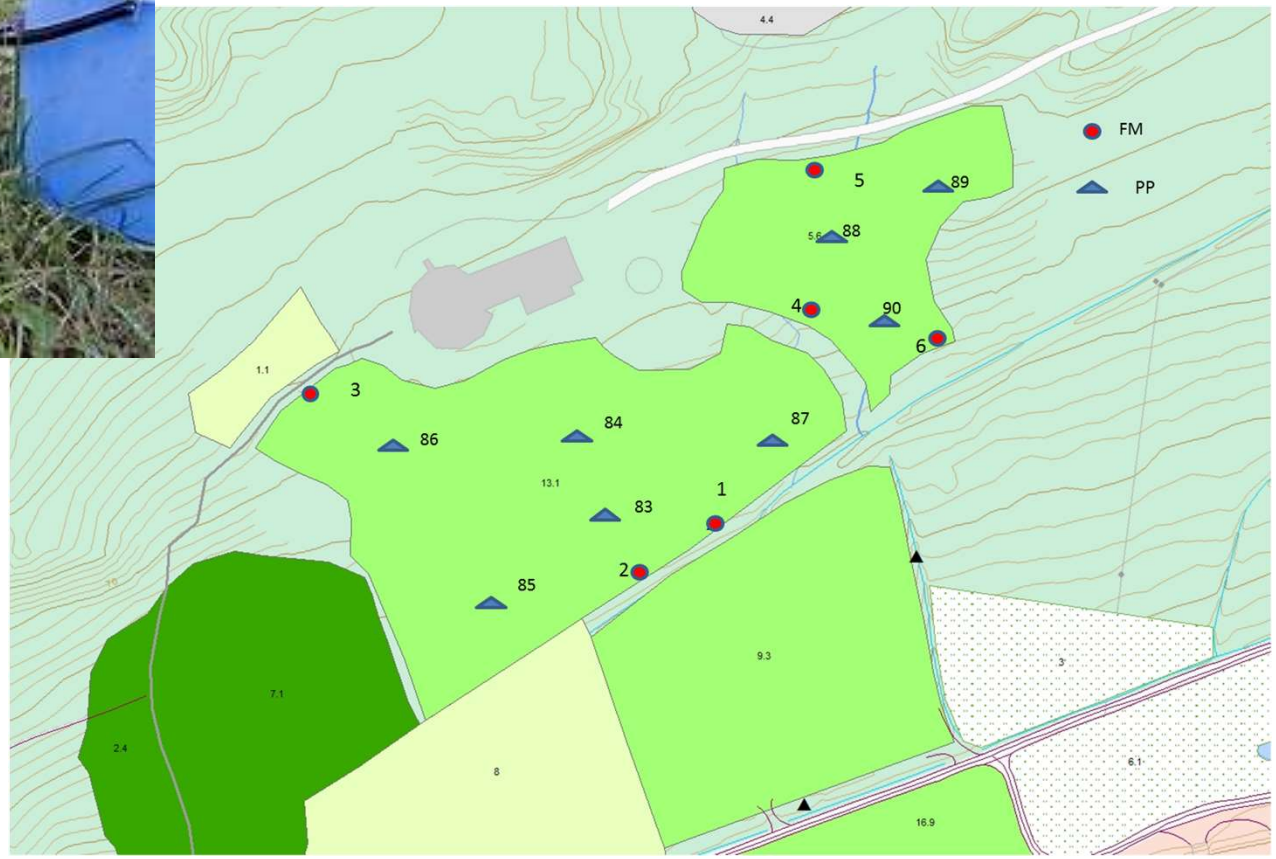
Tingvoll farm - organically managed dairy production + experimental farm

Loose-housing shed for 22 dairy cows; herd owned and managed by a tenant family

Small-scale biogas plant, site of R&D activities

Since 1989, regular soil sampling across 23 ha cultivated land + permanent pastures

- Soil sampled from 0-20, or 0-20 + 20-40 cm soil depth
- 6 subsamples taken within 3 m from the fixed sampling point (PP) (sampling area ca. 30 m^2)
- Sampling points identified by fixed landmarks (FM)



