Restoring *Alnus viridis*-encroached pastures using Highland cattle while providing good forage quality and reducing methane emissions

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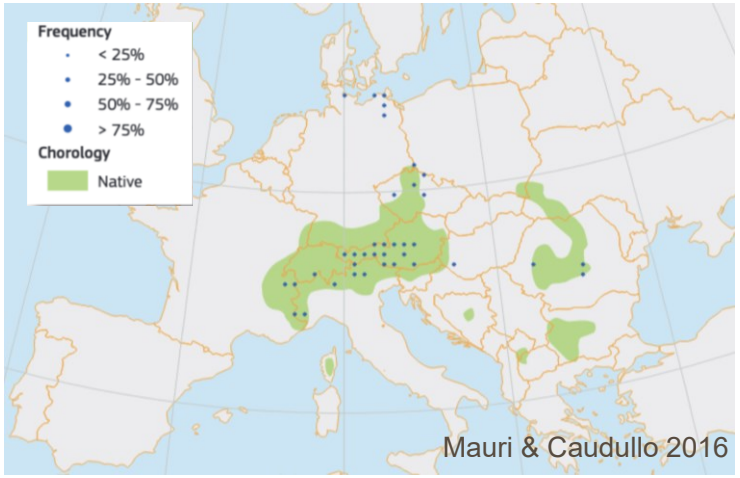
***Alnus viridis* (green alder)** is a pioneer shrub species that invades subalpine pastures.

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 palatability 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)

Engadine sheep

Peacock goat

Highland cow

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

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

Engadine sheep

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Highland cow

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

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
- In vitro analysis of digestibility and methane emissions

Study sites:

→ 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?

→ What are the impacts of *Alnus viridis* consumption on methane emissions?

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)
  - methane emissions (CH_4/dOM)

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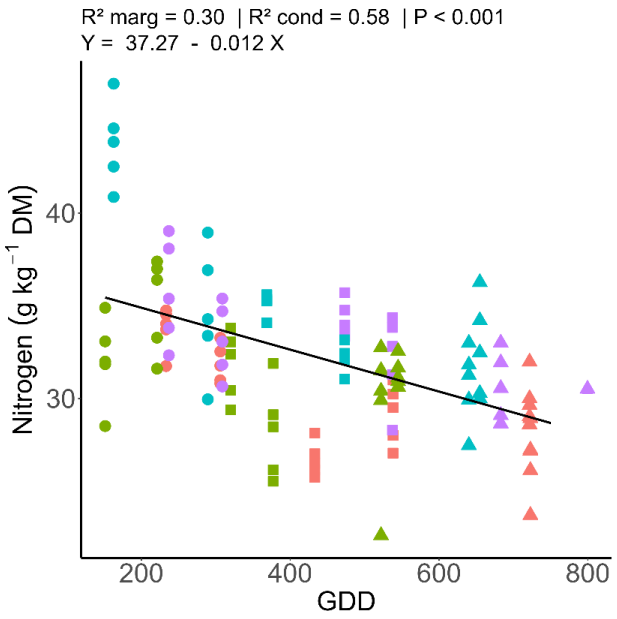
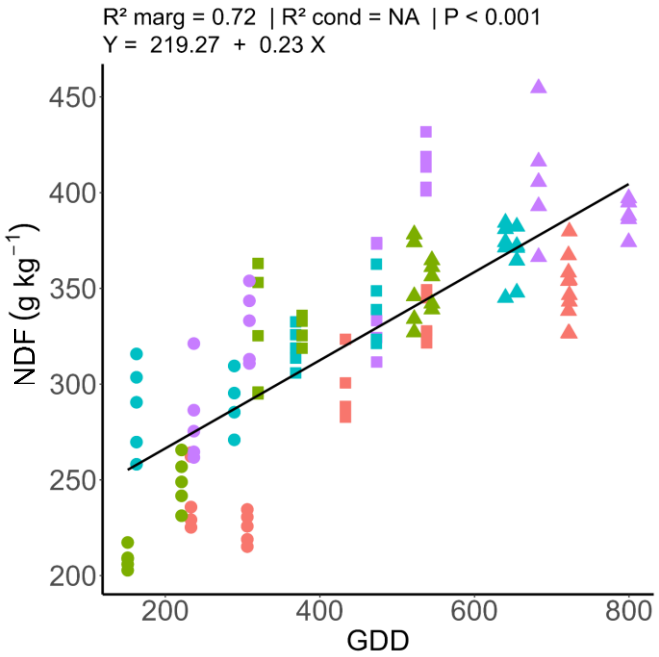
3) Temperature: Growing degree days (GDD) used as a proxy for the seasonal temperature changes

