Nutritive value of *Alnus viridis* leaves and nitrogen translocation by Highland cattle in *Alnus* viridis-encroached pastures

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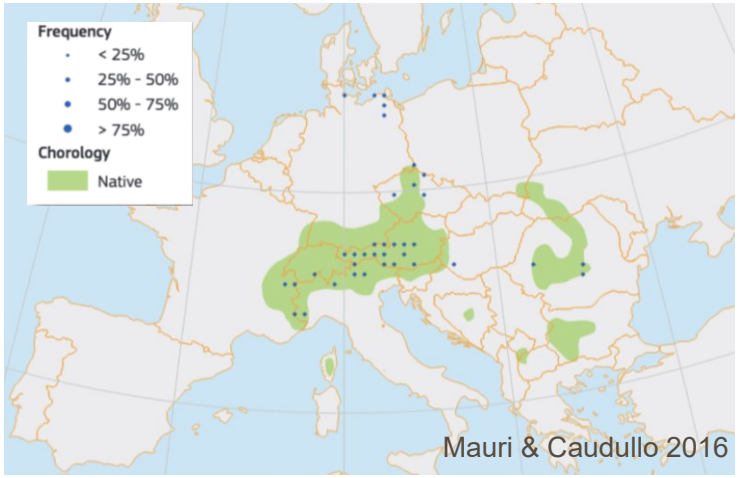
***Alnus viridis* (green alder)** is a pioneer shrub species that invades subalpine pastures.

Features:

- Rapid growth
- Most rapidly expanding shrub species in Central Europe due to grassland abandonment
- Represents **70%** of shrubland cover of Switzerland
- Symbiosis with nitrogen-fixing actinomycete (*Frankia alni*)



Sources: Farmer et al. 1985; Houle 2001; Anthelme et al. 2002

Alnus viridis encroachment produces several agro-environmental issues:

- A loss of grassland areas (reduced agricultural production)
- Nitrogen enrichment (N-fixing species)
- Nitrates leaching (up to 1.76 g N m^{-2}) and soil acidification
- Emission of N gases (~4.2 kg N_2O-N ha^{-1} $season^{-1}$)
- Decrease in temperature and light, and increase of humidity at the soil level
- Loss of animal and plant biodiversity
- No protection from avalanches (flexible branches) and prevents forest succession
- Change of alpine cultural landscape (tourism)

Sources: Anthelme et al. 2002; Brüchert et al. 2003; Caviezel et al. 2017

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→ Low forage quality for production-oriented breeds (avoidance), which promotes its invasion

Sources: Anthelme et al. 2002; Brüchert et al. 2003; Caviezel et al. 2017

Robust breeds:

Other livestock species have the ability to forage on woody plants, including *Alnus viridis.*

Highland cattle are a robust breed originating from Scotland:

- **Able to graze a large number of woody plants**
- Low maintenance energy requirements
- Higher feeding preference for woody species
- Low veterinary needs
- Able to break branches with their horns
- Able to move in humid and steep areas (low weight)

Highland cattle have great potential to reduce *Alnus viridis* encroachment: goal of the ROBUSTALPS project

Engadine sheep

Peacock goat

Highland cow

Sources: Pauler et al. 2020 (a,b); Berry et al. 2002

Study sites:

Part 1: Nutritional value of *Alnus viridis* leaves and methane emissions

Can Alnus viridis be used to feed robust livestock ?

Part 2: Nitrogen translocation in *Alnus viridis*-encroached alpine pastures

Can Highland cattle be used to translocate nitrogen from N-rich encroached area to N-poor open grasslands?

Part 1: Nutritional value of *Alnus viridis* and impact on greenhouse gas emissions

Svensk et al. 2023 Agriculture, Ecosystems & Environments 364, 108884.

Objectives:

- Assessment of ***Alnus viridis*** **leaf chemical composition**
- **Temporal variation** of leaf composition along the grazing season

→ Is *Alnus viridis* a good forage resource for robust livestock such as Highland cattle?

→ When is the ideal period for grazing in relation to *Alnus viridis* leaf composition?

Methods:

1) Sampling of *Alnus viridis* leaves in 4 sites:

- **3 times** during the grazing season (June, July, August), for two years (2020, 2021)
- **5 trees** selected at each sampling in each site
- At a suitable height for grazing by cows (< 1.80 m high)

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2) Measures and analyses in the laboratory:

- **Leaf composition**:
  - Nitrogen: N
  - Fibers: NDF
  - Phenols: total tannins (TT), condensed tannins (CT)
- **Digestibility and gas**:
  - In vitro OM digestibility (IVOMD)
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Estimation *in vitro* using the rumen fluid of Brown Swiss cows

Comparison between a diet of:

