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Agroscope

Influence of supplementing bakery products and cocoa bean shells to a herbage-based diet on rumen microbiota and gas emissions of early-lactating dairy cows

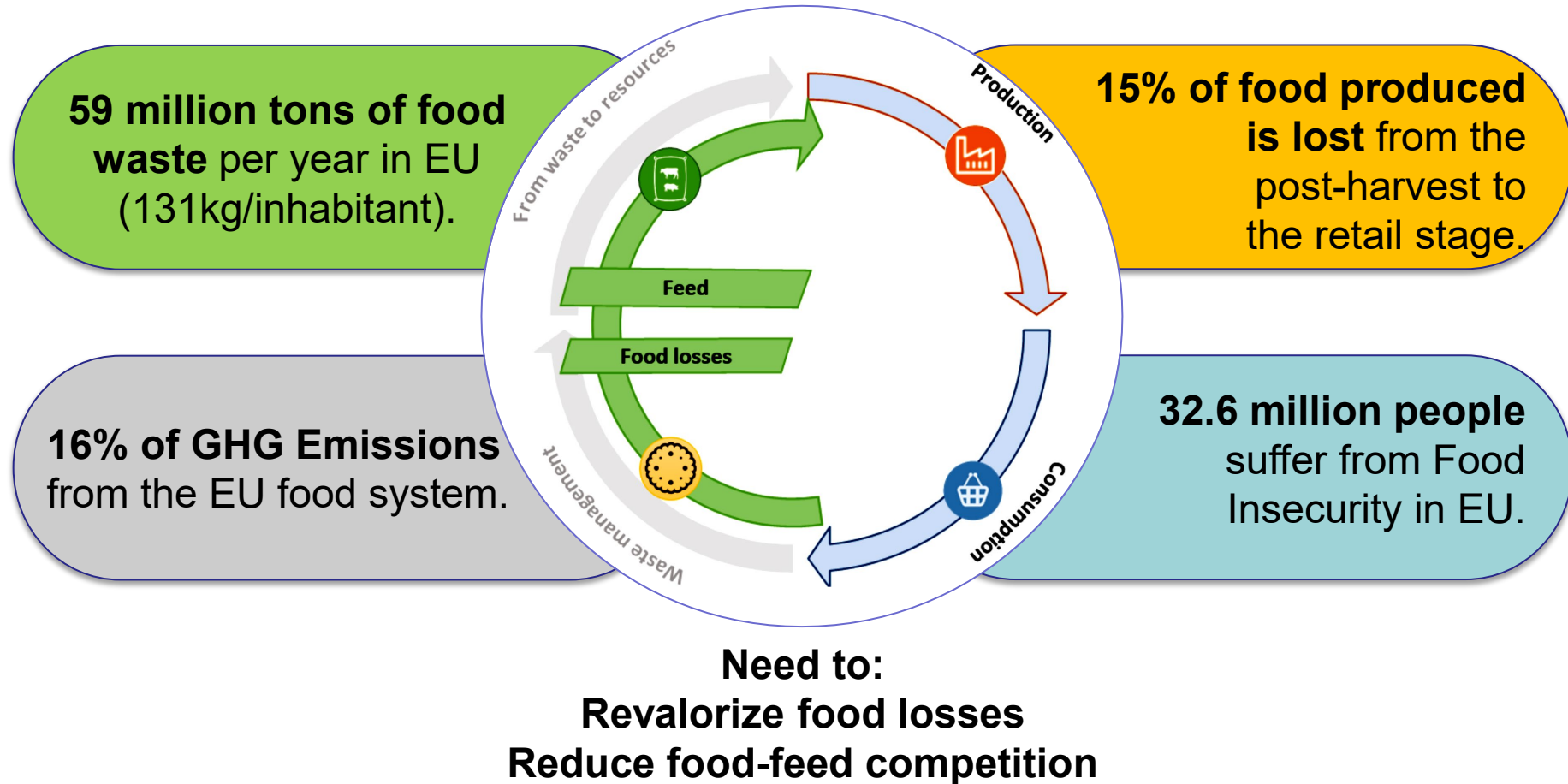
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EAAP 2024 – Firenze - Italy





The problem: Food wastage



(Eurostat, 2021 and FAO, 2019)



Bakery products as feed: an increasing trend in the EU



Marco Tretola



What are Bakery Products (BP)?