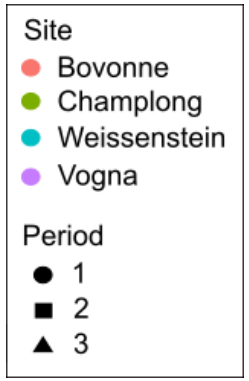
Results:

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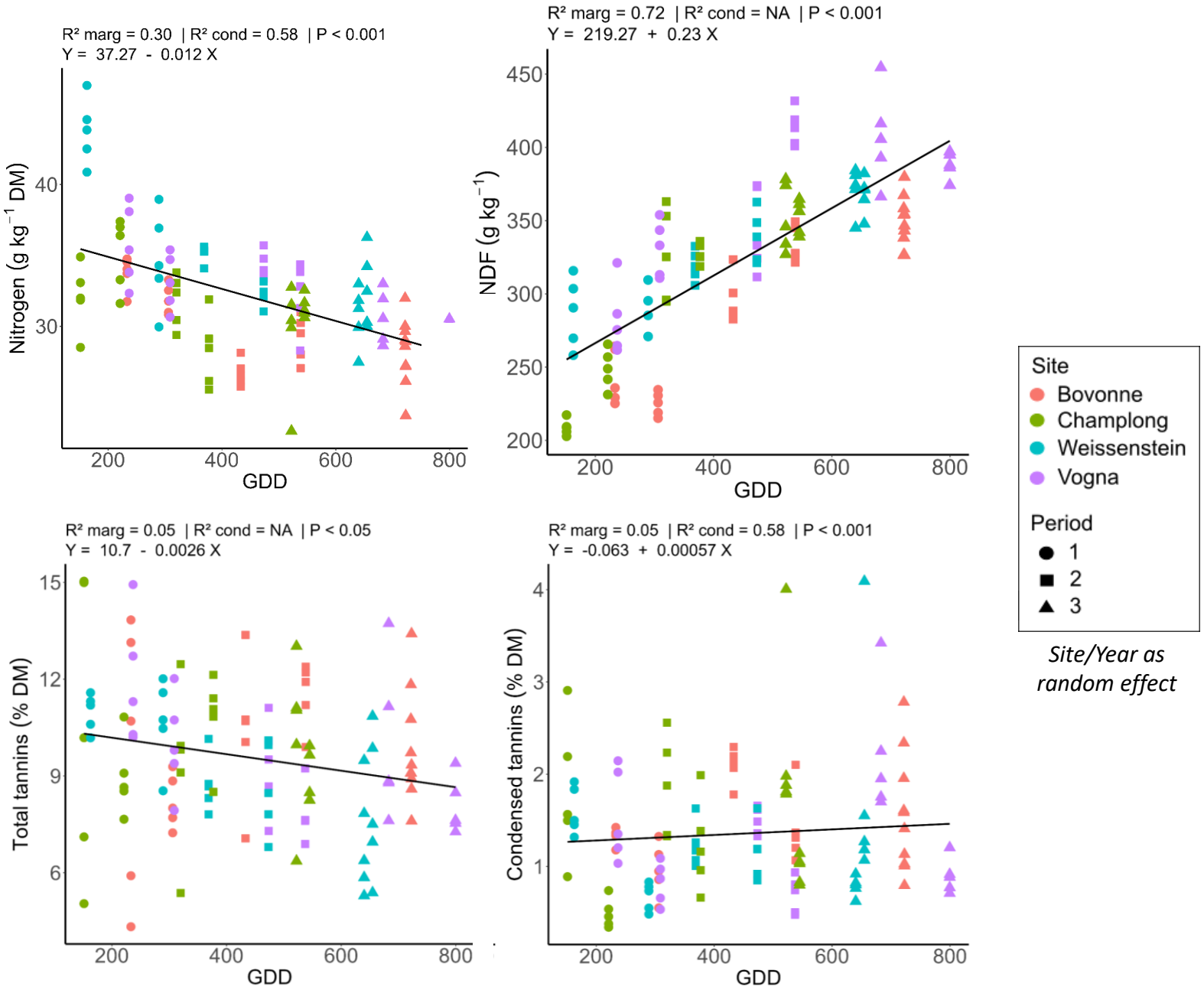
- **Higher leaf TT** concentrations than found in previous studies on *A. viridis.*
- **Constant leaf CT** over the season of about 1.5% (= positive effects)