- **20% *Alnus viridis* leaves + 80% hay**
- **100% hay (control)**

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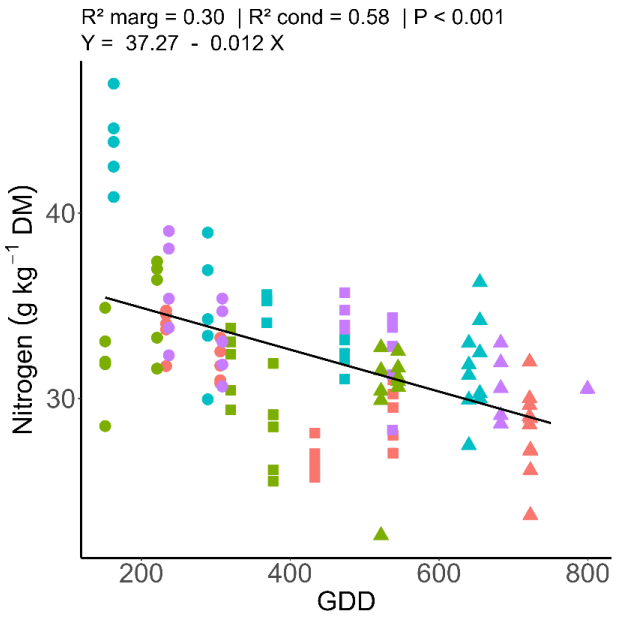
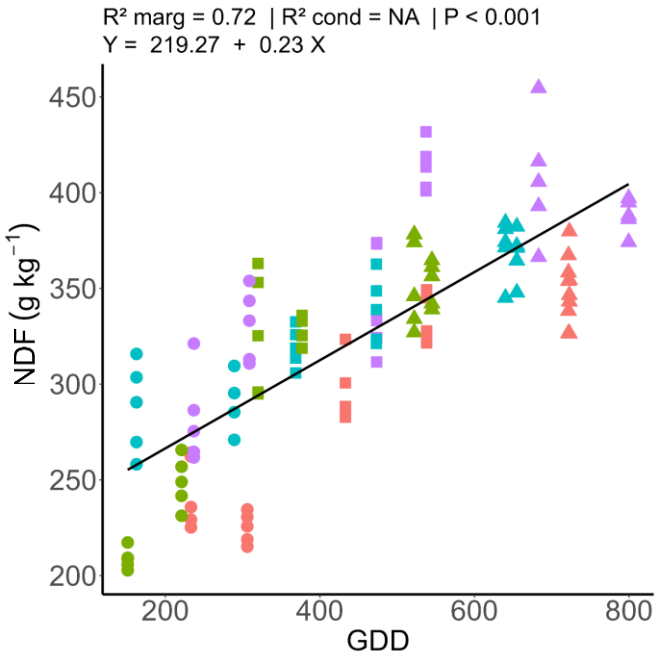
3) Temperature: Growing degree days (GDD) used as a proxy for the seasonal temperature changes

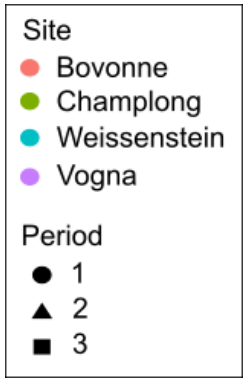
Results:

Leaf chemical composition

- **Higher N content** than usually found in temperate green fodder such as typical leguminous forage species.
- Similar **decrease in N along the season** than for other *Alnus* species.
- Similar range values of fibers than in other *Alnus* species.
- **Leaves become more fibrous from Spring to Autumn**