Food **Loss**



Food **Waste**

Food **By-Products**



secondary products
derived from the
production of a
principal product

Examples:

- **Cocoa bean shell (CBS)**



On Farms



During
storage



During
Transport

In
Restaurants



In
Households



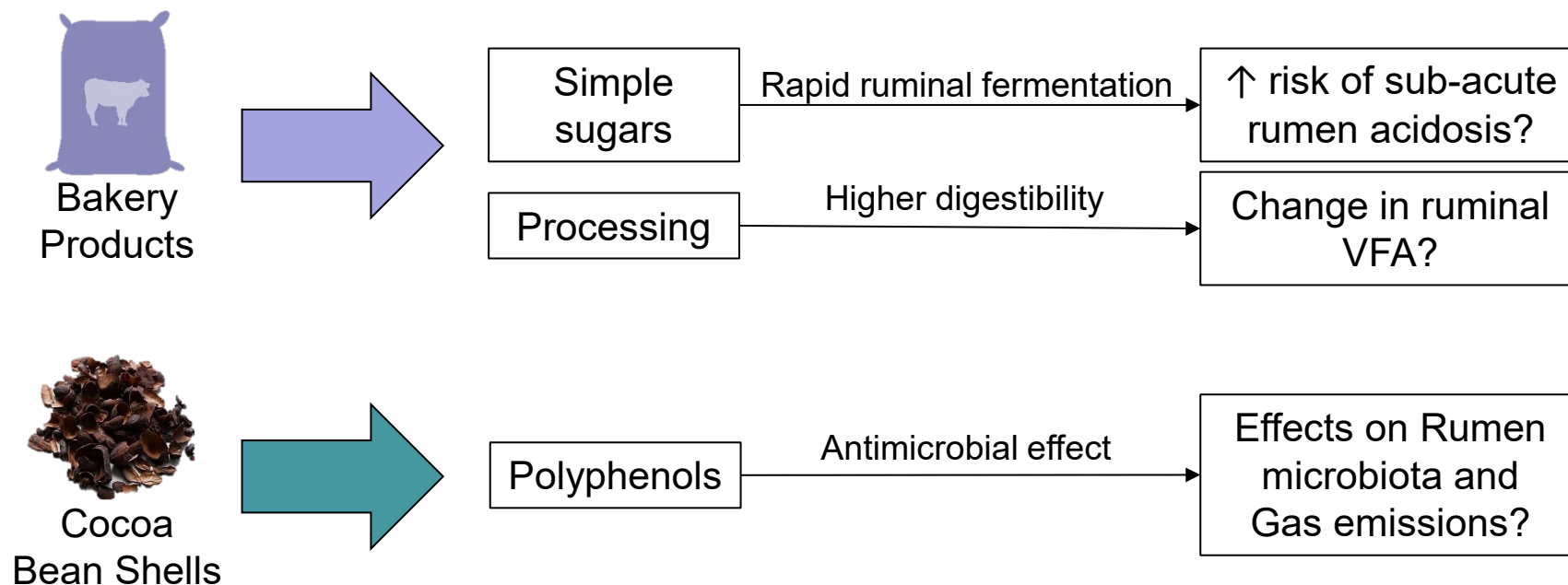
Sold to
consumers



Regulation (EC) No 1069/2009 and No 68/2013



Research questions



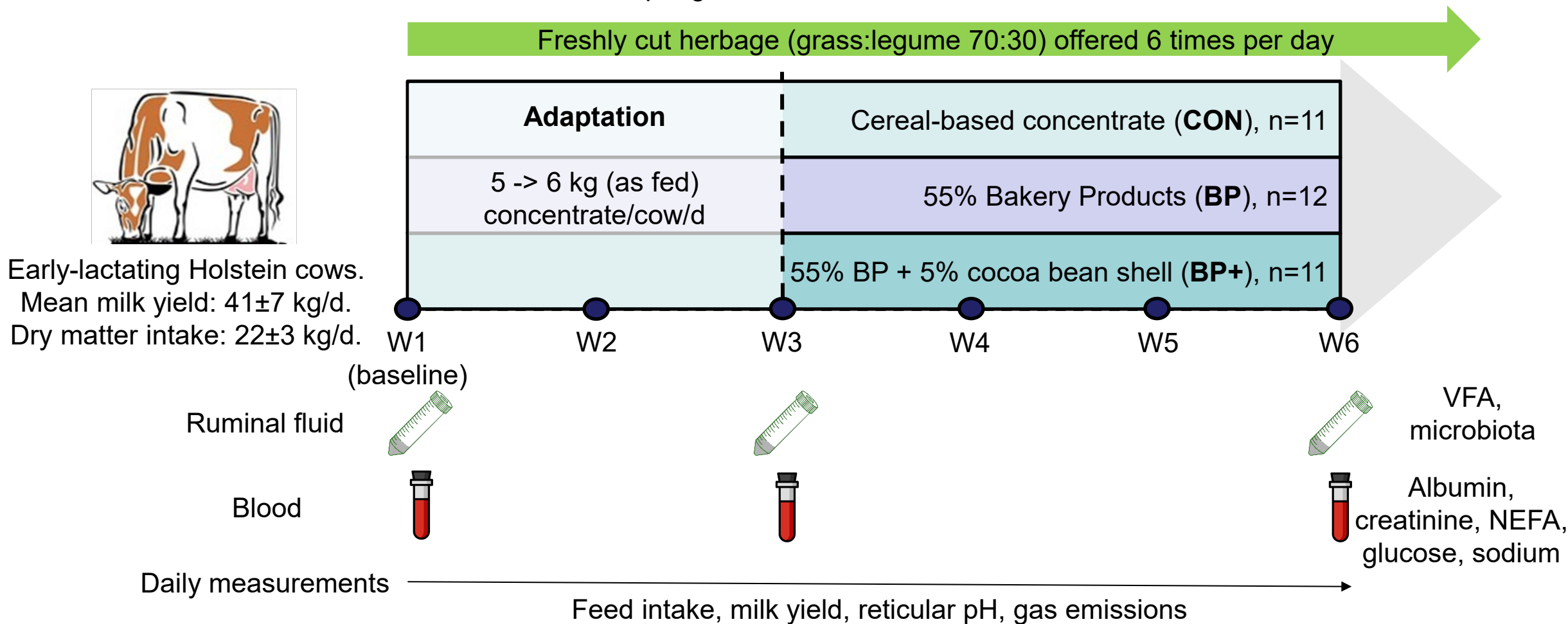
Hypothesis

- Feeding up to 55% BP in the diet would be well tolerated by cows.
- CBS at 5% would decrease ruminal emissions



Methods – study design

Spring vs Autumn trials





Methods – Diets

Concentrate ingredients

%	CON	BP	BP+
Bakery products	-	55	55
Cocoa bean shell	-	-	5
Corn	31	31	31
Barley	31	-	-
Wheat	33	-	-
Corn gluten	3	5	5
Minerals	2	3	3
Straw meal	-	5	-

BP vs native cereal grains:

- lower in starch
- higher in fat and sugar

Chemical composition of concentrates (in g/kg DM, unless otherwise specified)

