

The sum of temperatures as a decision-making tool for the management of permanent grasslands

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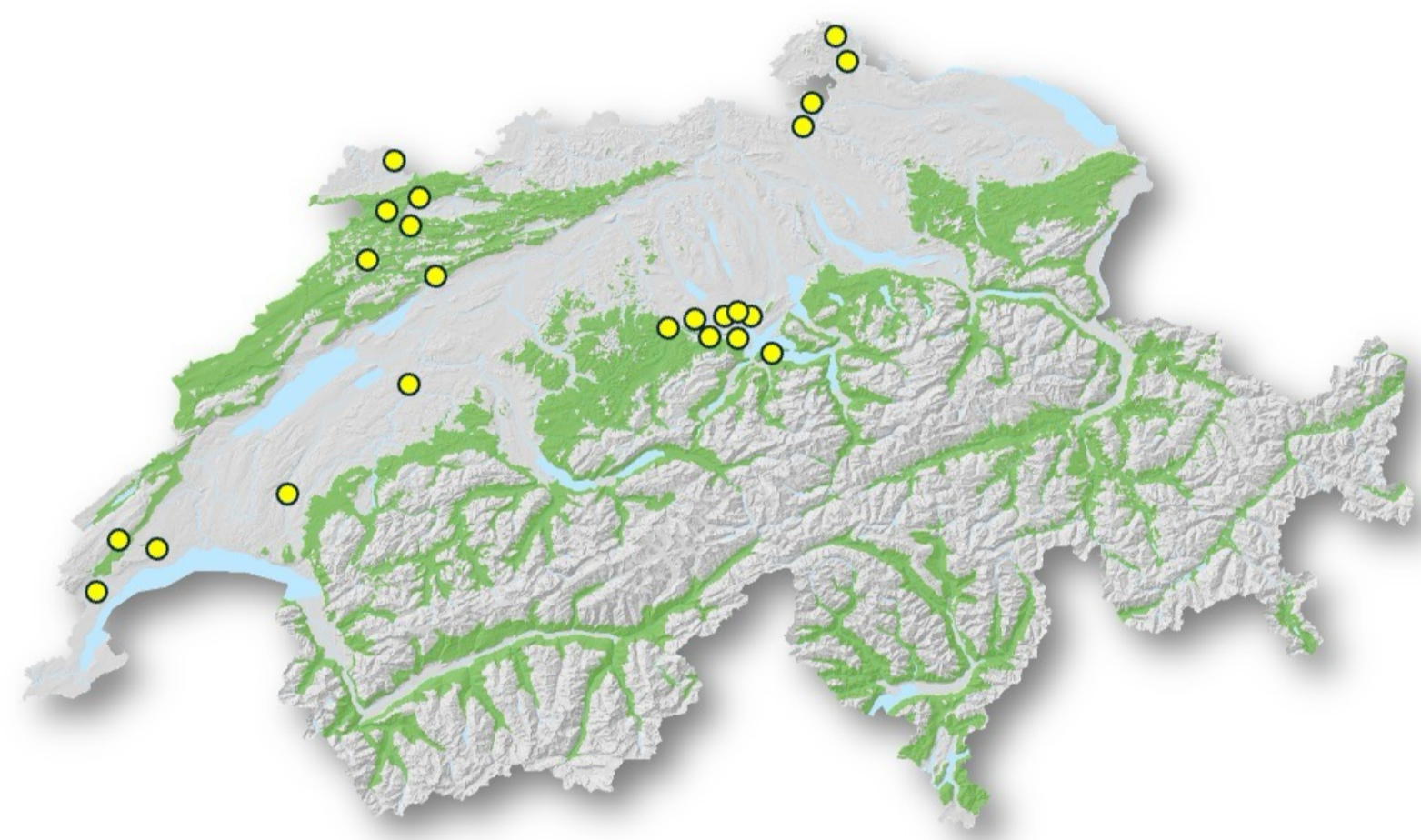
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Context