Year as random effect

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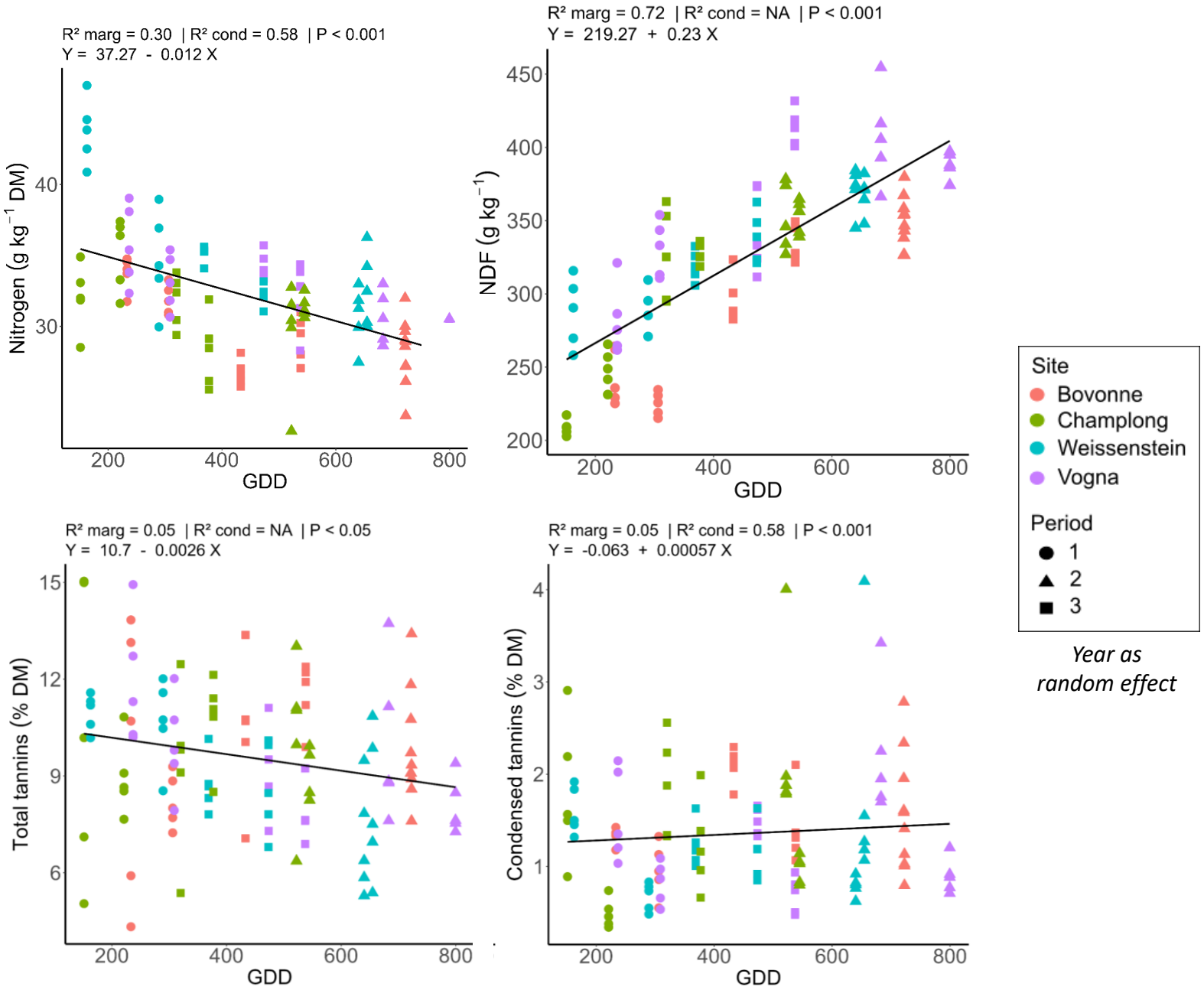
- **Higher leaf TT** concentrations than found in previous studies on *A. viridis.*
- **Constant leaf CT** over the season of about 1.5% (= positive effects)