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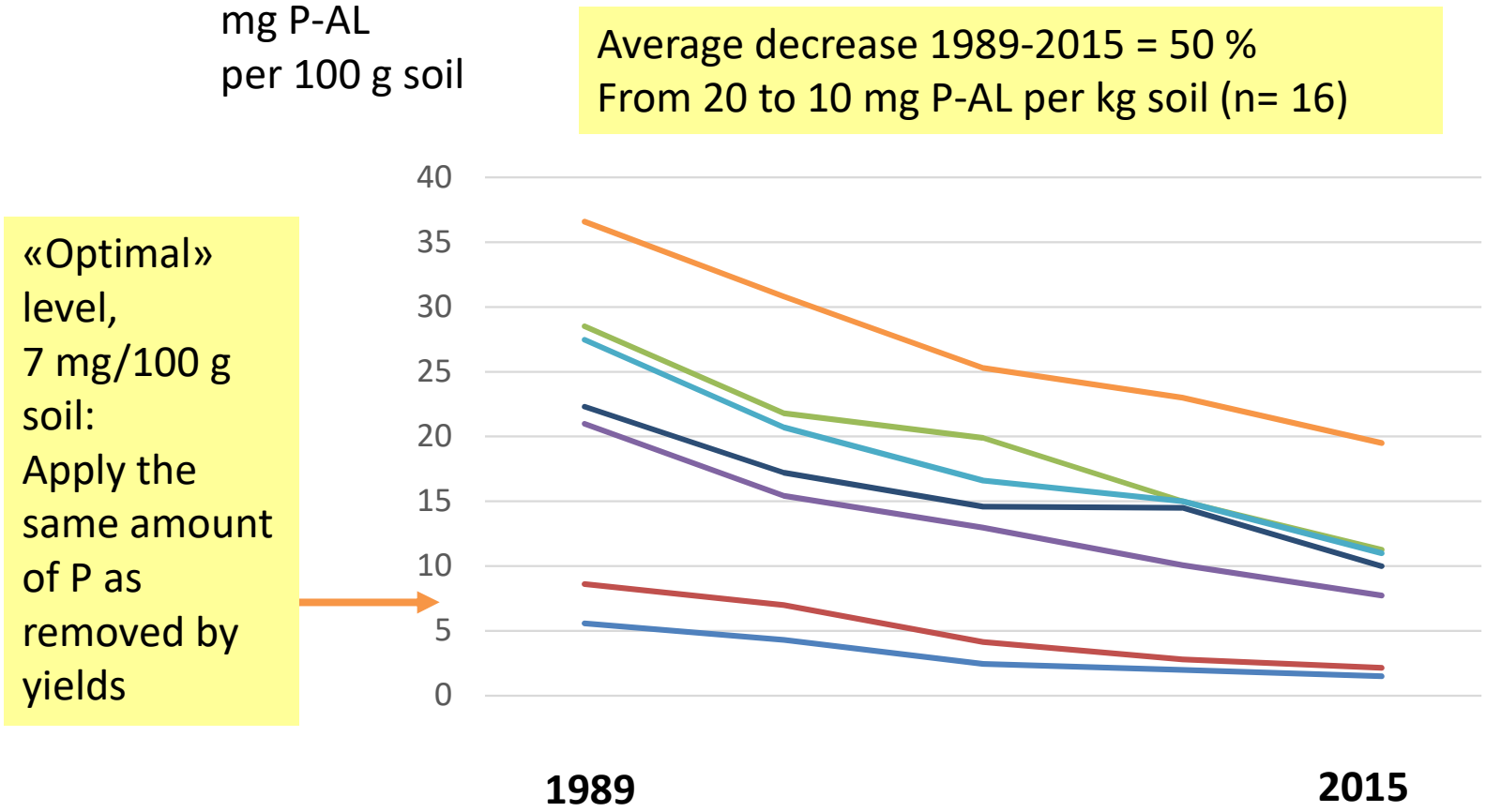
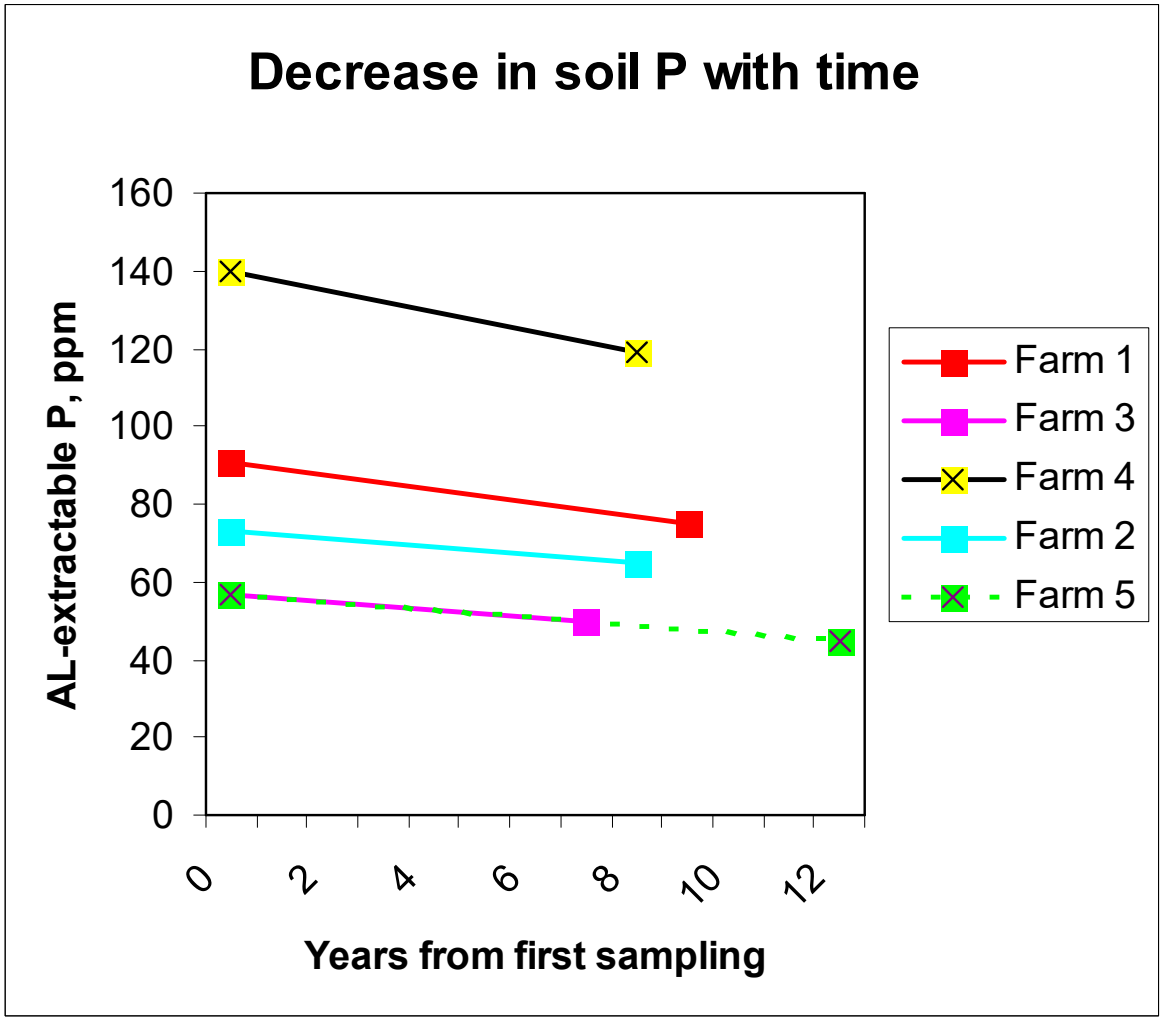
AL-extractable P in topsoil from Tingvoll farm 1989, 1995, 2002, 2009, 2015



