Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Département fédéral de l'économie,
de la formation et de la recherche DEFR

Agroscope

Yield and nutritional quality of drought-resistant leys under extreme and contrasting climatic conditions

Massimiliano Probo, Rainer Frick, Edwige Dereuder, David Frund, Bastien Raymond, Pierre Mariotte

Interreg SPAD «Systèmes de Production Agricole Durables» (2020-2023)

- Project location**:** the departments of Doubs, Territoire de Belfort, Haute-Saône and Jura (France). Jura Canton and the Bernese Jura region (Switzerland)
- Background: Climate change is not only affecting mountain pasture yield, but also hay/silage production on valley floors/plains during the summer. Due to increasing droughts, summer is becoming more and more a period of fodder stock utilization rather than production
- Objective: to test summer leys having forage species that are potentially more resistant to dry climatic conditions than the ones generally used in Switzerland

2021 and 2022 : two contrasting summers

	Average monthly precipitation (mm)								
	1991-2020			2021			2022		
	July	August	September	July	August	September	July	August	September
Delémont	94	96	72	234	46	41	48	80	116
Fahy	93	103	88	190	55	34	22	76	154
Mean	94	100	80	212	51	37	35	78	135
Mean Jul-Sep	273			300			248		
	Average monthly precipitation (°C)								
	1991-2020			2021			2022		
	July	August	September	July	August	September	July	August	September
Delémont	18.7	18.2	14.1	17.7	17.1	15.6	20.5	19.7	13.8
Fahy	18.2	18.0	13.9	17.2	16.3	15.8	20.5	20.5	13.8
Mean	18.5	18.1	14.0	17.5	16.7	15.7	20.5	20.1	13.8
Mean Jul-Sep	16.9			16.6			18.1		

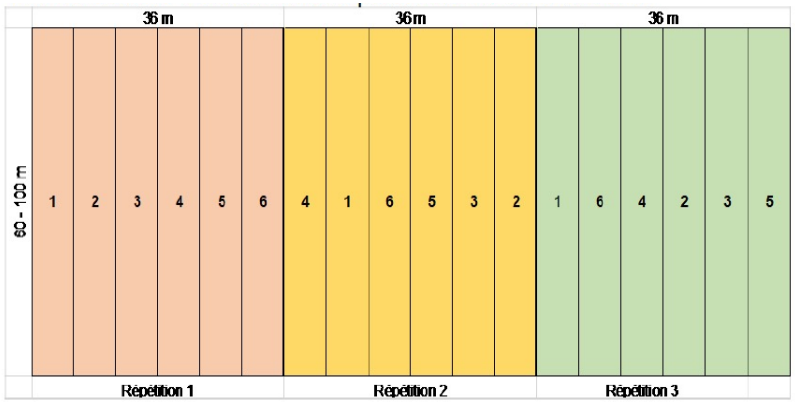
Climate change is also increasing **inter-annual climatic variation**:

- **2021:** extremely wet in spring and until the beginning of August, after very dry. Months of July and August cold, September hot
- **2022:** extremely dry and hot in July and August, September wet

Agronomic trial

- 6 different leys
- Trial location: 3 farms at 500 m in the Swiss Jura Canton
- Previous crop: winter barley
- Slurry before sowing: 30 m^3 ha^{-1}
- Sowing with cereal drill, row spacing 12.5 cm (sorghum 25 cm)
- Sowing period: 23-30/07/2021, 7-13/072022
- Harvest periods: 10-11/10/2021, 22/09/2022
- Forage conservation: round bale silage
- Analysis of: emergence speed, botanical composition, yields, nutritional value of the forage, silage quality

Number	Ley	Species	Seed density (kg ha^{-1})
1	Sudangrass	*Sorghum sudanense (Piper)*	15
2	Hybrid sorghum-Persian Clover-Egyptian clover	*Sorghum bicolor x Sorghum sudanense (Pacific graze)-Trifolium resupinatum-Trifolium alexandrinum*	45
3	Foxtail millet	*Setaria italica*	25
4	Pearl millet	*Pennisetum glaucum*	25
5	Black oat-Crimson clover	*Avena strigosa-Trifolium incarnatum*	80
6	Oat-Pea-Common vetch	*Avena sativa-Pisum sativum-Vicia sativa*	175



