

From waste disposal to a scientifically justified use of phosphorus in animal manure

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Introduction

Modern animal production with large production units has created areas with surplus of manure phosphorus (P) compared to the local plant requirement, with accumulation of P in soil and increased P leaching potential. We estimated plant P demand at municipality level by considering both soil test P (STP) values and local manure P production.

Material and methods

STP values (P_{aaacr} pH 4.65) and soil texture were obtained from commercial soil laboratories and based on soil samples (about 1 million, representing about 95% of field area) taken by farmers in 2005-2009. Total number of animals at a municipality level was provided by the Information Centre of the Ministry of Agriculture and Forestry, Saga Furs Oyj, Copenhagen Fur and Finnish trotting and breeding association. Total amount of manure P produced by each category of animals was estimated according to feeding trials conducted at MTT. Requirement of P fertilizer to obtain 95% of the maximum yield was calculated for each municipality based on yield response equations of Valkama et al. (2011), assuming cereals and grass to cover the cultivated area.

Results and discussion

The average STP value for all soil samples was 13.0 mg l^{-1} . For clay, coarse textured mineral and organic soils 12.3 , 13.9 and 9.8 mg l^{-1} , respectively, with the highest values found in South-West Finland and Ostrobothnia regions (Fig. 1). According to Valkama et al. (2011), STP values of 6, 10 and 15 mg l^{-1} for clay, coarse textured mineral and organic soils, respectively, are sufficient to produce 95% of the maximum yield without P fertilization.

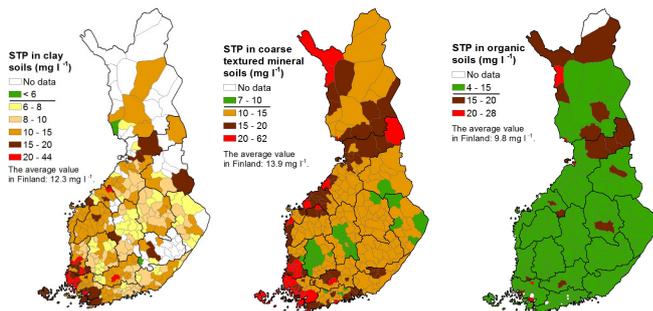


Figure 1. Average STP values at a municipality level according to soil textural classes. Green colour indicate need for P fertilization.

Of the analyzed soil samples, 48.6% had such a high STP value that P fertilization is unlikely to increase yield. For clay, coarse textured mineral and organic soils the respective values were 69.47 and 14% (Fig. 2).

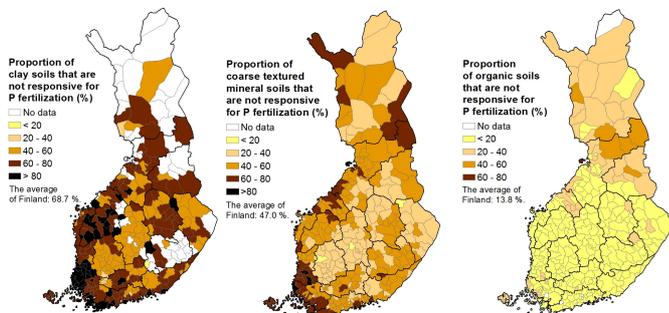


Figure 2. Proportion of clay, coarser mineral and organic soils at a municipality level that are not responsive for P fertilization.

Since past P fertilization has increased the STP values (Fig. 1), current average requirement for P fertilization is 8.6 kg ha^{-1} (Fig. 3). Ideally, this could be totally covered with manure (Fig. 4) that contains 8.8 kg P ha^{-1} if distributed evenly across cultivated fields, excluding the fallows.

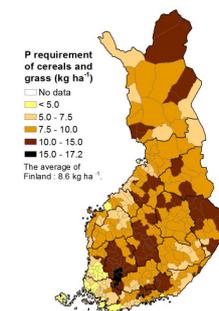


Figure 3. Requirement of P by cereals and grass at a municipality level to produce 95% of the maximum yield.

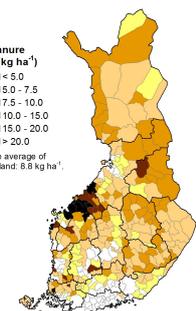


Figure 4. Production of manure P at a municipality level.

However, animal production is concentrated in Ostrobothnia (cattle and fur animals), in South-West Finland (pig and poultry) and in eastern Finland (cattle) regions. New methods for manure processing are required to distribute manure P to areas where yield responses are likely (Fig. 5). This would reduce the use of mineral P fertilizer (5.6 kg ha^{-1} in 2011) and ultimately the P leaching potential.

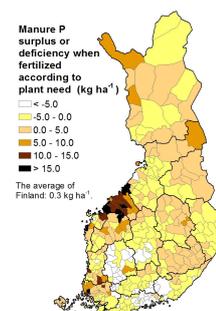


Figure 5. Surplus or deficit of P if manure P would be used as the sole P fertilizer.

References: Valkama, E., Uusitalo, R., and Turtola, E. 2011. Yield response models to phosphorus application: a research synthesis of Finnish field trials to optimize fertilizer P use of cereals. *Nutrient Cycling in Agroecosystems* 91: 1-15.