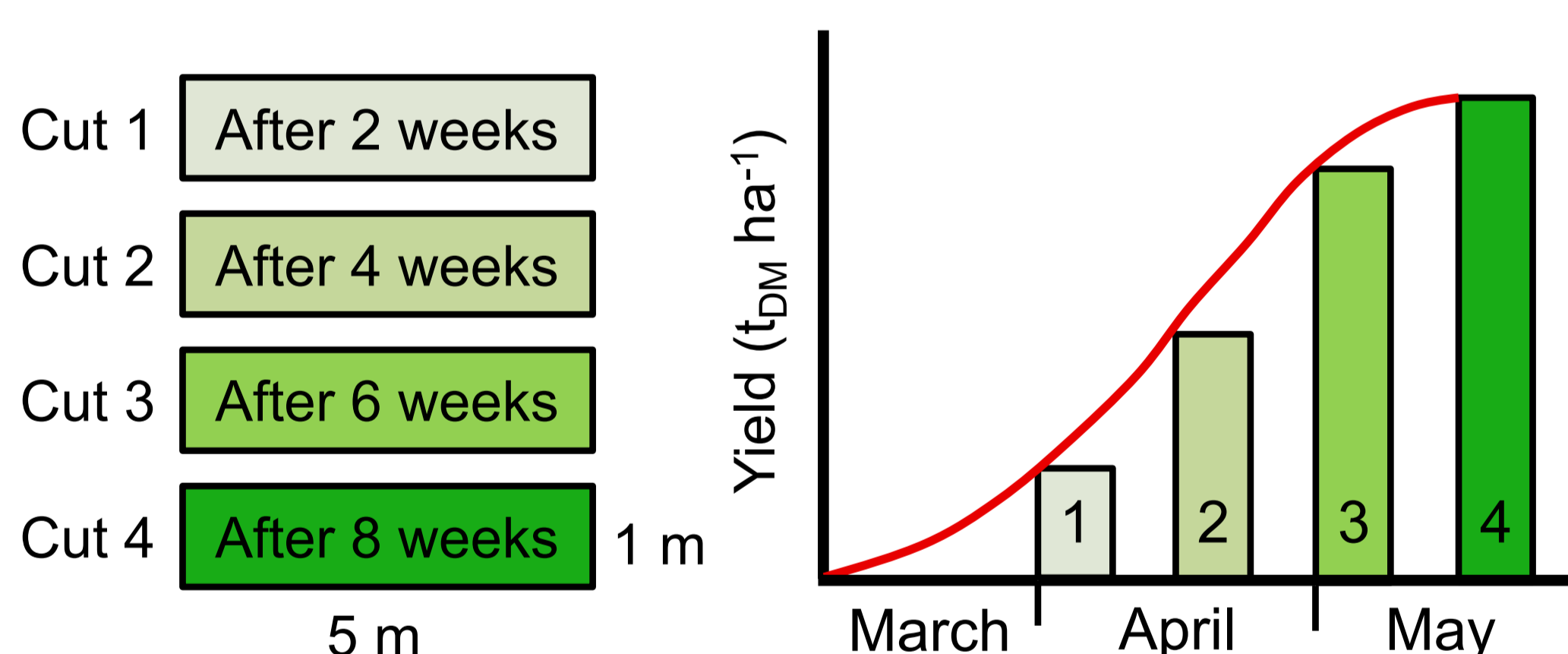
Maximizing both **forage yield** and **nutritive value** in grasslands is challenging, particularly in the face of climate change. The **sum of temperatures** has been proposed as a proxy for estimating forage yield and nutritive value at the first harvest of the year, but its validity at large scale remains unclear. The goal of our survey was to test the use of this index as a **decision-making tool** for the management of permanent grasslands in Switzerland.

Experimental design

- 23 intensively managed permanent grasslands at altitudes between 350-1000 m.a.s.l., representing 4 botanical types (A, AB-BA, bA-Ab, Bb-bB).



- Forage yield sampling in 2017, 2018, 2019 based on a staggered cutting timing (similar design at each site with 3 replicates of each cutting date).