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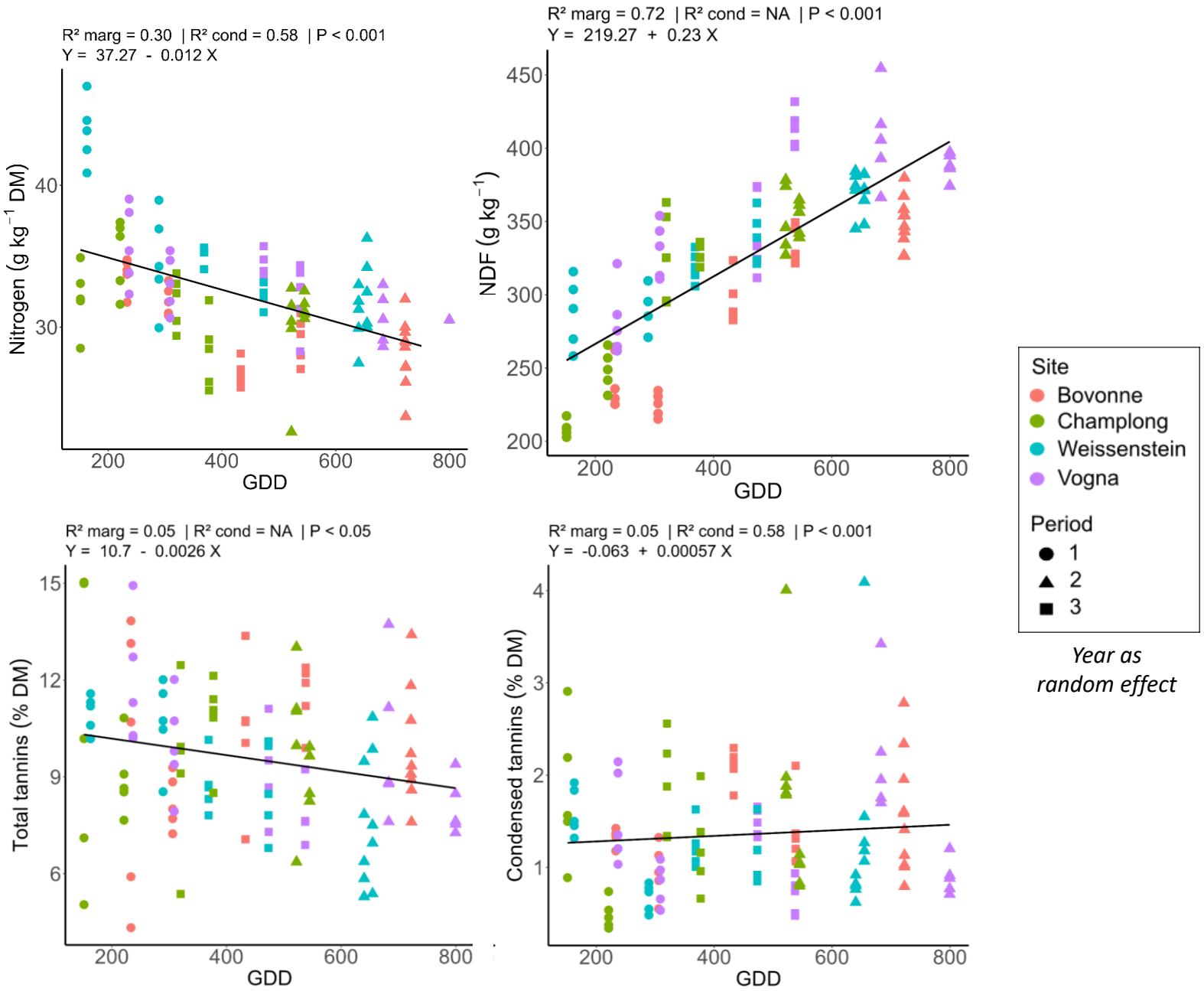
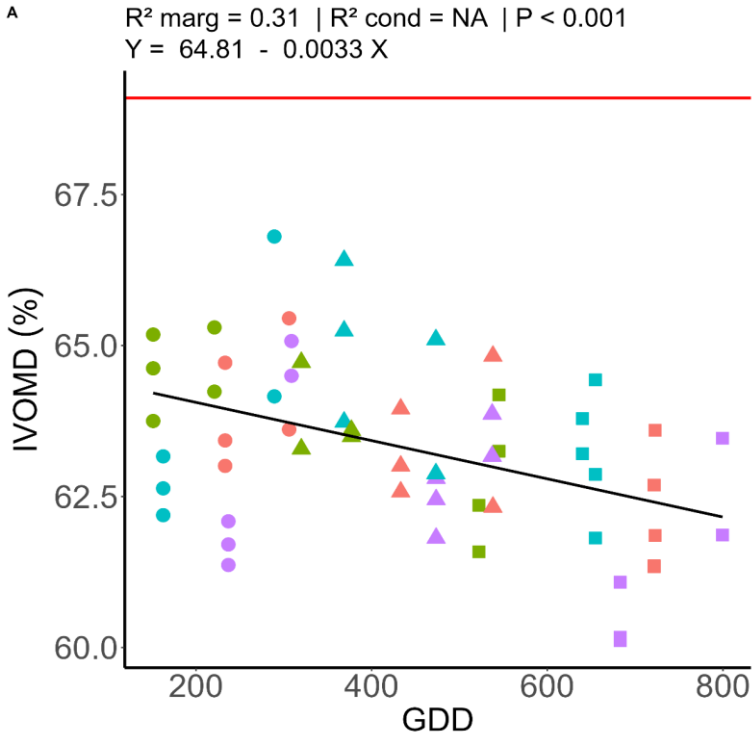
Higher forage quality at the beginning of the summer season

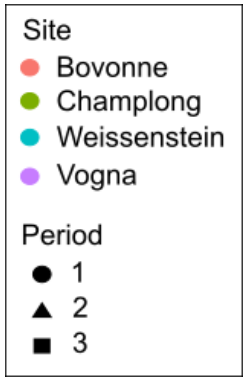


Results:

Digestibility

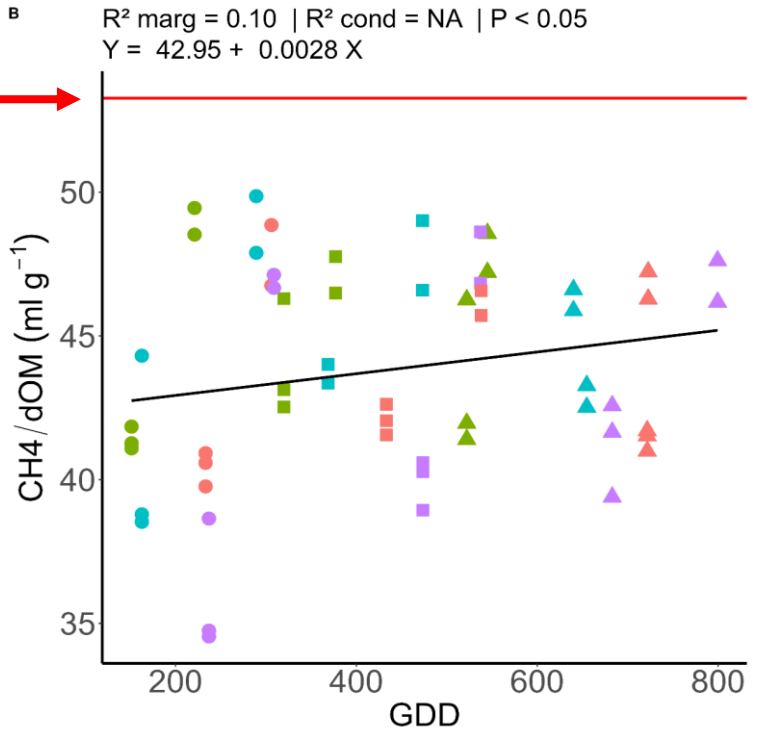


Control (hay)



Year as random effect

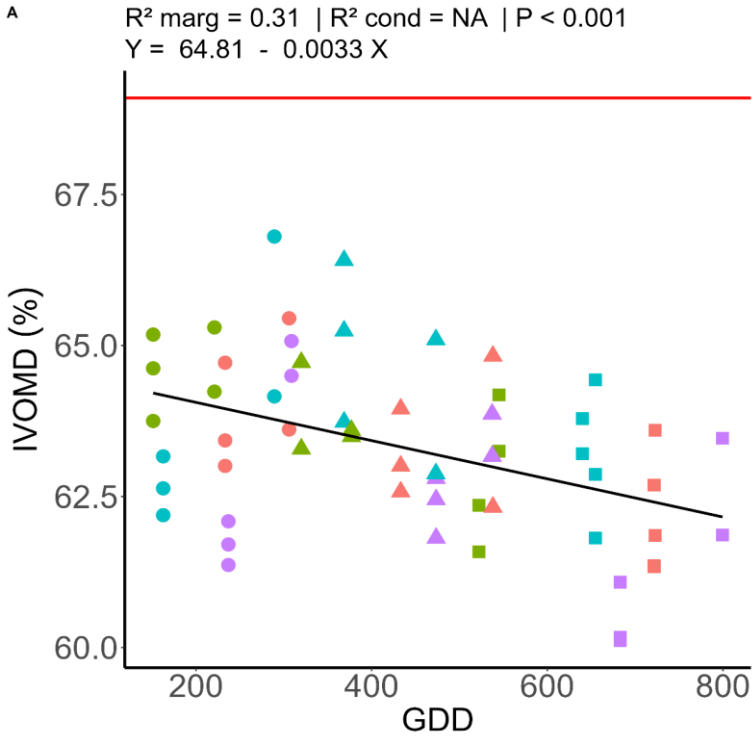
Methane production



- **On average, decrease of digestibility by about 10% and decrease of methane emission by about 20% when the diet is composed by 20% of green alder leaves** by comparison to the control (100% hay)
- Low decrease of leaf digestibility throughout the grazing season
- Relatively constant methane emission throughout the grazing season

Results:

Digestibility



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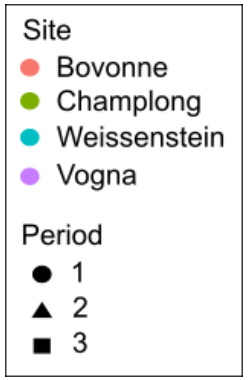

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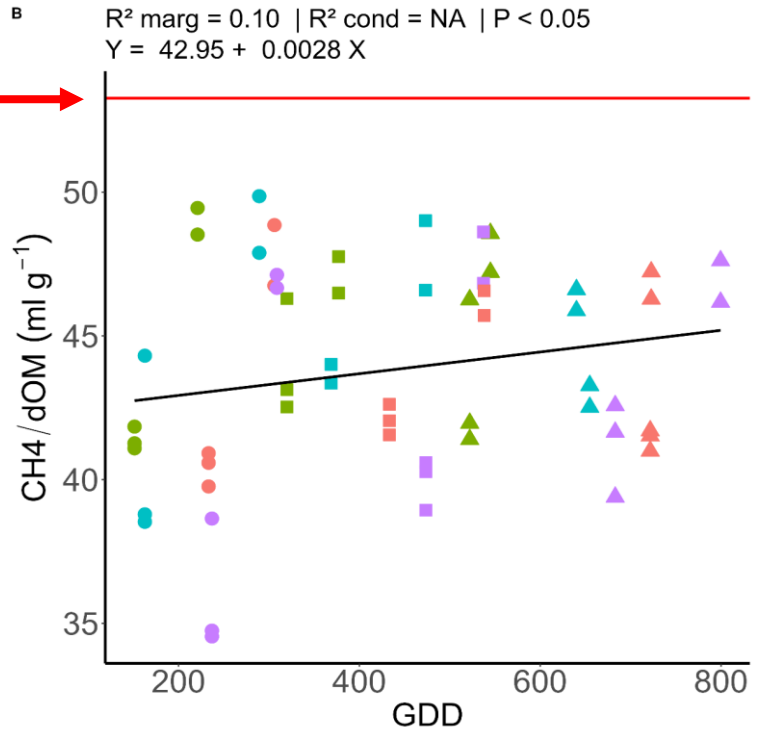