Site/Year as random effect

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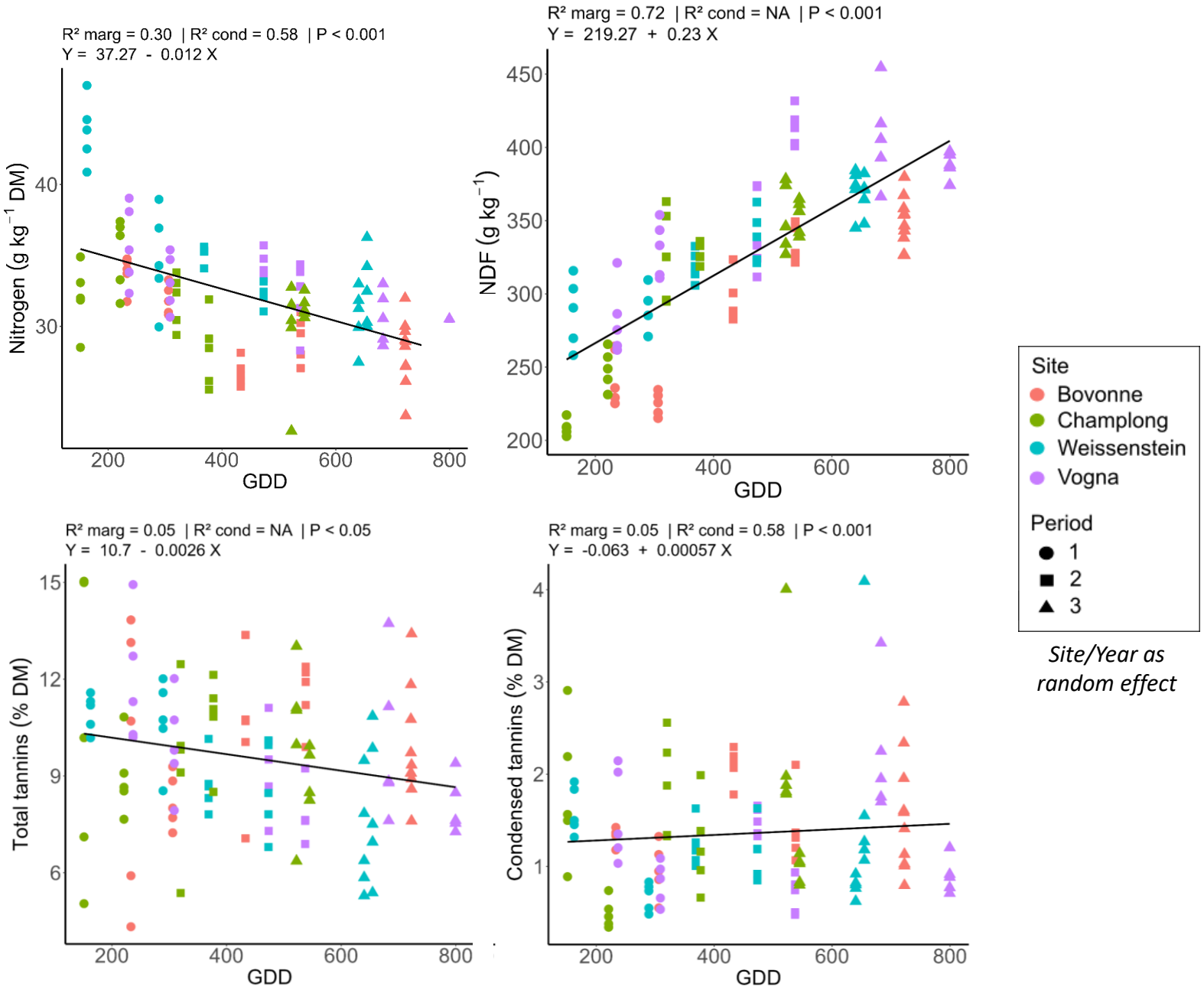
Higher forage quality at the beginning of the summer season