	Spring trial				Autumn trial			
	Herbage	CON	BP	BP+	Herbage	CON	BP	BP+
DM	160	885	910	910	138	881	909	908
OM	94	55.7	65.8	66.6	120	55.0	58.6	61.7
ADF	272	43.2	71.7	74.7	245	45.3	73.0	72.7
NDF	426	142	149	136	386	144	137	124
CP	185	105	114	114	232	103	109	105
WSC	110	39	141	142	90	34	165	172
Starch	-	653	402	397	-	641	371	367
EE	-	63.6	114	119	-	59.4	102	104
NE_L (MJ/kg DM)¹	6.2	8.5	8.8	9.0	6.4	8.5	8.8	8.9
GE (MJ/kg DM)	-	19.1	20.1	20.1	-	18.6	19.4	19.4

¹Estimated for herbage and concentrates following equations for roughage and concentrates, respectively (Agroscope, 2021)



Methods - Statistics

Software: R-studio (v 4.3.2)

Rumen Microbiota

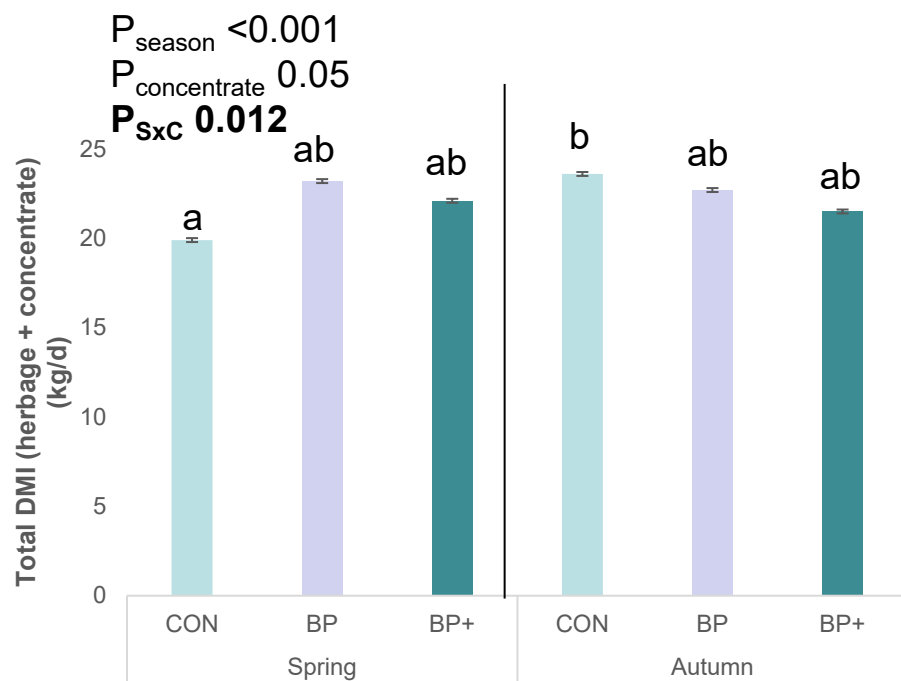
- Alpha diversity: number of ASVs, Chao1, Simpson, Shannon (microbiome package)
- Weighted and unweighted Unifrac distances calculated on rarefied ASVs.
- Linear Discriminant analysis of Effect Size (Lefser package)
- Correlations of microbiota with gas emission data (MaAsLin2 package).