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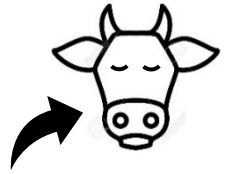
Field conditions



~12% *Alnus viridis* leaves in their diet

We expect 12% reduction in methane emission in field conditions

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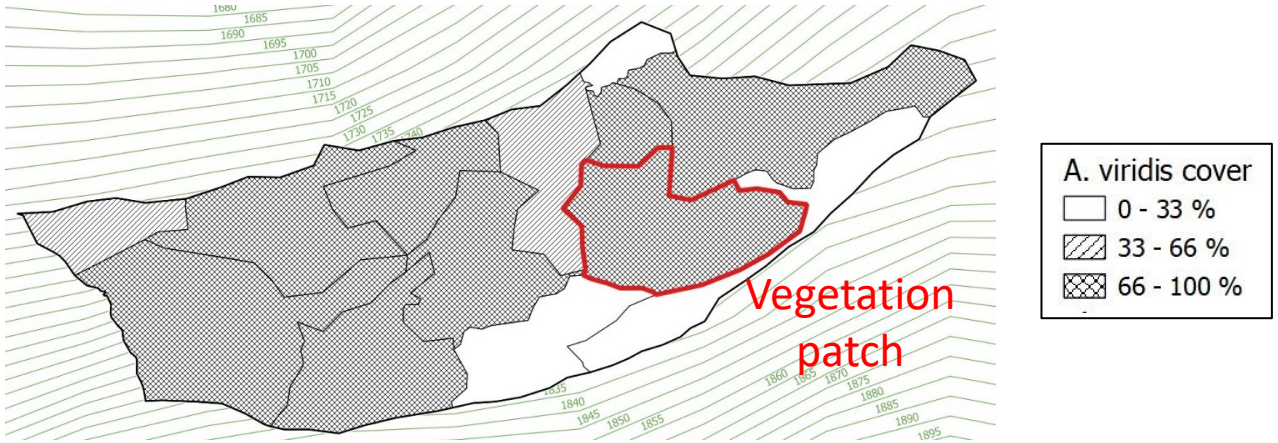
Part 2: Nitrogen translocation by Highland cattle grazing in *Alnus viridis*-encroached pastures

Svensk et al. 2023 Nutrient Cycling in Agroecosystems, 126, 127–141

Objectives:

- Estimate the N ingested by cows in each patch
- Estimate the N excreted by cows in each patch



- Assess the **nitrogen import-export fluxes over the landscape (N balance)**

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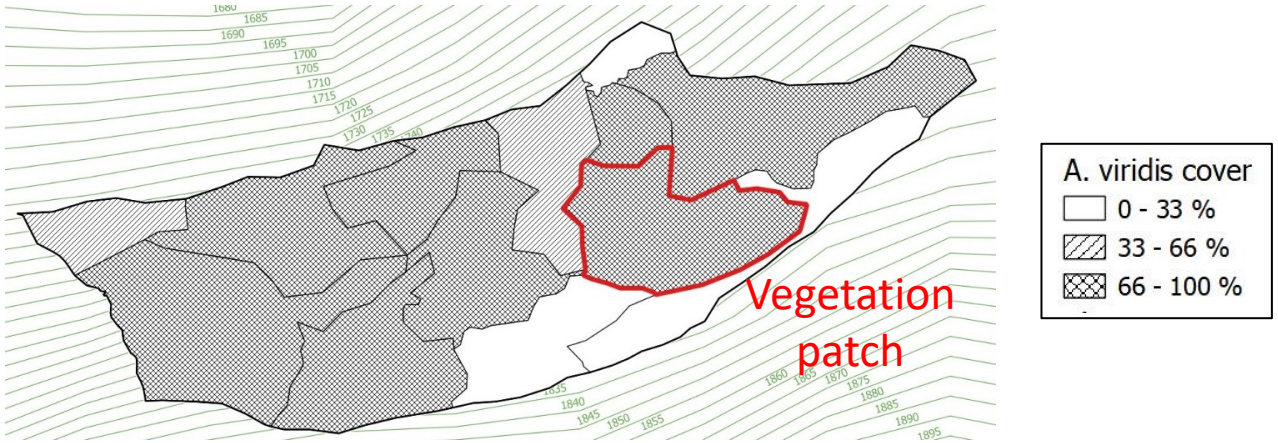