Forage species

Multi-cut sorghum
- Withstands drought well, if enough water to emerge
- Multi-cut varieties: high regrowth capacity
- Use as after-cereal ley: avoid late sowing (before mi-July)
- Use: hay, silage or pasture (*Sudangrass*)
- High hydrocyanic acid content

Foxtail millet (*Setaria italica*)
- Drought-resistant species
- Mono-cut species
- Use: mowing; not so palatable for livestock
- Forage quality rapidly drops after heading (favor late varieties)

Pearl millet (*Pennisetum glaucum*)
- Undemanding culture, with deep root system (up to 1.6 m)
- Adapted to light and acid soils
- Strong tillering capacity, good regrowth
- Nitrate content can be high (in the first 15 cm)
- Use: mowing or grazing (minimum height 40-50 cm)

Black Oat (*Avena strigosa*)

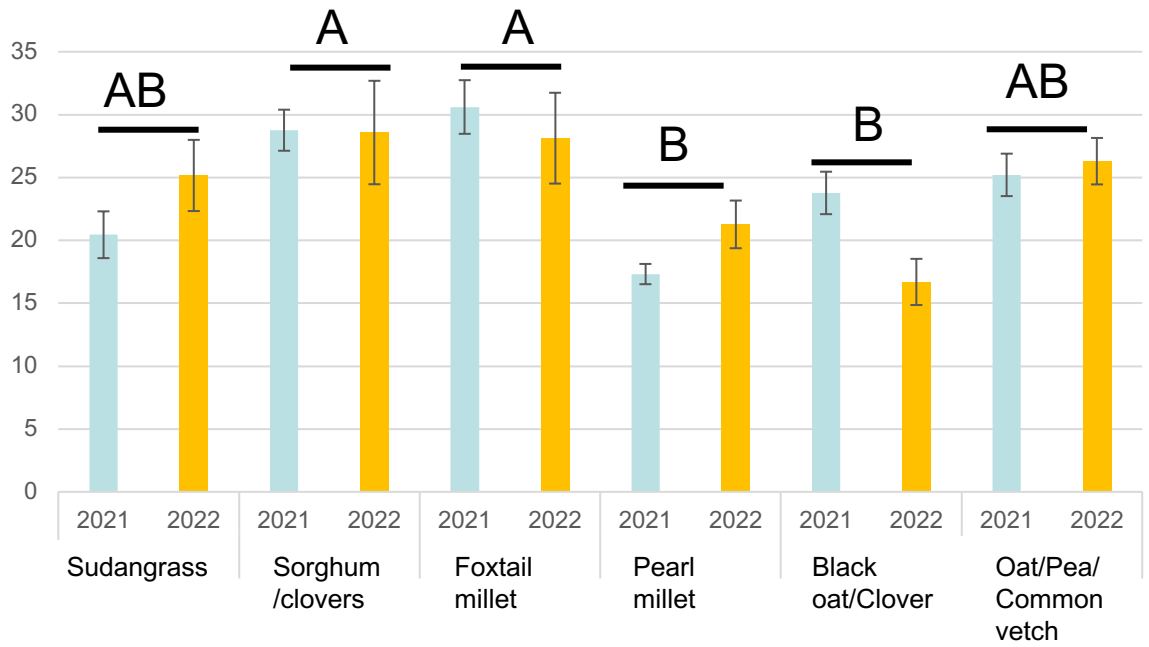
- Undemanding crop, grows on all soils
- Less sensitive to leaf diseases than forage oat (rust)
- There are great varietal differences: avoid early varieties heading too quickly
- Contents comparable to forage oat, good protein/energy balance and digestibility
- It associates well with annual clovers

Egyptian, Persian and Crimson clovers (*Trifolium alexandrinum, Trifolium resupinatum, Trifolium incarnatum*)

- Persian clover: high water content, provides higher fresh matter yields than Egyptian clover, but comparable dry matter yield
- Persian clover: higher energy and protein content than Egyptian clover
- Crimson clover: winter hardiness, slightly lower yields than Egyptian and Persian clover

Forage yield (dt DM ha^{-1})

Treatment ***
Year n.s.
Interaction m.s.