Other data

- ANCOVA test (lme4 package)
- Baseline values = covariate.
- Time = fixed effect;
- Animal = random effect.



Results – Dry matter intake

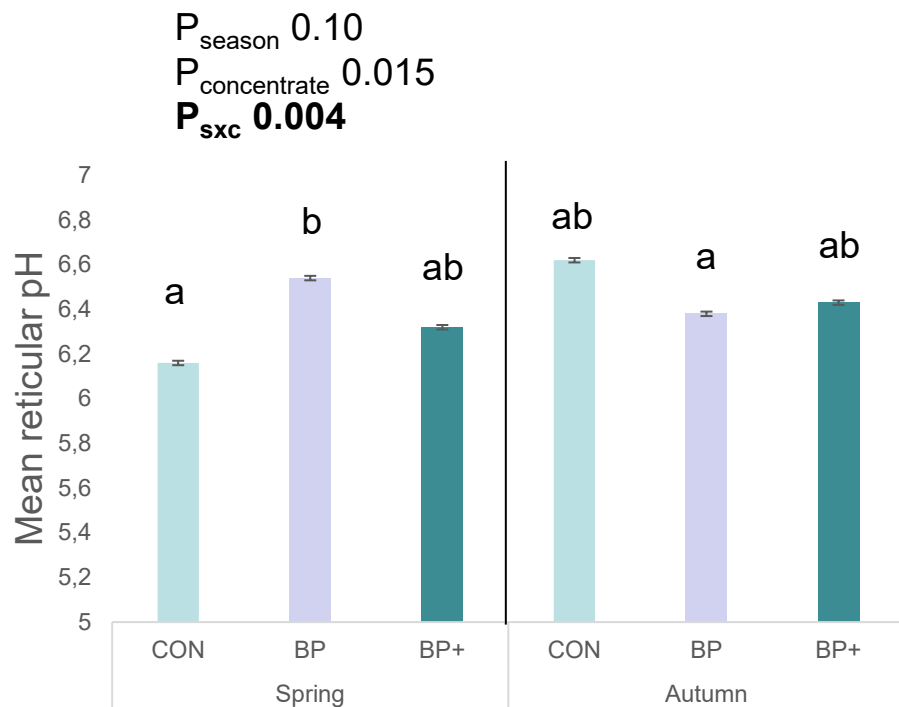


No differences in concentrate intake

Differences in DMI due to different herbage intake



Results – Reticular pH and ruminal fluid analytes