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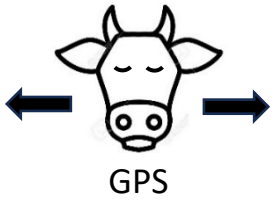
Methods:

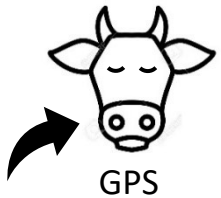
N in vegetation in each patch



GPS

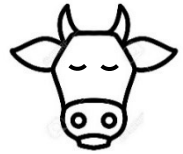
Time spent in each patch

N in *Alnus viridis* leaves

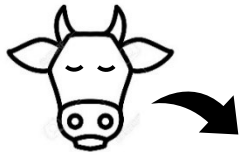


GPS

Time spent grazing each patch

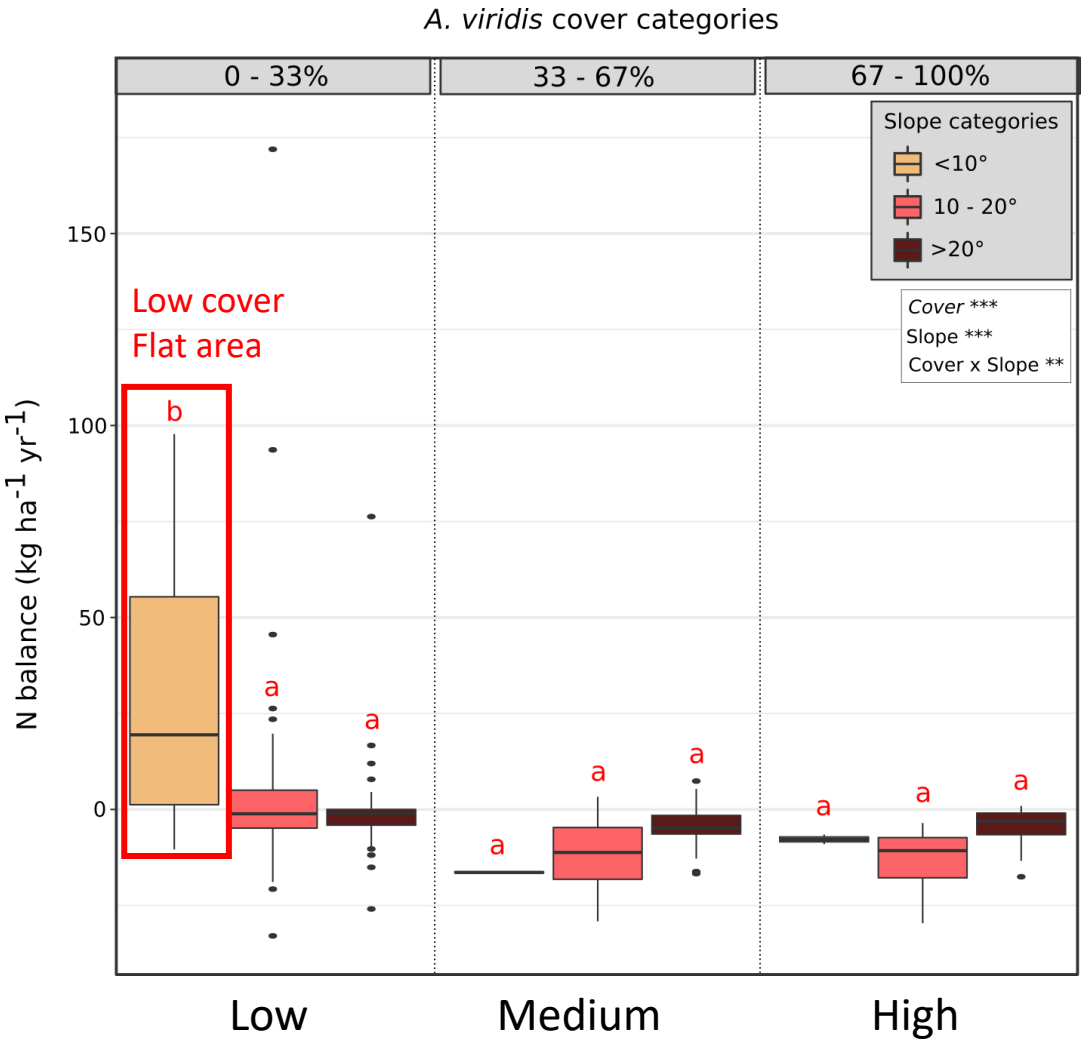


Daily dry matter intake (incl. 12% *A. viridis* in encroached patches)



93% N excreted through urine and feces (literature)

