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Soil, plant and environmental indicators to minimize phosphate inputs in permanent grasslands

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Motivation: Phosphorus (P) is an essential nutrient for plant growth. However, P losses from over-fertilized grasslands in areas with high livestock density are still a major cause for eutrophication of surface waters (Fig. 1). Since agro-ecological measures to decrease P losses (e.g. P balance at farm level) were not fully successful in Switzerland and most of the P losses derive from Critical Source Areas, a plot specific investigation is needed. The complexity of the grassland ecosystem suggests the necessity to consider several plant and soil parameters for proper assessment of P fertilisation strategies.

The aim of this project is to propose a set of soil, plant and environmental indicators to propose strategies to limit P inputs into permanent grasslands to reduce the risk of P losses to the hydrosphere, while maintaining sufficient P supply for high yields.

Fig. 1: Heavy eutrophication in lakes

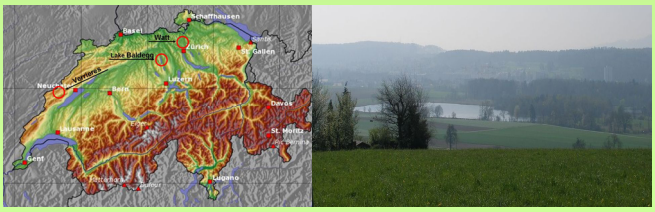

Fig. 2: Experimental sites in Switzerland (left) and grassland near Watt (right)

Locations:

- Three grassland sites, which differ in use intensity (cutting regime), fertilization, soil type, altitude and local climate.
- Located at Watt / Reckenholz (extensive use), Verrieres (semi intensive use) and Lake Baldegg (intensive use).

1) **Soil:**

- Potential contribution of different P pools in soils to the P in soil solution, (Fig. 3)
- Availability of P for plants
- Trace the fate of manure P in the soil / manure / plant / water system by measuring the natural abundance of ^{18}O in PO_4 groups

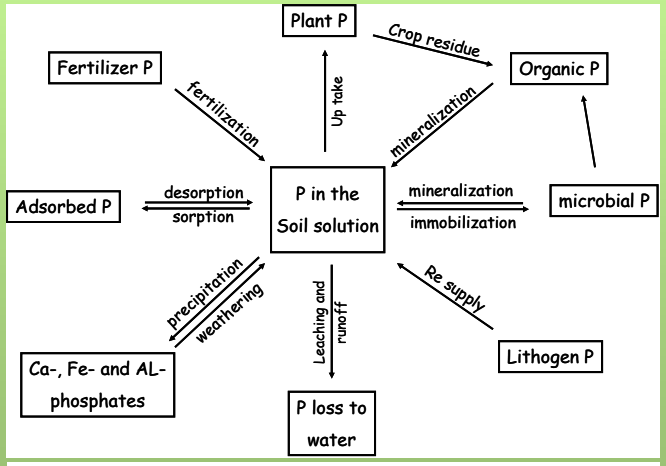

Fig 3: Different P pools contributing to the soil solution

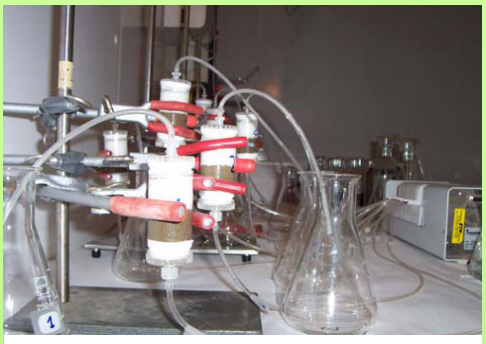

Fig. 4: Flow-through column experiments with ^{33}P-labeled soils for determination of the risk of P losses by leaching.

2) **Risk estimation for P losses**

- Identification of P pools with high risk of losses
- Estimation of P losses by leaching (Fig. 4) or run off
- Environmental factors favoring P losses

3) **Botanical composition:**

- Biodiversity and potential indicator plants (Fig. 5)
- Yield
- Plant nutrient concentrations (analysed for the 3 botanical fractions grass, legumes and herbs)
- Calculation of the P nutrition index (PNI), plant P uptake and nutrient balances

Fig. 5: Diversity in a grassland with extensive use near Watt

The work will be carried out in collaboration with the Department of Earth Sciences of the ETH, the Agricultural Research Stations ART Reckenholz and ACW Changins, and the canton Luzern. This project contributes directly to the objectives of the working group 3 “Mitigation options” of the COST action 869.