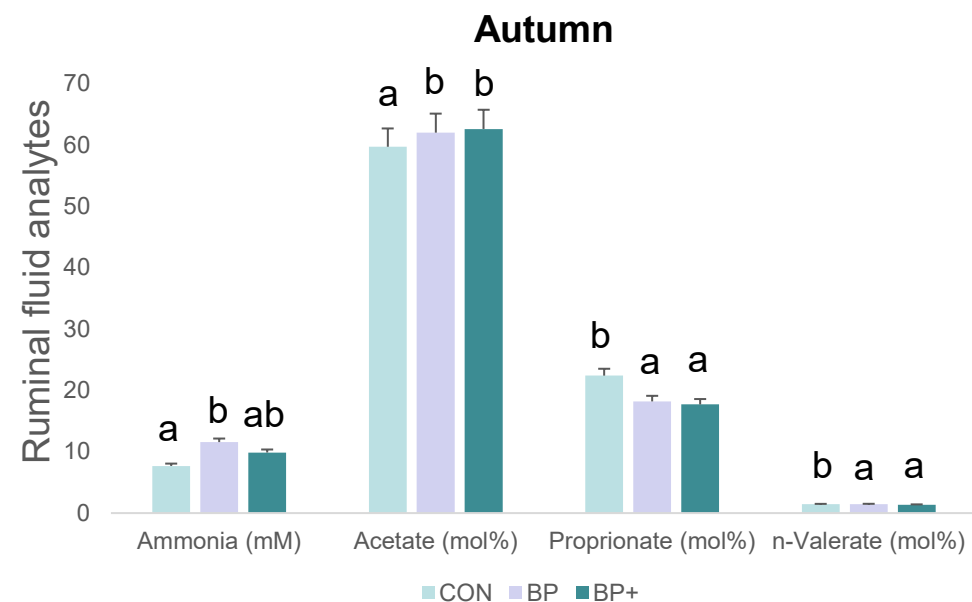
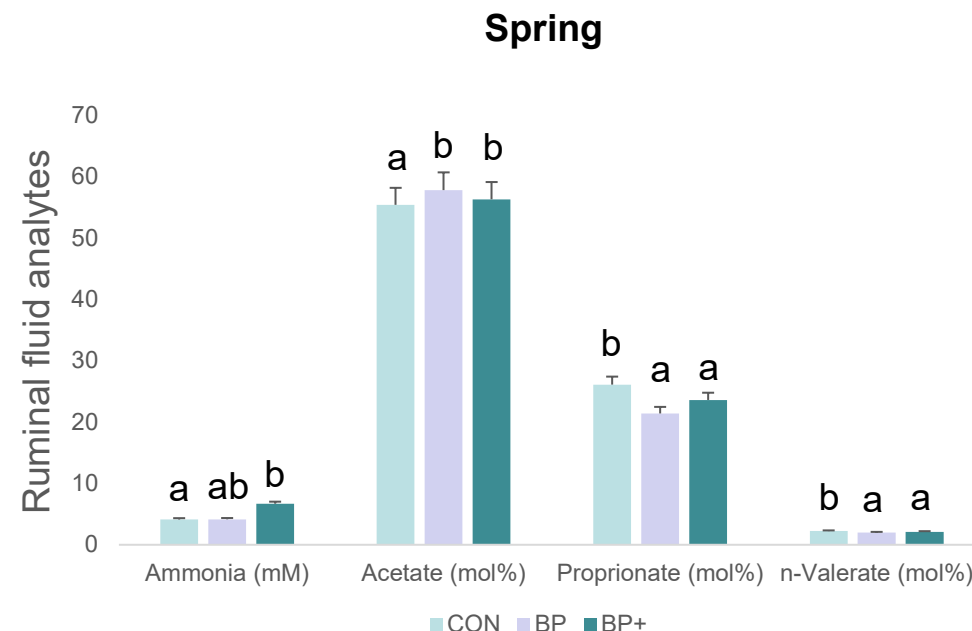


BP and BP+ had no detrimental effect on reticular pH

BP and BP+ increased acetate → ↑ lipogenic precursor

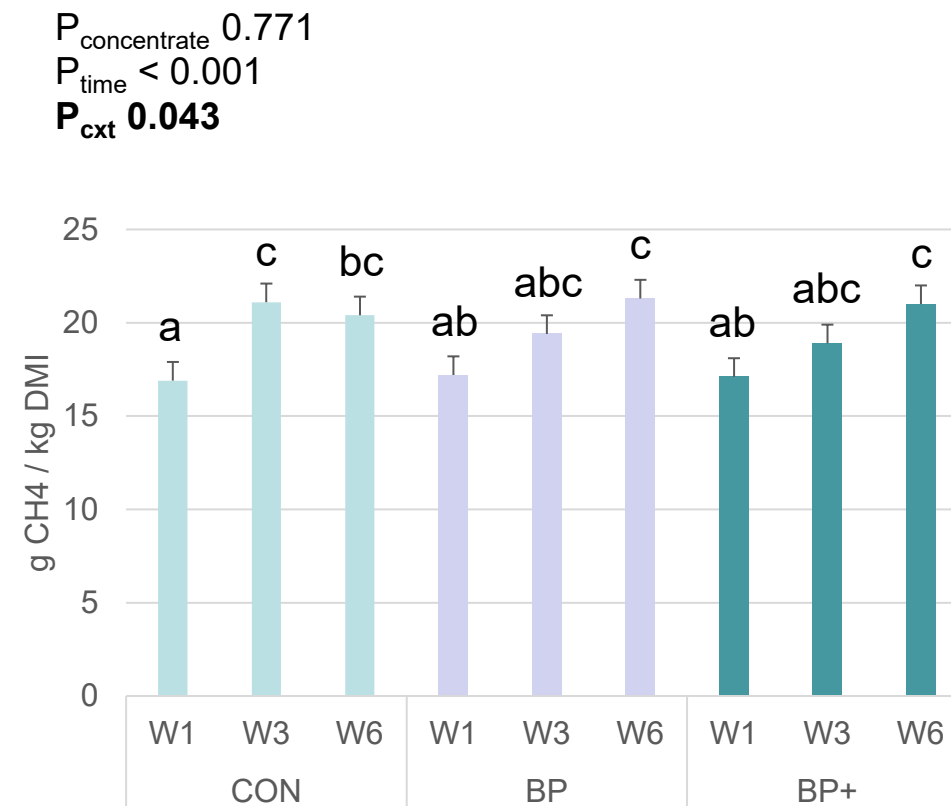
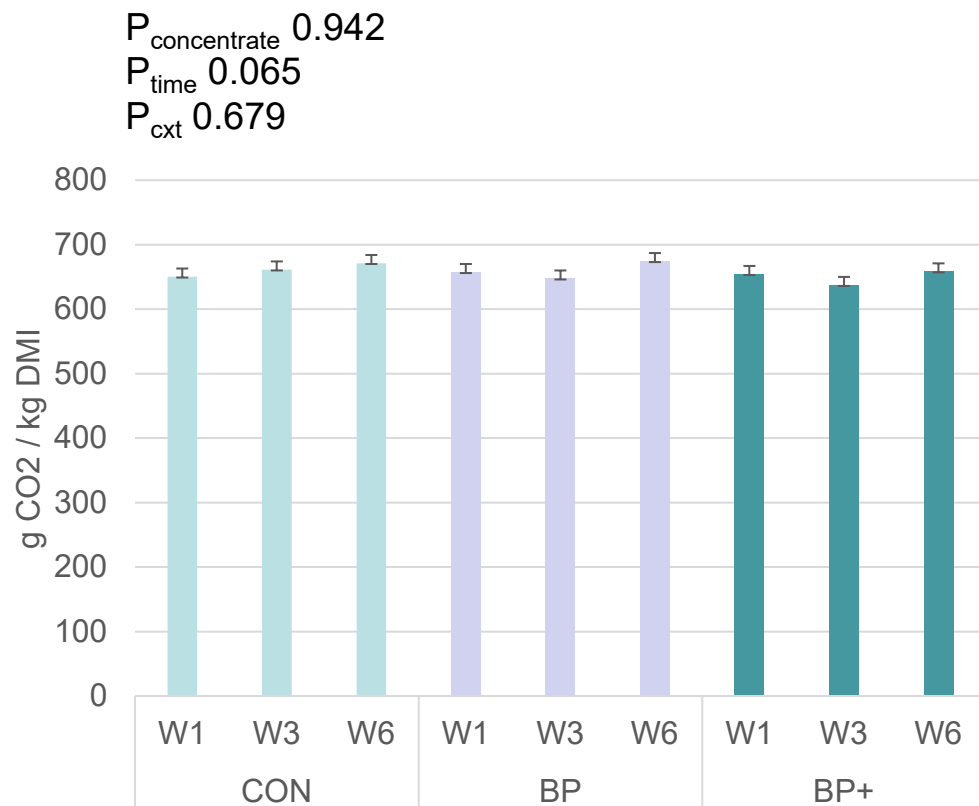
BP and BP+ decreased propionate and valerate →
↓ glucogenic precursors