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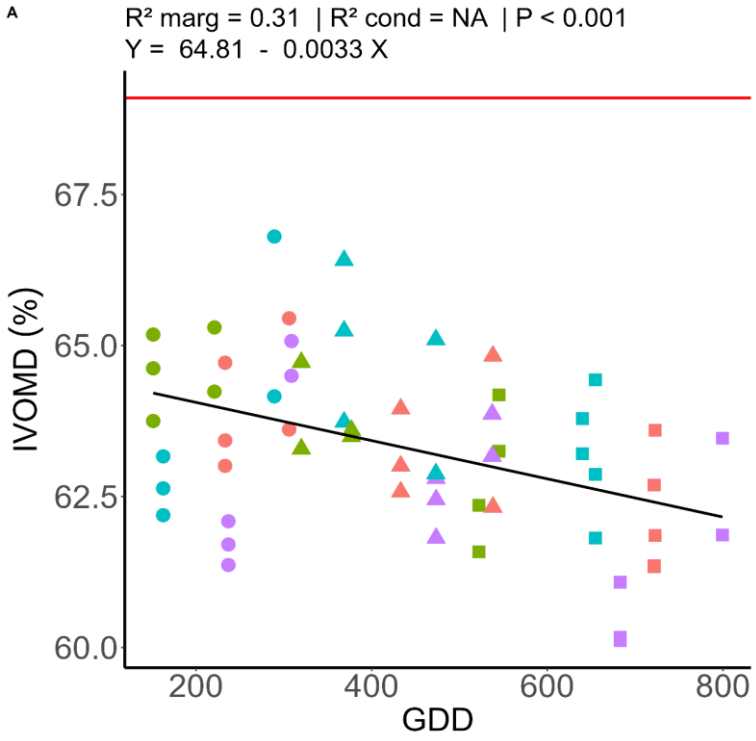
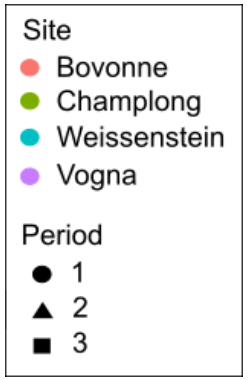
Digestibility



Control (hay)



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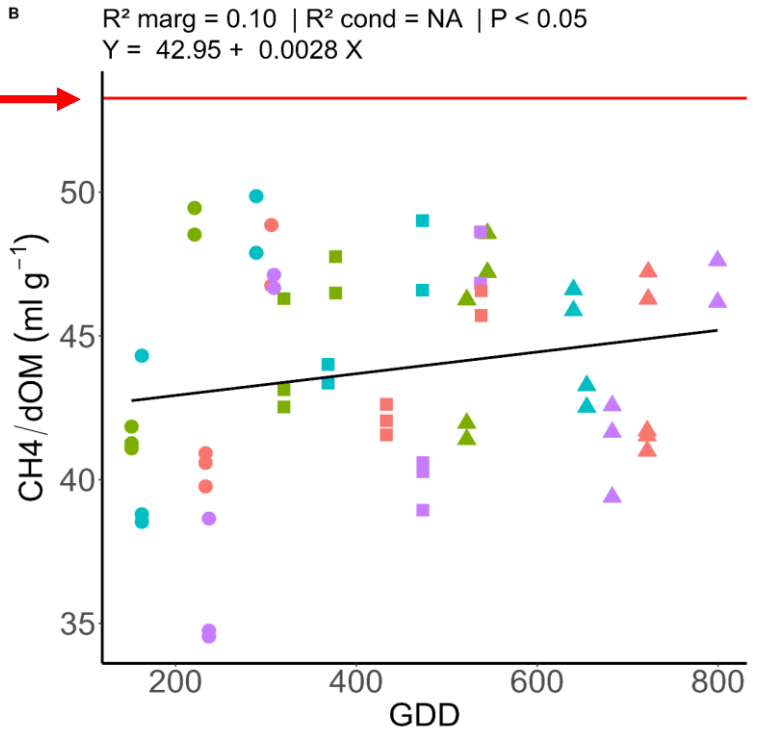
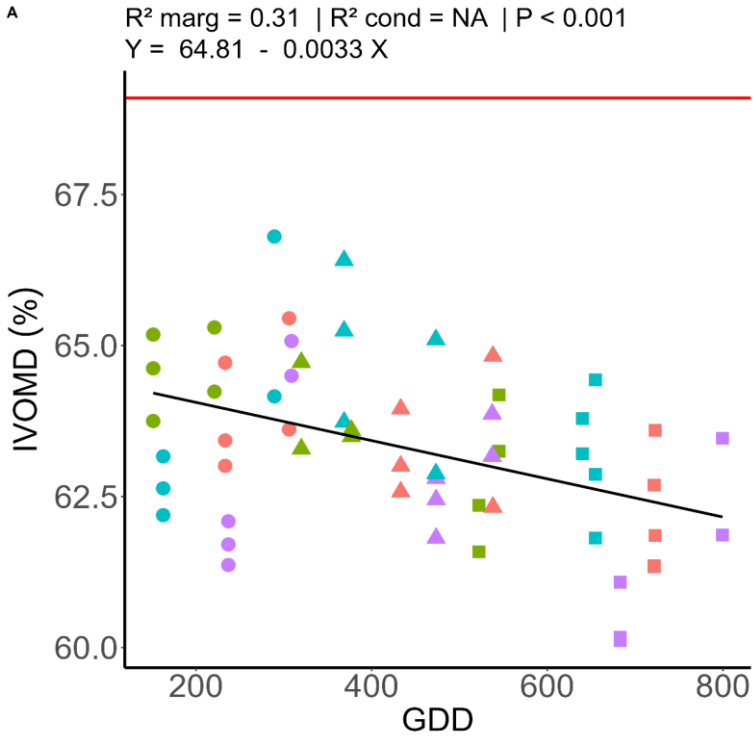
Methane production