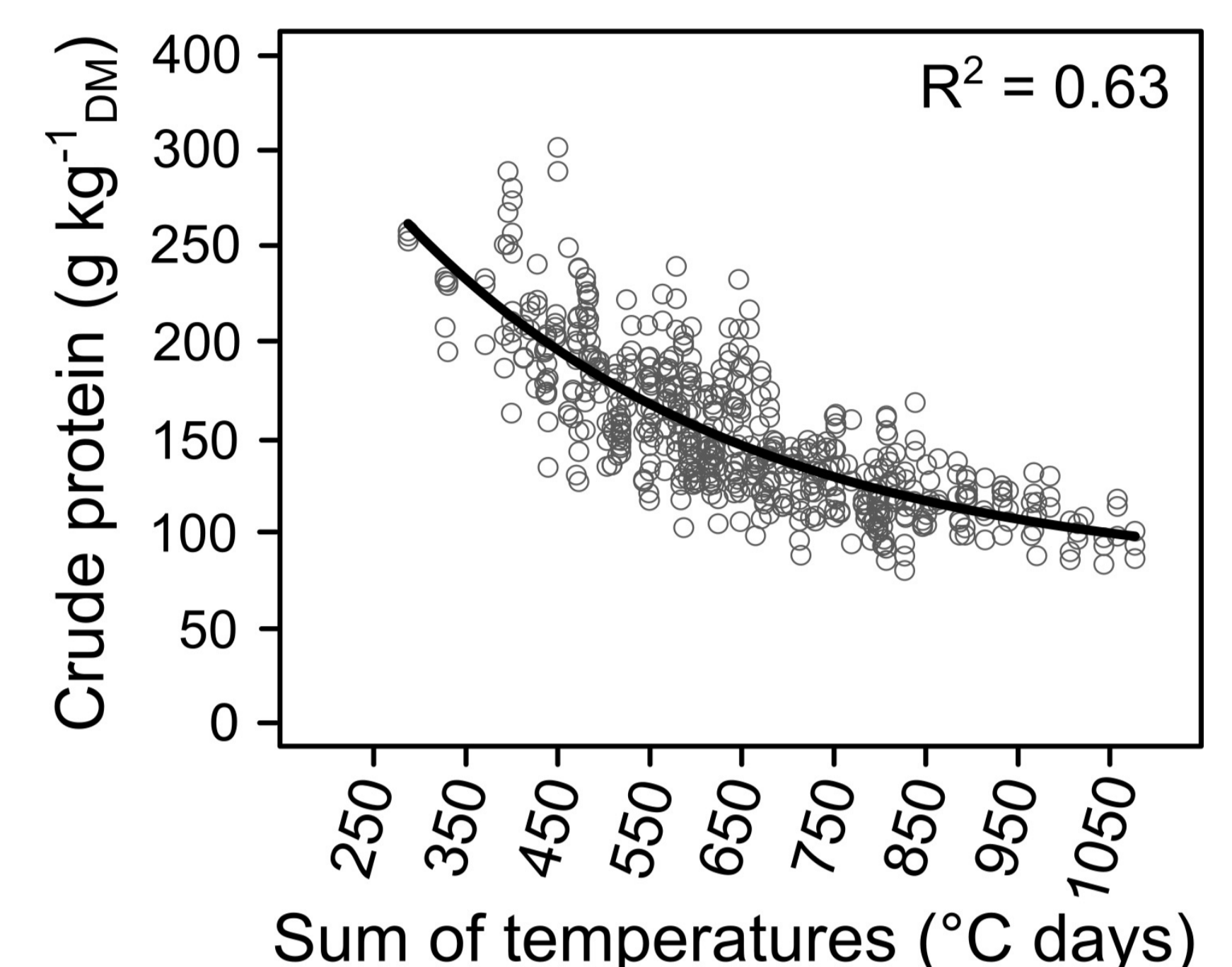
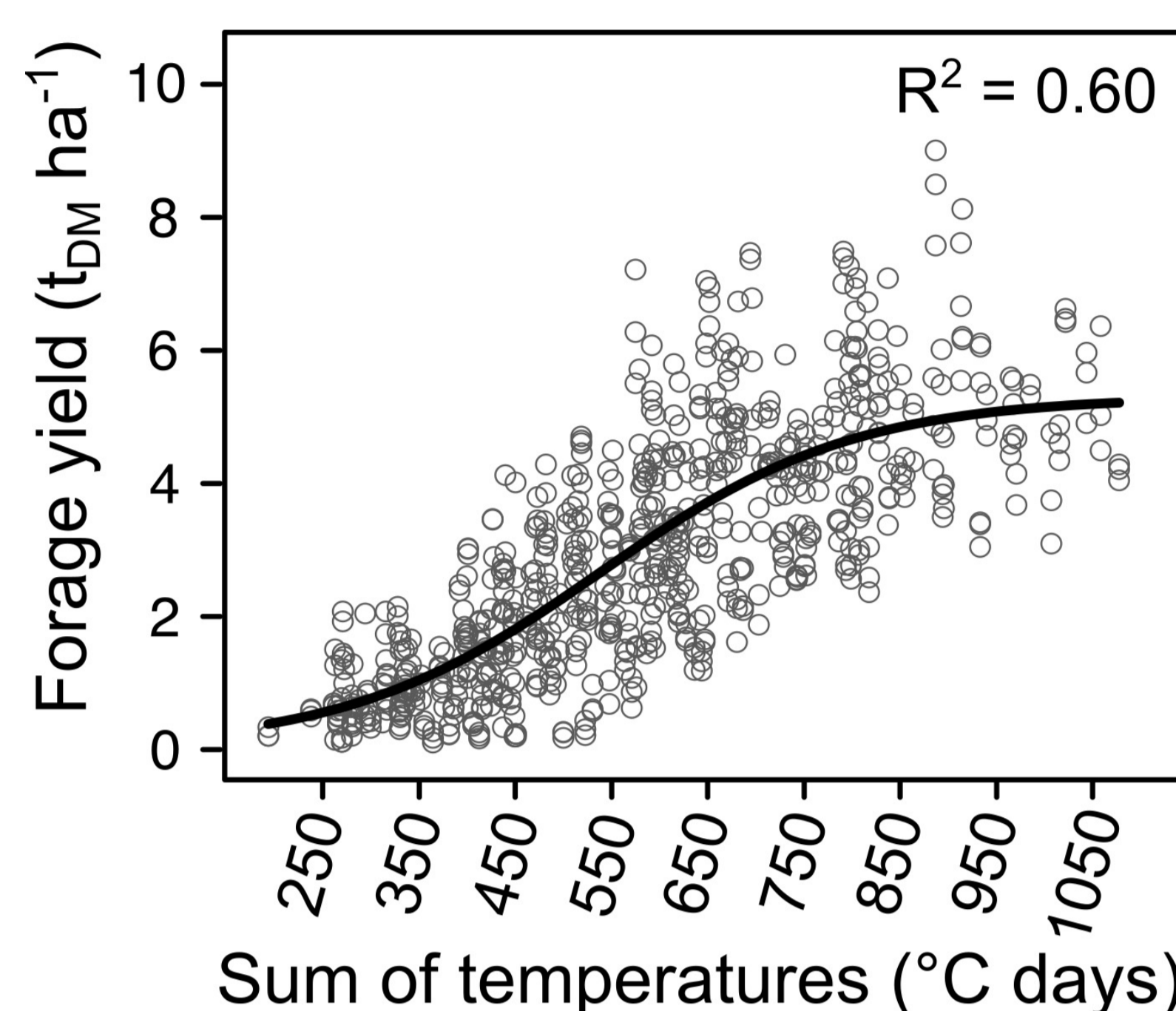