Steady decrease corresponds to former study: Decreased soil P by long-term organic dairy farming



Soil test: Ammonium lactate-acetate soluble P (P-AL)

0-30 mg/kg= Low

30-70= Medium

70= Optimal level

70-150= High

>150= Very high

Sampling 1: 1985-1990
Sampling 2: 1995-1998

On average 31 sampling points per farm

Farm level P budgets:
Surplus of P required to maintain soil P

- Average farm level P-balance on Tingvoll farm, kg P per hectare x year

1992-2009: +0.9

2010-2016: +4.3

- Løes & Øgaard 1997, farm level study of converting farms with different animal husbandry:

> 8 kg P per hectare and year required to maintain soil P-AL

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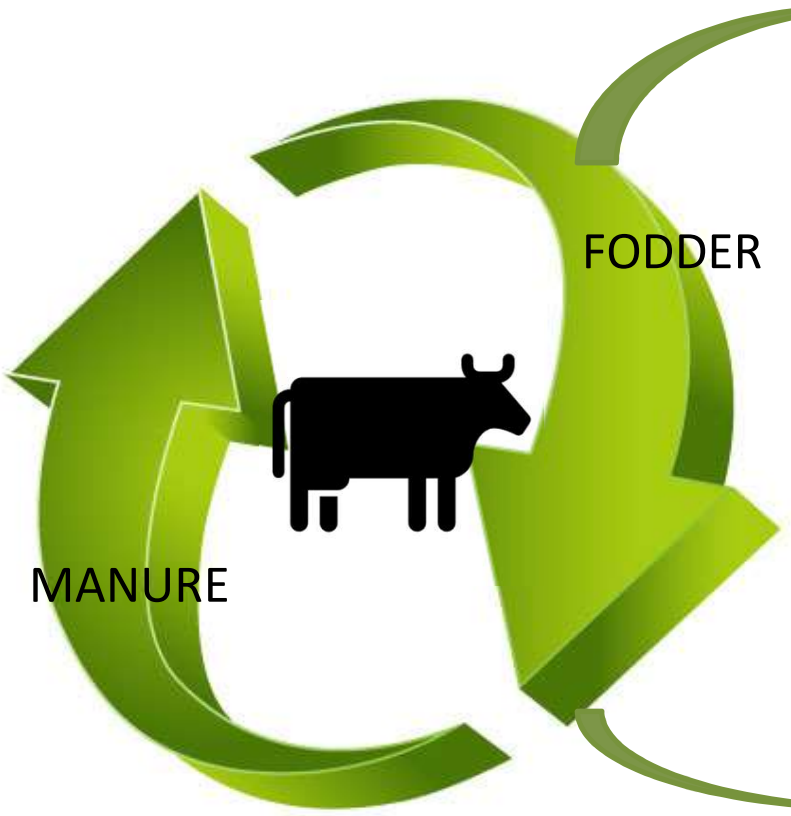
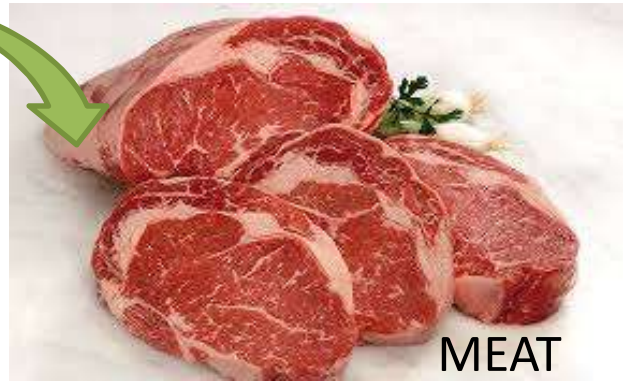
Organic dairy production – self-sufficient in nutrients? The answer is no, even with significant purchase of concentrates