Shift from gluconeogenic to lipogenic metabolism





Results – Gas emissions

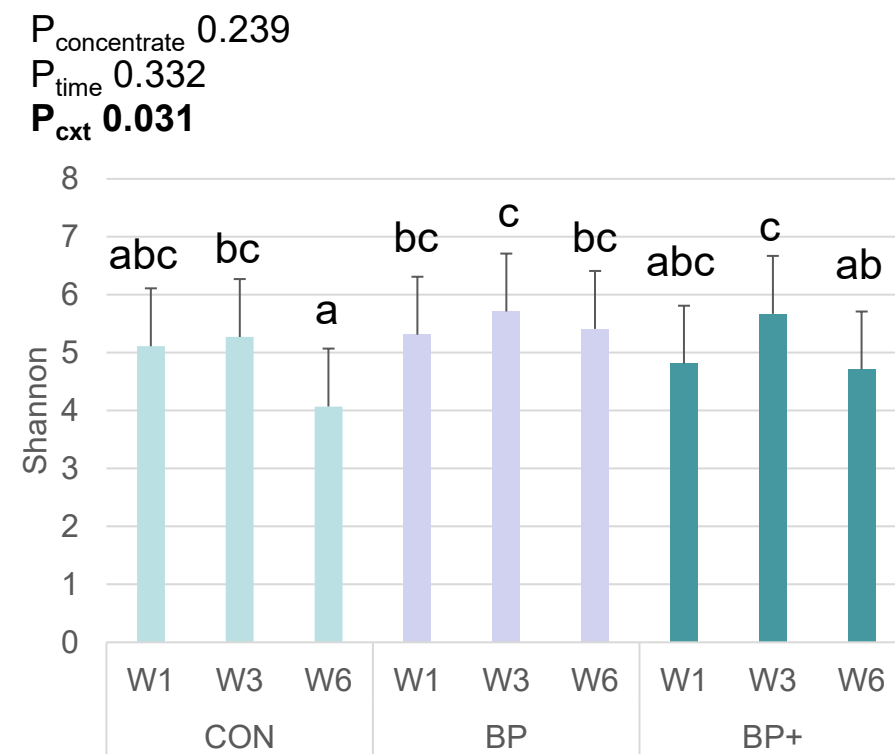
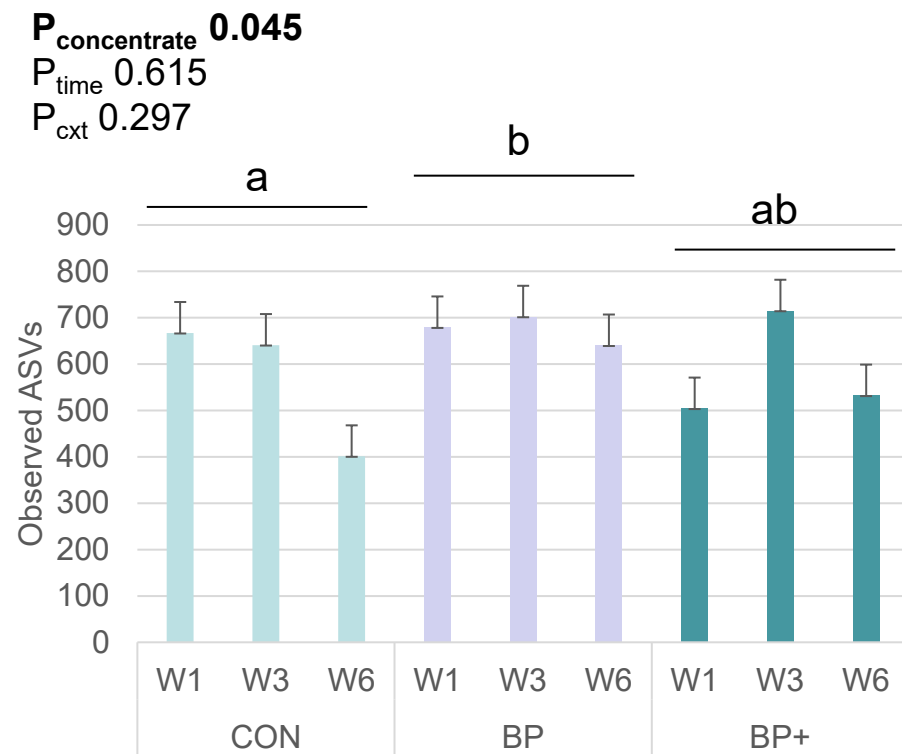


Slight tendencies/differences only in spring trial