- **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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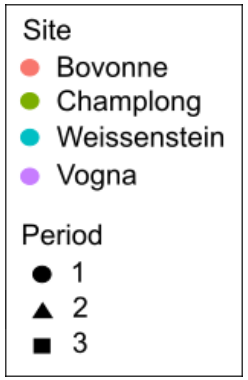

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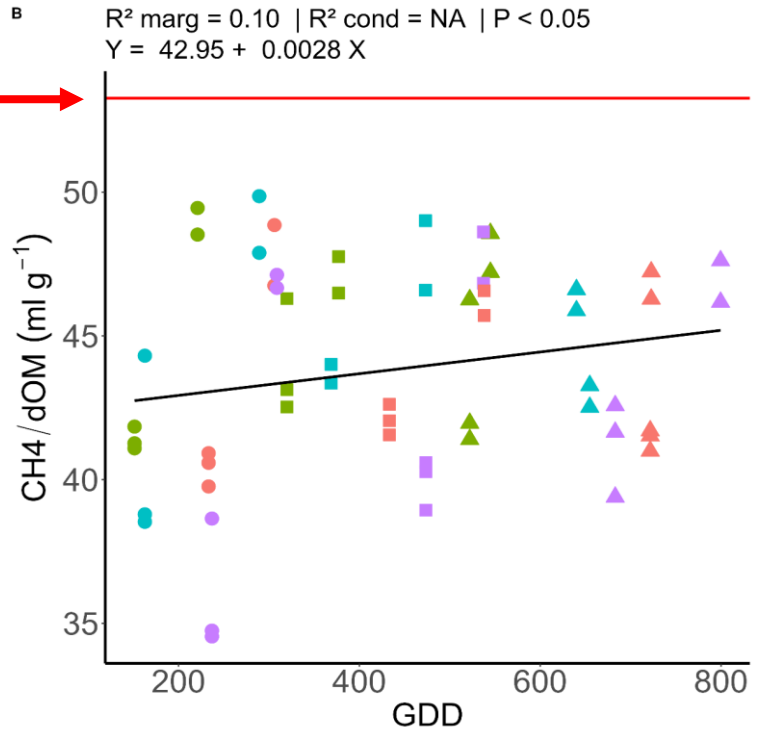

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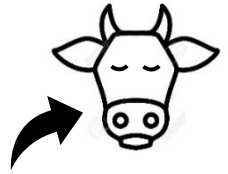
Field conditions



~12% *Alnus viridis* leaves in their diet

We expect 12% reduction in methane emission in field conditions

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Conclusions:

- *Alnus viridis* 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.
- Including *Alnus viridis* in the animal diet induces a decrease in methane emissions and provide satisfactory animal weight gain over the summer season.
- Other results from the project show that Highland cattle can reduce encroachment through **consumption of leaves** and **damage to the branches and trees**, restore the understorey vegetation by favouring the **return of typical grassland species** and **translocate nitrogen** from highly encroached patches to flat open pastures.