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Most of Norwegian soils are slightly acidic (pH 5-6) with a high binding capacity for P

- The soil was often podzolic when cultivation started
- Phosphate is fixated by iron and aluminium-oxides (red colour)

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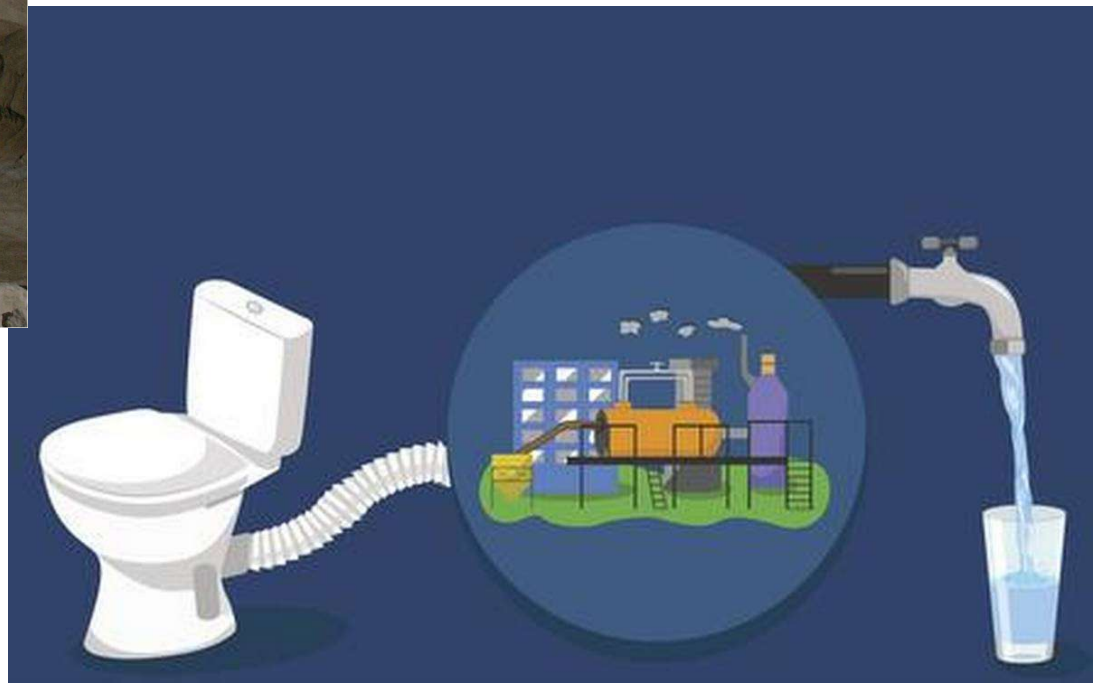
How to get the P back to agricultural fields?

- Rock P is a scarce resource
- Is recycling a better option?
- Several reasons to take a look at nutrients, organic matter and water in sewage!

Organic agriculture allows the use of rock phosphate…



https://www.thehindubusinessline.com/specials/india-file/waste-water-everywhere-recycle-it/article24436356.ece#

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Struvite – proposed by EGTOP in 2016 to be permitted in organic agriculture in EU

- Struvite: Plant available, not water soluble
- Formed when phosphate precipitates with magnesium and ammonium
- Permitted for use in Canada, Japan, most of USA, Belgium, Denmark, Germany, Switzerland , Netherlands and Norway, but not yet in the EU

- 6 % N , 13 % P, 10% Mg

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«Long»-term field experiment «SoilEffects» used to study application of struvite

«SoilEffects» compares since 2011 digested and raw dairy cow slurry in two amounts: is digestion for biogas negative for soil quality?

SoilEffects: experimental design

- Initiated in 2011, 40 plots 3 m x 8 m defined in a 2nd year grass-clover ley on low P soil (P-AL 2-3 mg/100 g soil)
- Aimed at studying long-term effects on soil characteristics when manure is anaerobically digested for biogas production
- Ley re-established with barley or oats as cover crop in 2014 and 2019; such years used to measure after-effect of manure applied to ley in former seasons
- 2011-2013, 20 plots used for ley, 20 for arable crops (oats, ryegrass, spring wheat)
- 2014 ley sown on all plots
- Since 2015, 8 replicate plots of 5 treatments:
- Control (no manure)
- Low manure level, raw slurry (110 kg N/ha * y; ca. 30 tons)
- Low maure level, digested slurry
- High manure level, raw slurry (220 kg N/ha * y; ca. 60 tons)
- High manure level, digested slurry

soil effects

2016: Ground marble applied on 20 plots in spring
2018: Struvite applied on 20 plots in spring