Results: N fluxes

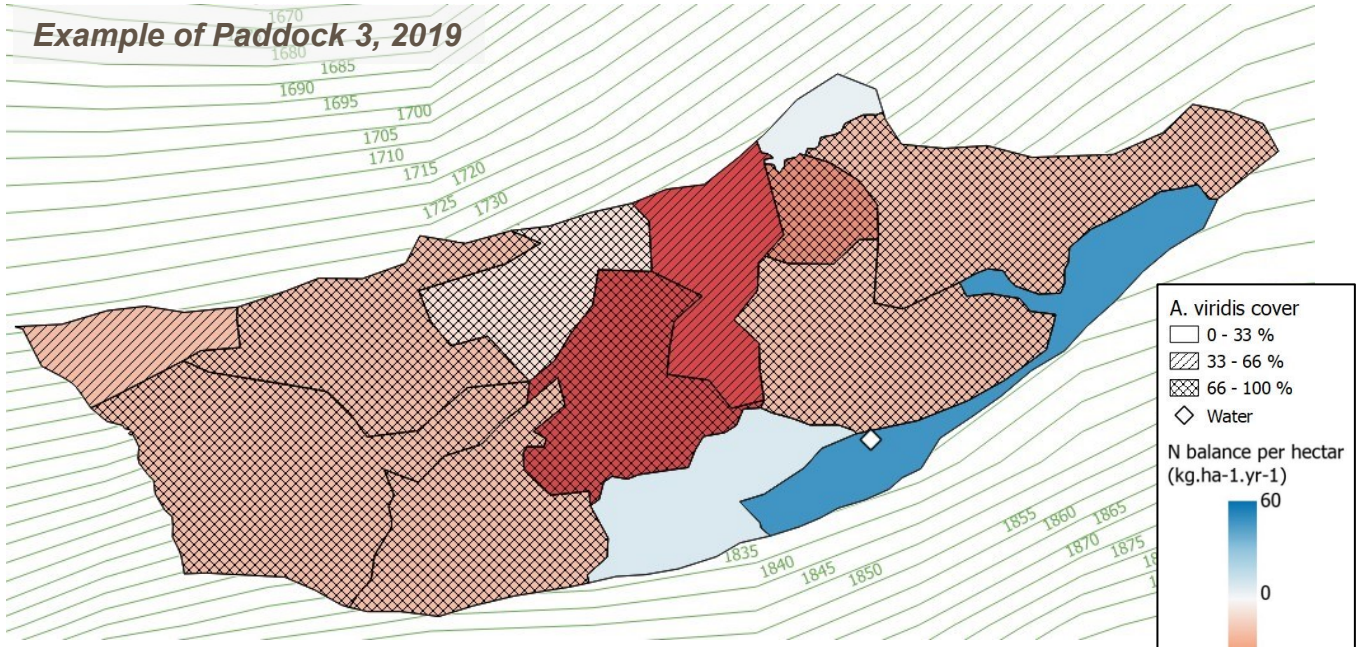


***Alnus viridis* cover**

(include the 3 sites, site as random effect)

- *A. viridis*-encroached (medium and high) and steep areas have overall **negative N fluxes values**
- Flat and open pastures have **positive N fluxes**

There is a significant N accumulation in the open flat (resting) areas, and a N depletion in the highly encroached areas.



Conclusions:

Part 1

- Green alder has real potential to become a **valuable forage resource for robust livestock**.
- The **beginning of the summer season** seems to be the ideal time for grazing.

These results will help to define targeted management strategies in overgrown areas to reduce encroachment, optimize productivity and reduce greenhouse gas emissions (methane)

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- The **beginning of the summer season** seems to be the ideal time for grazing.

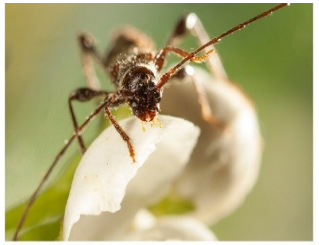
→ **These results will help to define targeted management strategies in overgrown areas to reduce encroachment, optimize productivity and reduce greenhouse gas emissions (methane).**

Part 2

- There is an **effective nitrogen translocation** from the highly encroached areas to the open flat (resting) areas.

→ **Highland cattle can help to moderately fertilize adjacent open pastures and can be used as a strategic management tool to translocate nitrogen.**





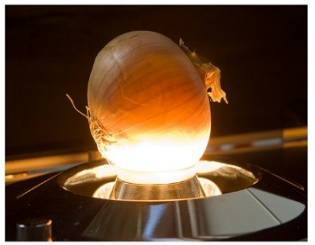










Thank you for your attention

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Grazing of green alder by Highland cattle

#RobustAlpsProject

bit.ly/4aDffGg

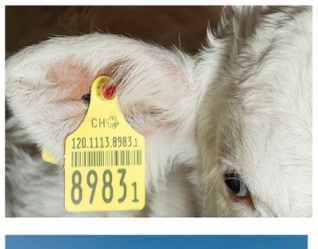
Fodder tree hedgerows

#AgroForageTreeProject

bit.ly/3vvCbsU









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