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These results will help to define targeted management strategies in *Alnus viridis*-encroached pastures to reduce encroachment, optimize grassland and animal productivity and reduce greenhouse gas emissions (methane).

Very efficient on young trees

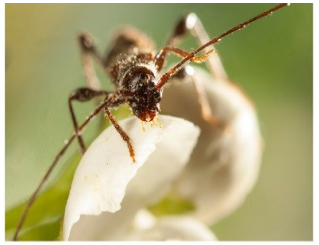
Breaking of branches

Damages to the branches

Breaking of large trees

Creation of trails that open the canopy





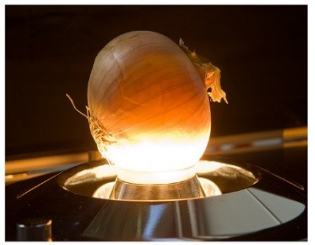










Thank you for your attention

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Grazing of green alder by Highland cattle

#RobustAlpsProject

bit.ly/4aDffGg

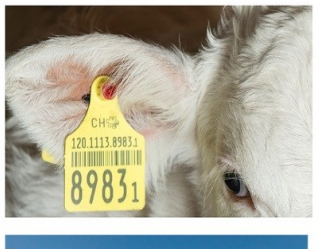
Fodder tree hedgerows

#AgroForageTreeProject

bit.ly/3vvCbsU









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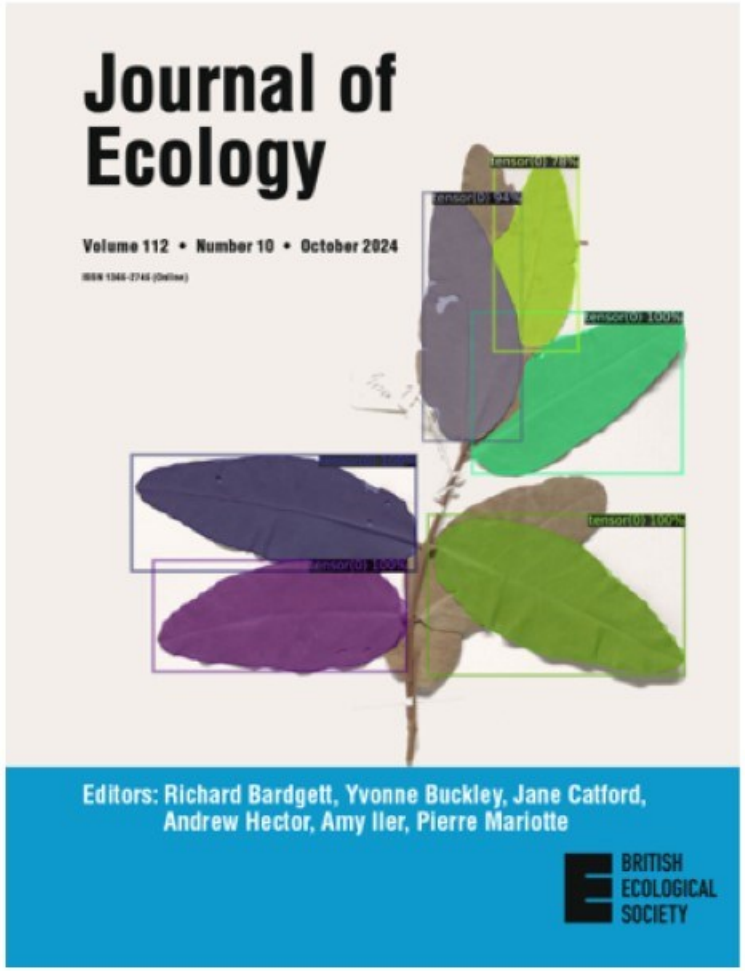

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