No concentrate effect on gas emissions corrected for DMI



Results - rumen microbiota



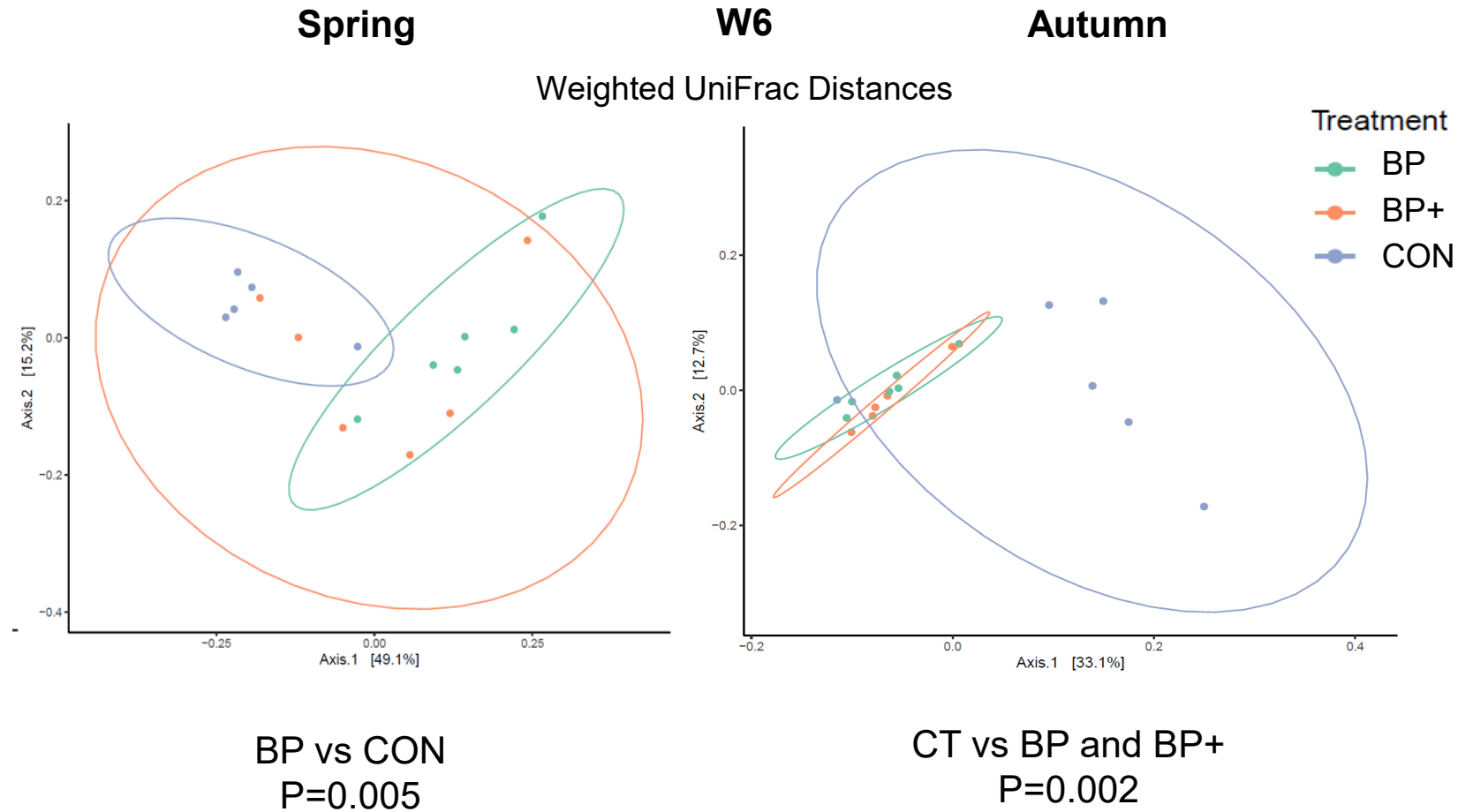
Effects observed only in the spring trial