- Forage analysis for crude protein (CP) and fibers content at each cut (except cut 1).
- Estimation of organic matter digestibility (OMD), net energy for lactation (NEL) and protein digestible in the intestine (PDIN) based on Daccord et al. (2021).
- Statistical modelling of forage yield and nutritive value parameters using the sum of temperatures as independent variable.

Sum of temperatures (°C days)

Calculated for each cut as the cumulation of daily mean temperatures starting on January 1st and constraining temperatures in the range between 0 and 18°C (Theau and Zerourou, 2008).

Results & Discussion



- Satisfactory results ($R^2 > 0.6$) were obtained with a logistic model for forage yield and NEL, an exponential model for CP and PDIN, and a linear model for OMD (Table).
- For yield, botanical composition and year had little influence on the relationship to the sum of temperatures. The same yield was achieved only 50°C days earlier (*i.e.*, few days) during the drier spring 2018, 100°C days earlier (*i.e.*, a week) for grasslands type A and 100°C later for grasslands Type Bb-bB.
- No influence of the year nor of the botanical composition was found in the case of CP, OMD, NEL and PDIN.
- Best compromise for maximizing both forage yield and nutritive value for temperature sums between 650 and 750°C days.

	Units	Equation	R ²	Sum of temperatures (°C days)				
				550	650	750	850	950
Yield	t _{DM} ha ⁻¹	$y = 5.28 / \{1 + e^{-0.0076(x-539)}\}$	0.60	2.75	3.69	4.40	4.83	5.06
CP	g kg _{DM} ⁻¹	$y = 75.9 + 405.1e^{(-x/369.3)}$	0.63	167	146	129	116	104
OMD	%	$y = -0.028x + 95.248$	0.69	79.8	77.0	74.2	71.4	68.6
NEL	MJ kg _{DM} ⁻¹	$y = 4.87 + 2.32 / \{1 + e^{0.0056(x-746)}\}$	0.60	6.6	6.3	6.0	5.7	5.4
PDIN	g kg _{DM} ⁻¹	$y = 48.9 + 270.6e^{(-x/375.3)}$	0.63	111	97	86	77	70

Conclusions

- Mowing between **650 and 750°C days** at the first growth cycle would offer the **best compromise between forage yield and nutritive value**. Farmers aiming to maximize yield should consider mowing at up to 950°C days, whereas farmers aiming to maximize forage nutritive value should consider mowing at 650°C days.
- Overall, findings from our study demonstrate that the sum of temperatures appears as a **valuable decision-making tool** for site-adapted management of permanent grasslands across altitudes and pedo-climatic conditions.