- **Sorghum + clovers and Foxtail millet**: best yields
- **Sorghum + clovers**: clovers accounted for 55% of DM in 2021, but only for 5% in 2022 (sorghum was too much competitive, it grewth rapidly with July and August temperatures)
- **Sudangrass sorghum and Pearl millet**: they suffered cold temperatures and wet climate in 2021
- **OPC and Black oat + Crimson clover**: rust on oat leaves in 2021
- **2022**: barley regrowth on 2 sites (Fontenais and Grandfontaine)

Sorghum + clovers, 29.09.2021

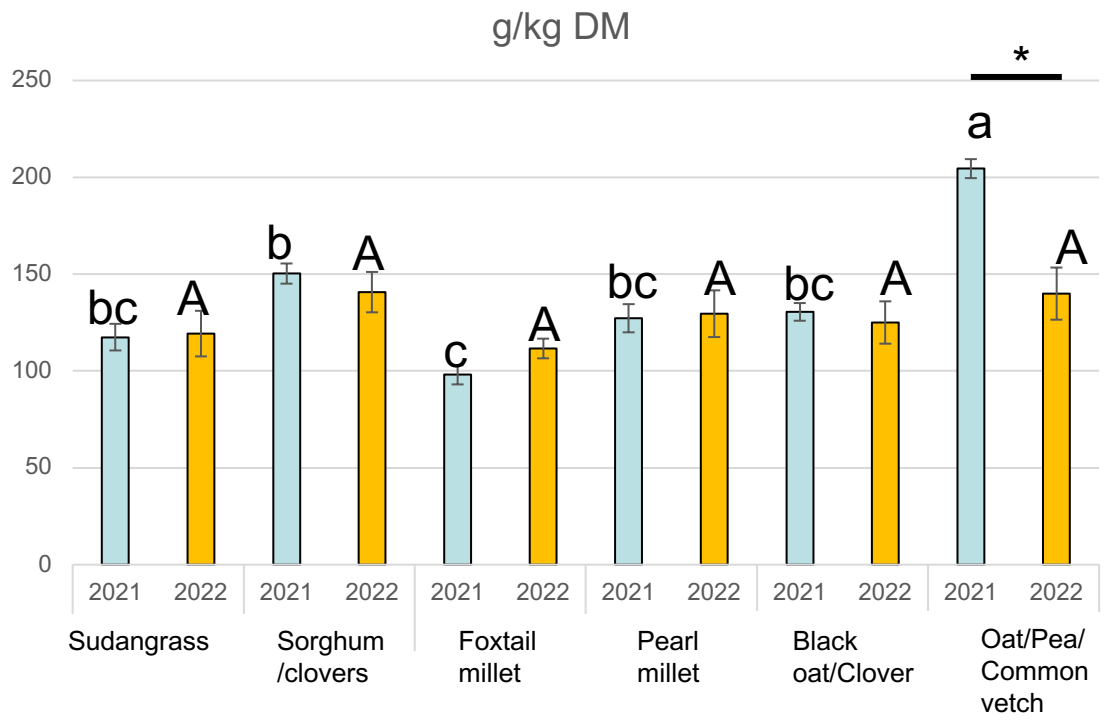
Sorghum + clovers, 15.09.2022

Rust on forage oat, 8.09.2021

Pearl millet, 8.09.2021

Protein content

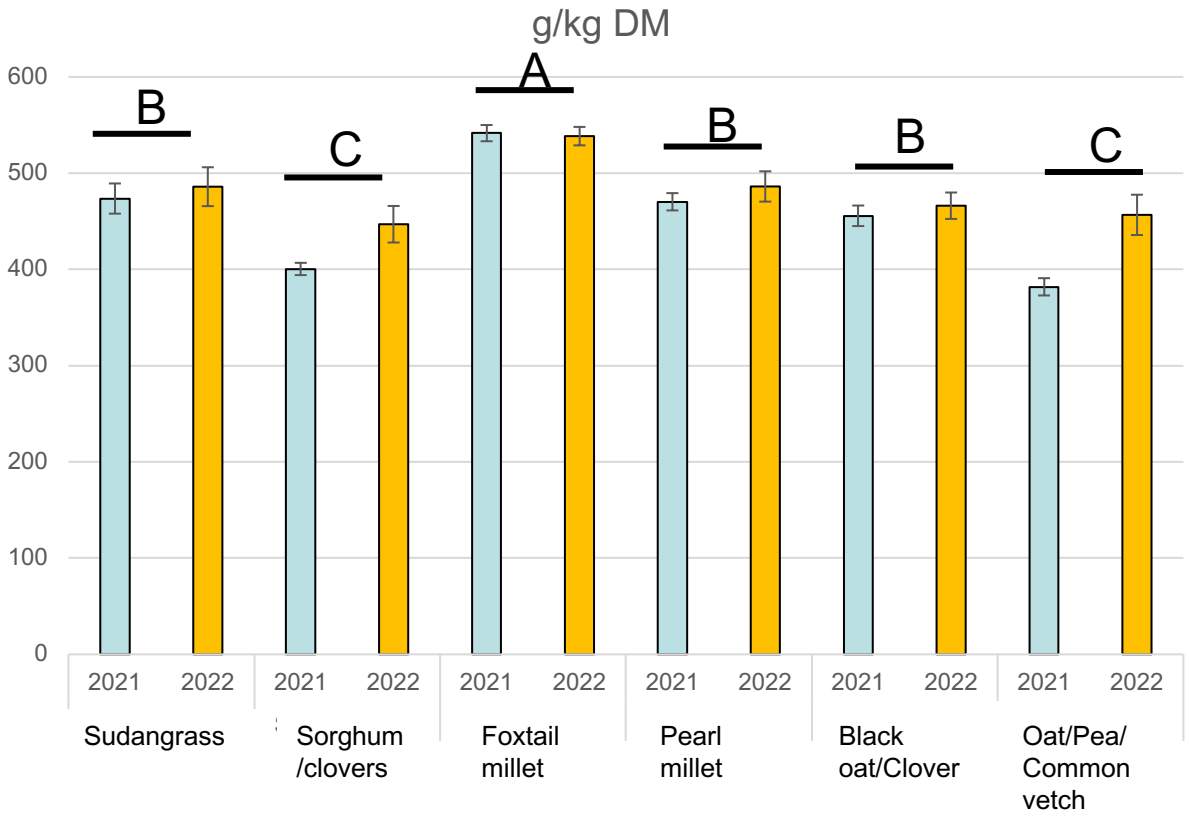
Treatment ***
Year *
Interaction ***



- **OPC**: highest content in 2021 (mainly pea and common vetch in the mixture)
- **Sorghum + clovers**: good protein content in 2021 (higher clover proportion within the mixture) and not significant reduction in 2022
- **Foxtail millet**: low protein content

Neutral detergent fibers (NDF)