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Hias IKS sewage plant, Hamar, Norway

Hias-struvite applied
to field plots, late April 2018

Large yield increase in control + with low manure level

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Main effects of struvite application (40 kg/ha)

- Increased plant production
- Increased plant P concentrations
- No increase in plant N concentrations - mineral N used to produce plant material?
- Increased soil extractable P (Olsen, AL)

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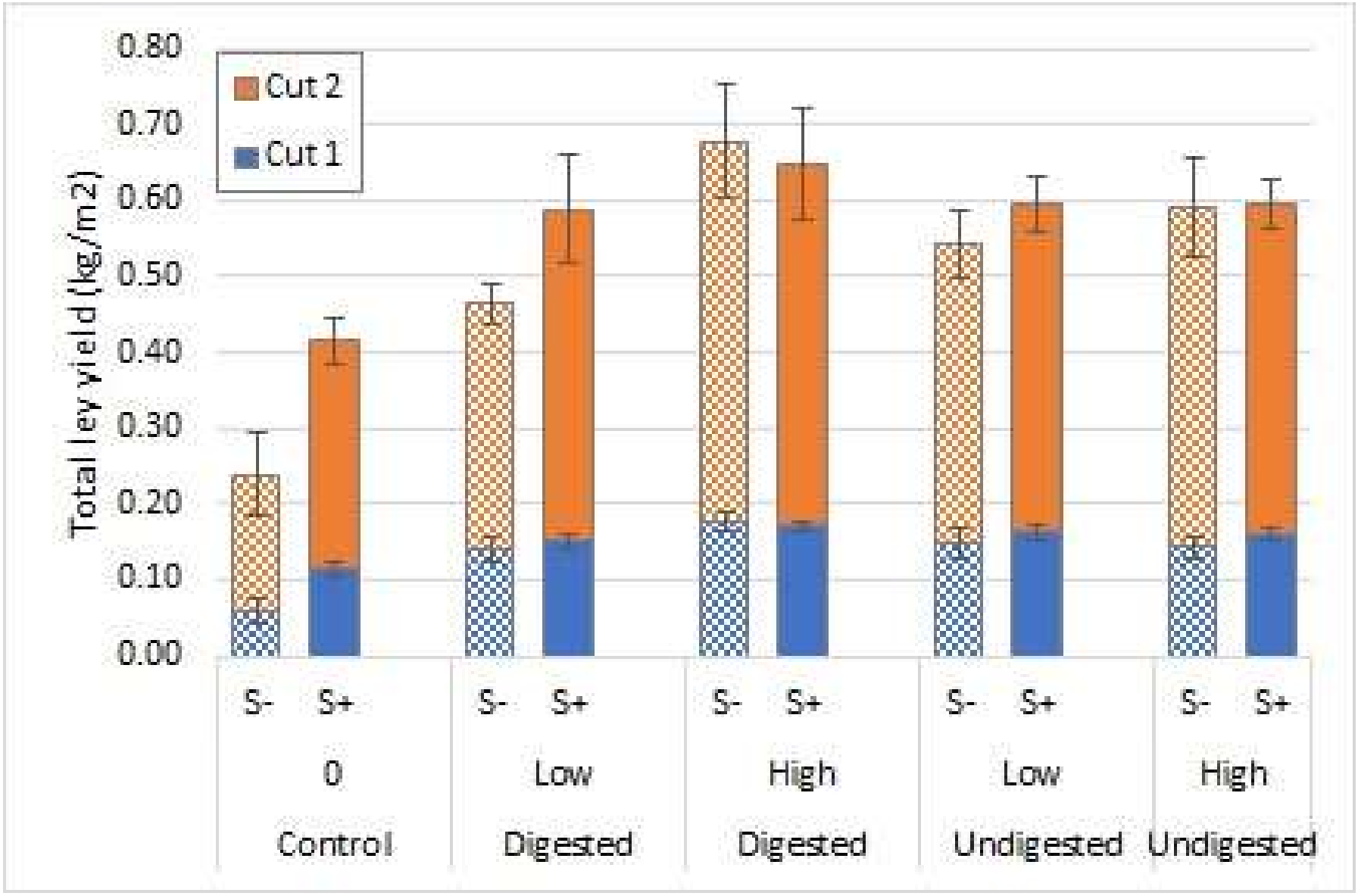
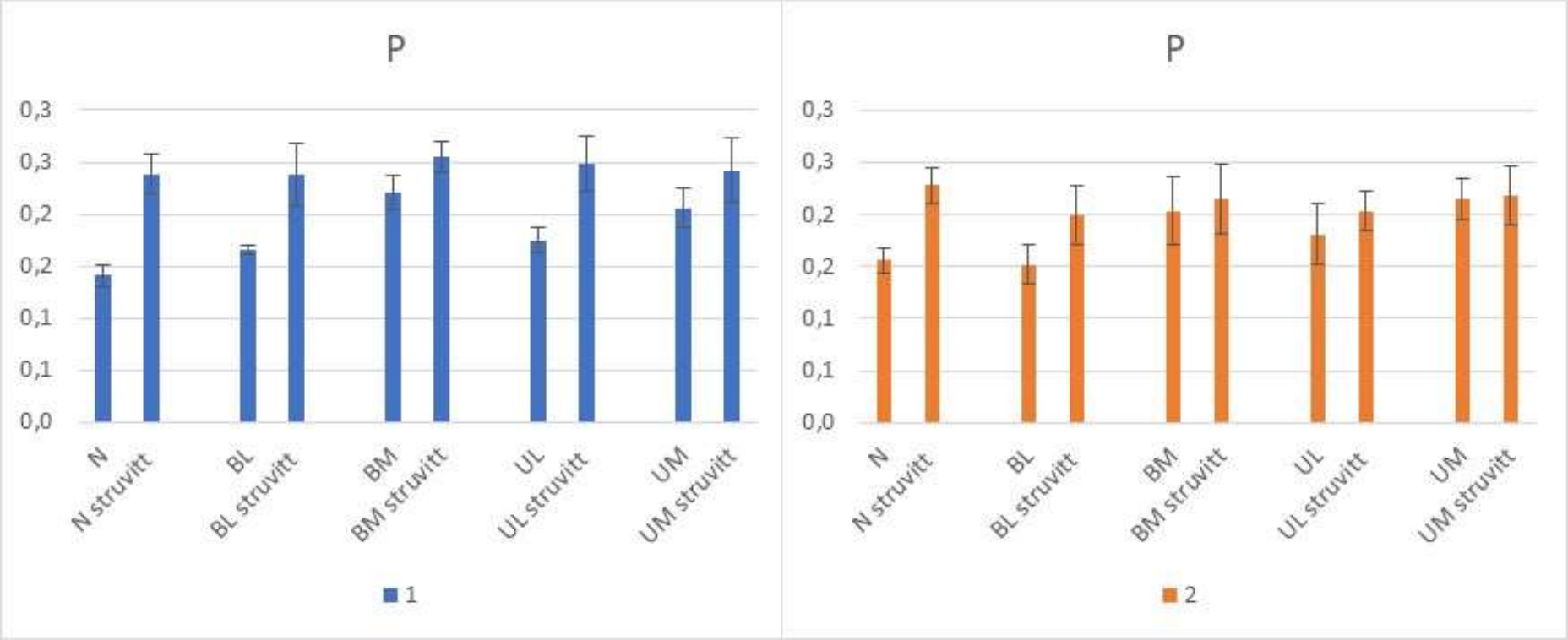
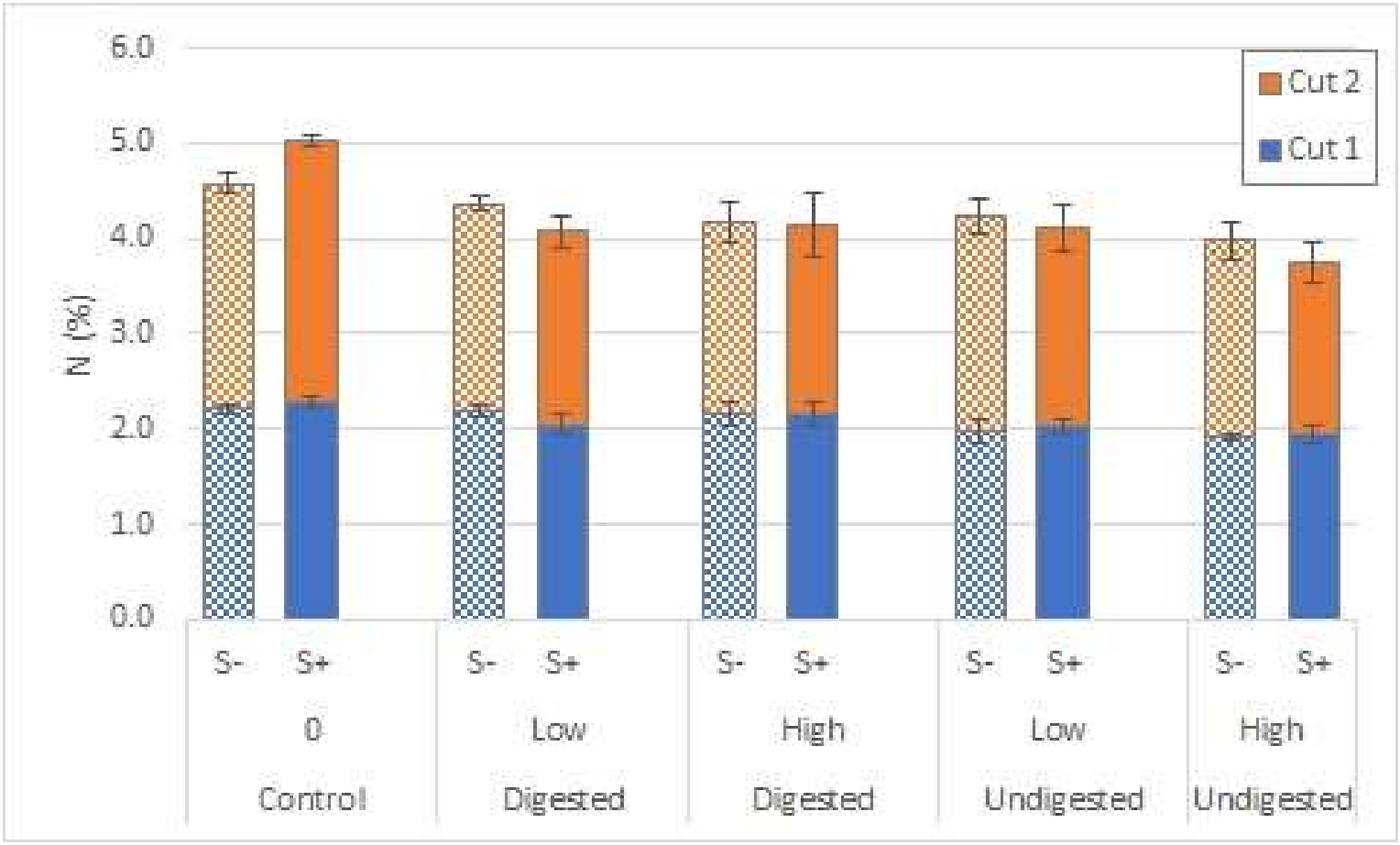
Yields increased significantly with no or low manure application



