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Tracing the fate of ^{15}N-labelled animal manure in the environment

Background

- **Nitrate leaching threatens** both the environment and drinking water quality
- Switzerland ca. 380,000 ha with > 25 mg nitrate/L in groundwater (quality criteria for drinking water) [1]; the *Gäu* region (Canton Solothurn) is especially vulnerable
- **Organic fertilizers** (slurry, farmyard manure, etc.) might entail considerably increased leaching risks due to variable nitrogen (N) content and availability
- **Aim:** increase N use efficiency, simultaneously reduce leaching

Research questions

- How much N is lost from cattle slurry by **leaching**?
- Can slurry treatments improve **N use efficiency** of cattle slurry and reduce leaching risk?

Production of ^{15}N-labelled ryegrass hay

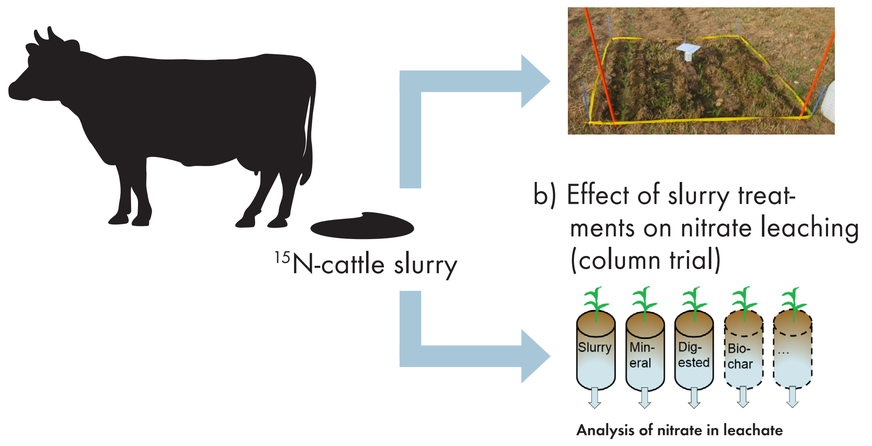

Fig. 1: Experimental approach

Expected outcome

- Field data on N use efficiency, leaching losses, and residual effect of fertilizers over several years
- Better understanding of processes behind formation of stable soil organic N pools
- Identification of measures for reducing nitrate leaching from slurry

Material and Methods

- **^{15}N-labelled animal manure** was produced by feeding a cattle with ^{15}N-labelled ryegrass hay (*L. multiflorum*) over several days (Fig. 1 & 2)
- In a **microplot study** (Fig. 1a), fate of N from labelled fertilizers will be tracked over 2.5 years
- effect of slurry treatments on nitrate leaching and N use efficiency will be investigated in a **column trial** (Fig. 1b)
- (possible) treatments for column trial: anaerobic digestion, mixing with straw + composting, nitrification inhibitors, biochar, magnesia, etc.

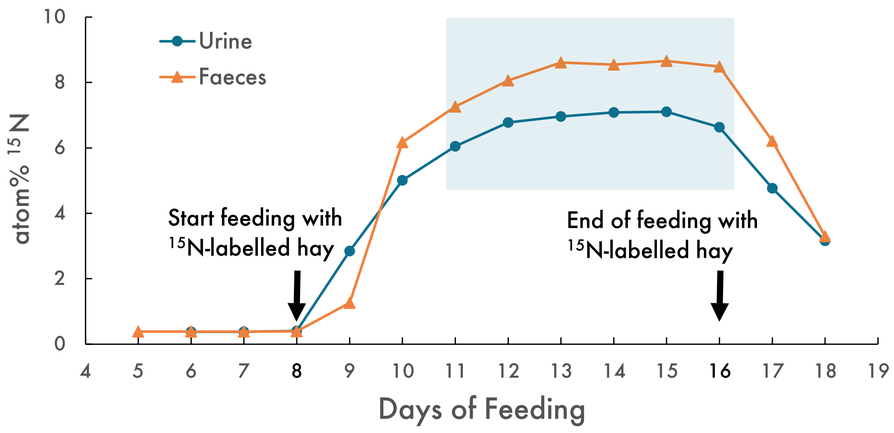

Fig. 2: Development of ^{15}N-enrichment in cattle manure over time

Experimental approach field study

Year	Field A	Field B
2018	Grass-clover / Maize	Grass-clover
2019	Winter wheat	Grass-clover / Maize
2020	Cover crop	Winter wheat

Fig. 3: Crop rotation at the two field sites for the microplot study in the *Gäu* region, Switzerland

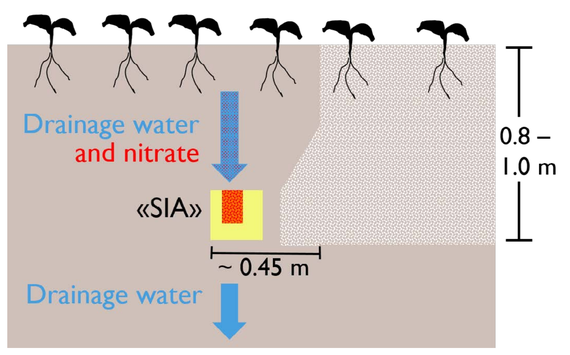

Fig. 4: Assessment of nitrate leaching with „self-integrating accumulators" (SIAs) (adapted after TerrAquat 2017)

- Two field sites with shifted crop rotation (Fig. 3) (soil type cambisol)
- Treatments: ^{15}N-slurry, ^{15}N-mineral fertilizer, 0N-control; ^{15}N-labelled fertilizers will be applied only in 2018
- Aim: Tracing the **fate of fertilizer N in the field** over 2.5 years and establishing a full soil-system **N-balance** by (repeatedly) analysing
  - ammonia emissions (only upon fertilizer application)
  - N uptake by the crop
  - Residual N in the soil (mineral, microbial, organic N)
  - nitrate in drainage water (via self-integrating accumulators [SIAs] [Fig. 4]); method based on ion exchange resin, exchanged after each crop [2]

References
[1] Prasuhn, V., Kupferschmied, P., Spiess, E., Hürdler, J. 2016. Szenario-Berechnungen für das Projekt zur Verminderung diffuser Nährstoffeinträge in die Gewässer der Schweiz mit MODIFFUS. Bundesamt für Umwelt BAFU.
[2] Bischoff, W.-A. 2007. Development and applications of the self-integrating accumulators: A method to quantify the leaching losses of environmentally relevant substances. PhD thesis, TU Berlin.

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