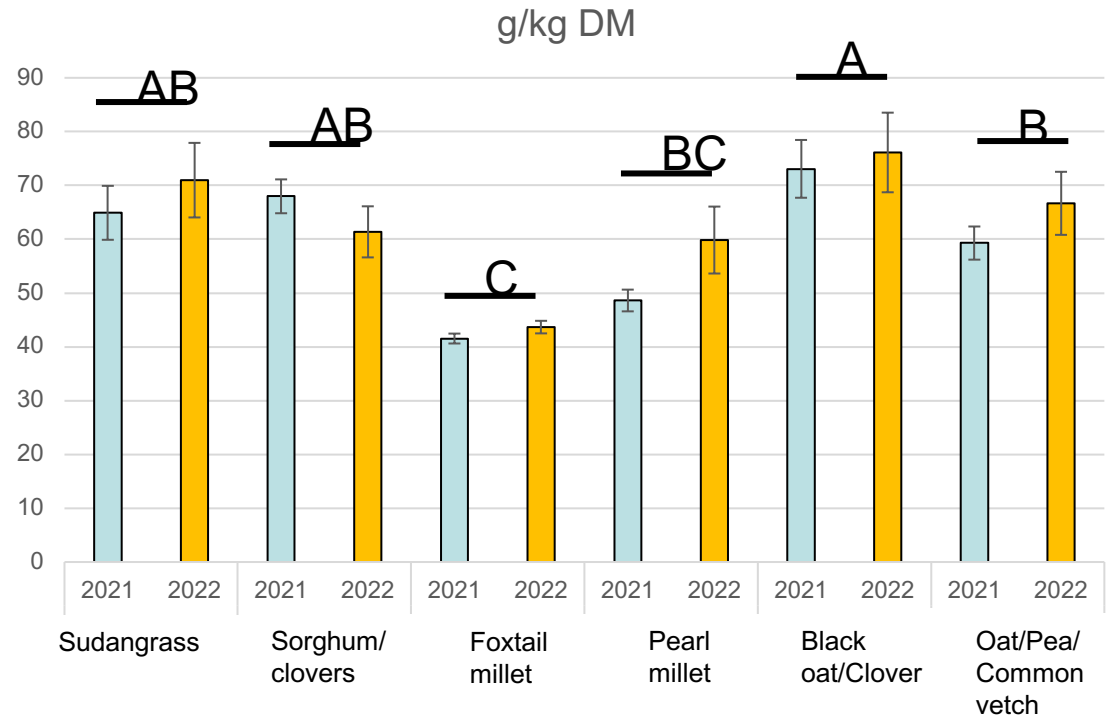
Treatment ***
Year **
Interaction m.s.



- **Foxtail millet** : highest content
- **Sorghum + clovers and OPC**: lowest content

Water soluble carbohydrates (WSC)

Treatment ***
Year m.s.
Interaction n.s.

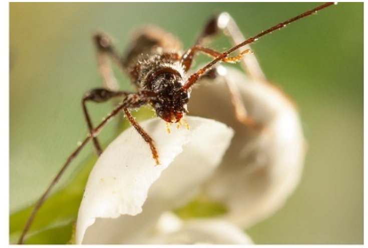


- Higher content in 2022 than in 2021: imbalance between assimilation with photosynthesis and plant growth with drought
- Generally low content
- **Foxtail millet:** lowest content
- **Black oat + Crimson clover**: highest content

Conclusions

- The **2021 and 2022 summers were climatically contrasting** (opposite wet and dry periods) and characterized by often **extreme values** (far from the historical averages of the period, also for temperatures)
- Considering both forage yield and quality over 2 years, the treatment that provided the best results was the mixture **sorghum + Egyptian and Persian clovers**, thanks to the alternate growth of sorghum (favored by dry and hot conditions) or clovers (favored by cooler and wetter conditions)
- **Foxtail millet** showed a good capacity to produce biomass under contrasting climatic conditions, but its nutritional value was modest. It should be improved in the future by trying to combine it with legumes
- The **Oat-Pea-Common Vetch** mixture provided some interesting results (e.g. protein content), while all the other treatments provided unsatisfactory results





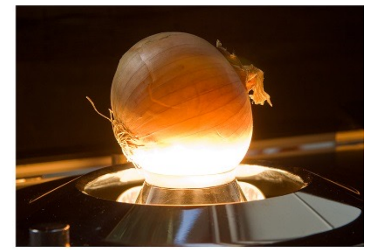







Thank you for your attention

Massimiliano Probo
massimiliano.probo@agroscope.admin.ch

Agroscope une bonne alimentation, un environnement sain
www.agroscope.admin.ch








Agroscope