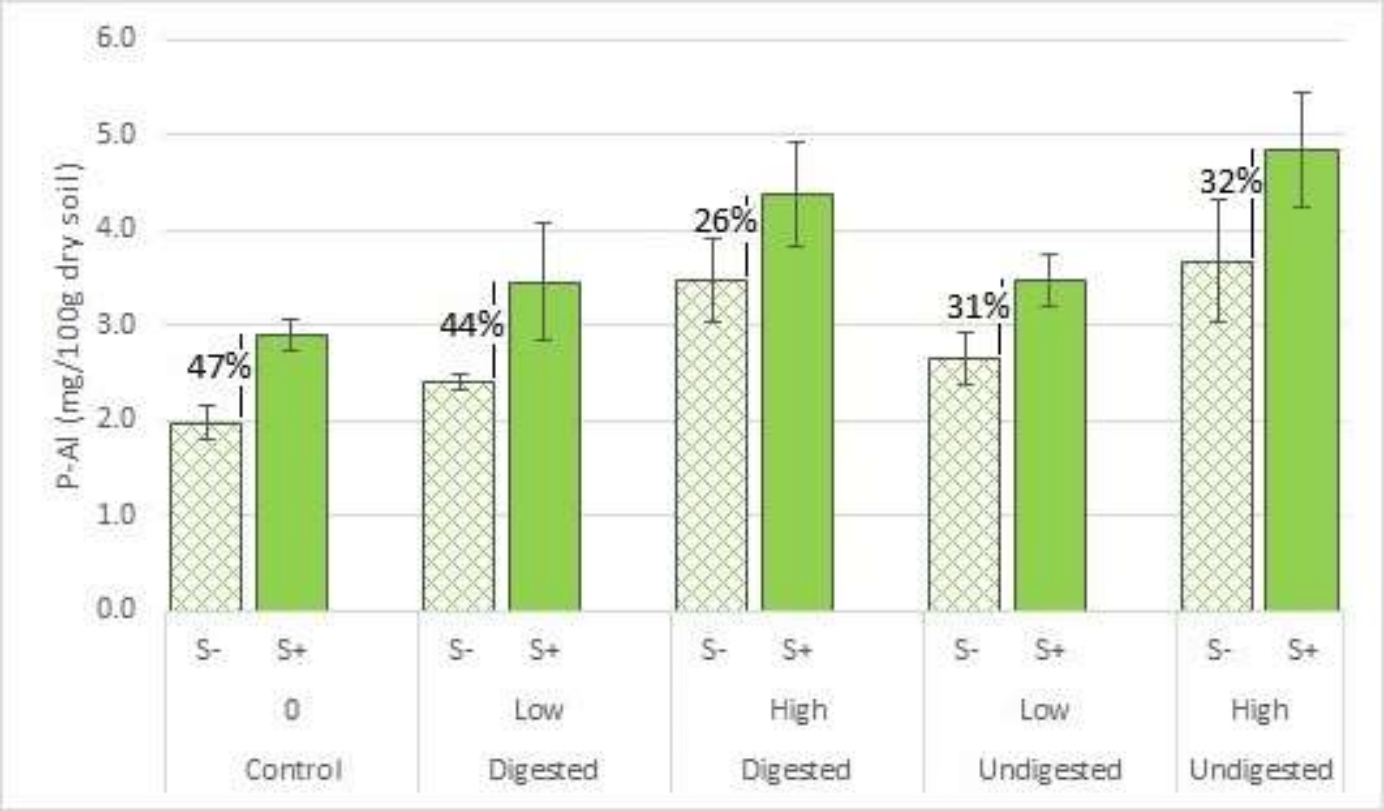
Increase in plant P concentrations (% DM), especially in 1st cut



Struvite slightly decreased plant N concentration except in control: Applied N used to produce organic matter



Soil P-AL increased significantly in all treatments with struvite (40 kg/ha)



- Average start value of soil P-AL=2.6

- Applied over 7 years in manure:
- 85 kg P/ha, low
- 170 kg P/ha, high

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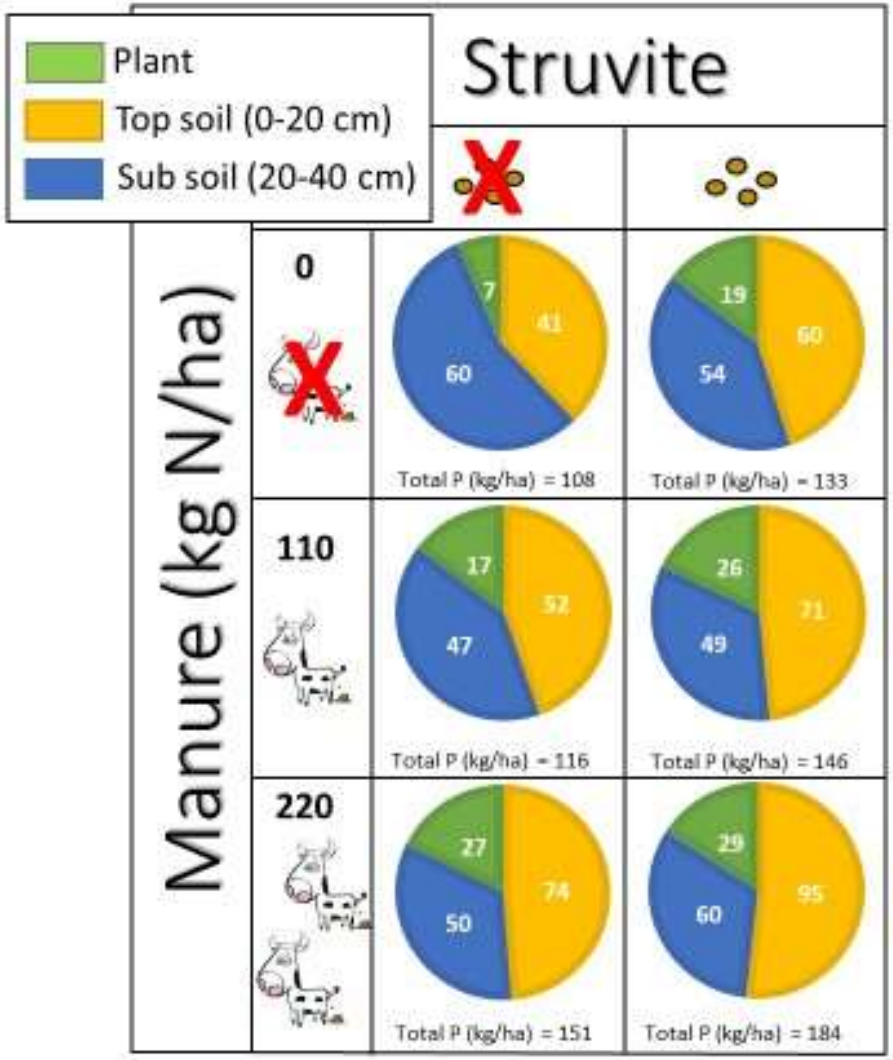
Fate of struvite applied in early spring 2018 (40 kg P/ha): In plants, topsoil, subsoil or unexplained?



- About 30 kg P/ha «recovered» as P in aboveground plant material, topsoil P-AL and subsoil P-AL

- control: 133- 108 = 25 kg
- low level 146 -116 = 30 kg
- high level 184 -151 = 33 kg

- Unexplained: in plant roots and stubble, in soil P not extractable by ammonium-acetate lactate, lost by leaching and/or unaccuracy

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Conclusion

An application of 40 kg P/ha of struvite increased plant yield, and P concentrations especially in the 1st cut (dry summer)

A significant proportion of P was recovered as soil P-AL

Struvite is a mineral fertiliser which is well suited to replace P removed in products (and lost to water) from organic farming systems

EU should approve struvite in organic farming, to maintain soil fertility in organically managed soil.

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Relevant publications

- Løes & Øgaard 1997: Changes in the nutrient content of agricultural soil on conversion to organic arming, in relation to farm level nutrient balances and soil contents of clay and organic matter. Acta Agric. Scand. Sect. B., Soil Plant Sci. 47: 201-214. http://orgprints.org/5945/

- Løes & Øgaard 2001: Long-term changes in extractable soil P in organic dairy farming systems. Plant and Soil 237: 321-332.

- Løes & Ebbesvik 2017: Phosphorus deficits by long-term organic dairy farming? 19th Organic World Congress, New Dehli, India Nov 9-11, 2017. http://orgprints.org/32708/

- Rittl, Krogstad, Eikås, Saltnes, Sørensen, Glestad & Løes 2019: Effects of struvite application on soil and plants: a short-term field study. NORSØK report vol. 4 no. 10, 2019. http://orgprints.org/36472/

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