BP increased Observed ASVs index compared to CON and BP+



Results – rumen microbiota

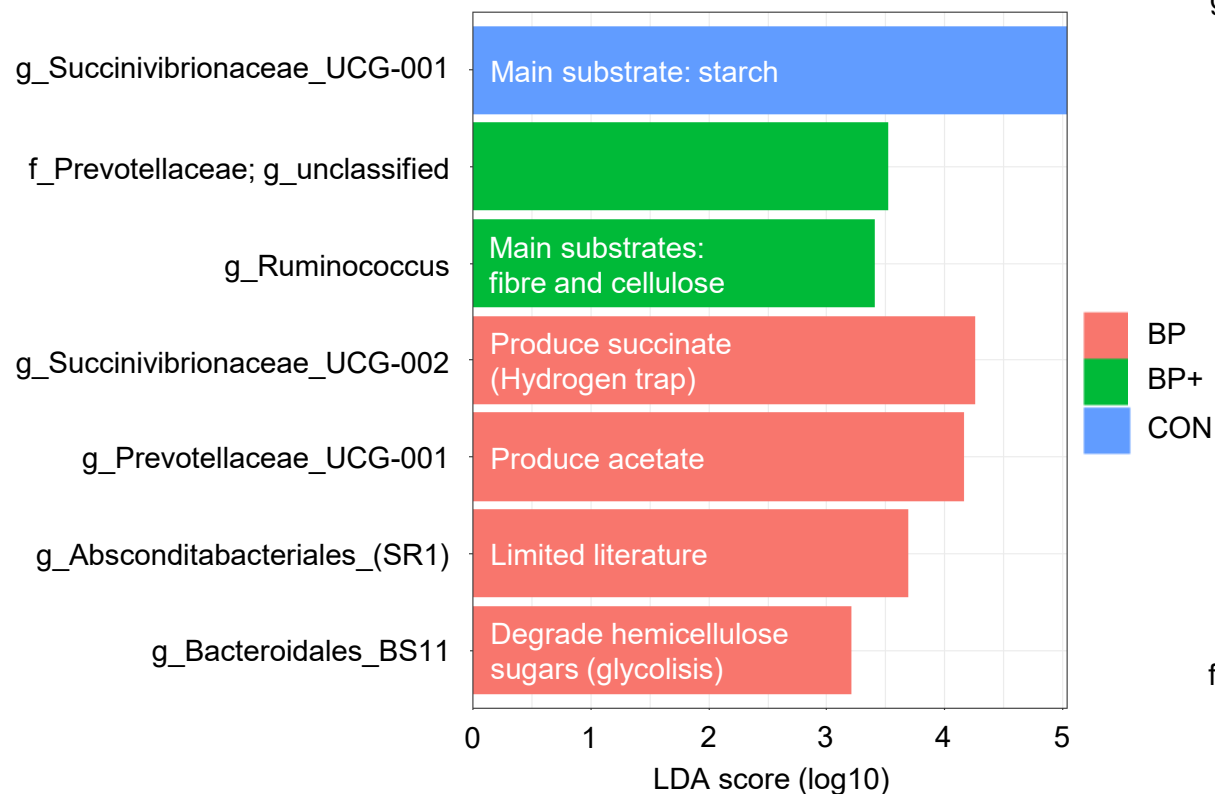
Effects on beta-diversity
only at W6



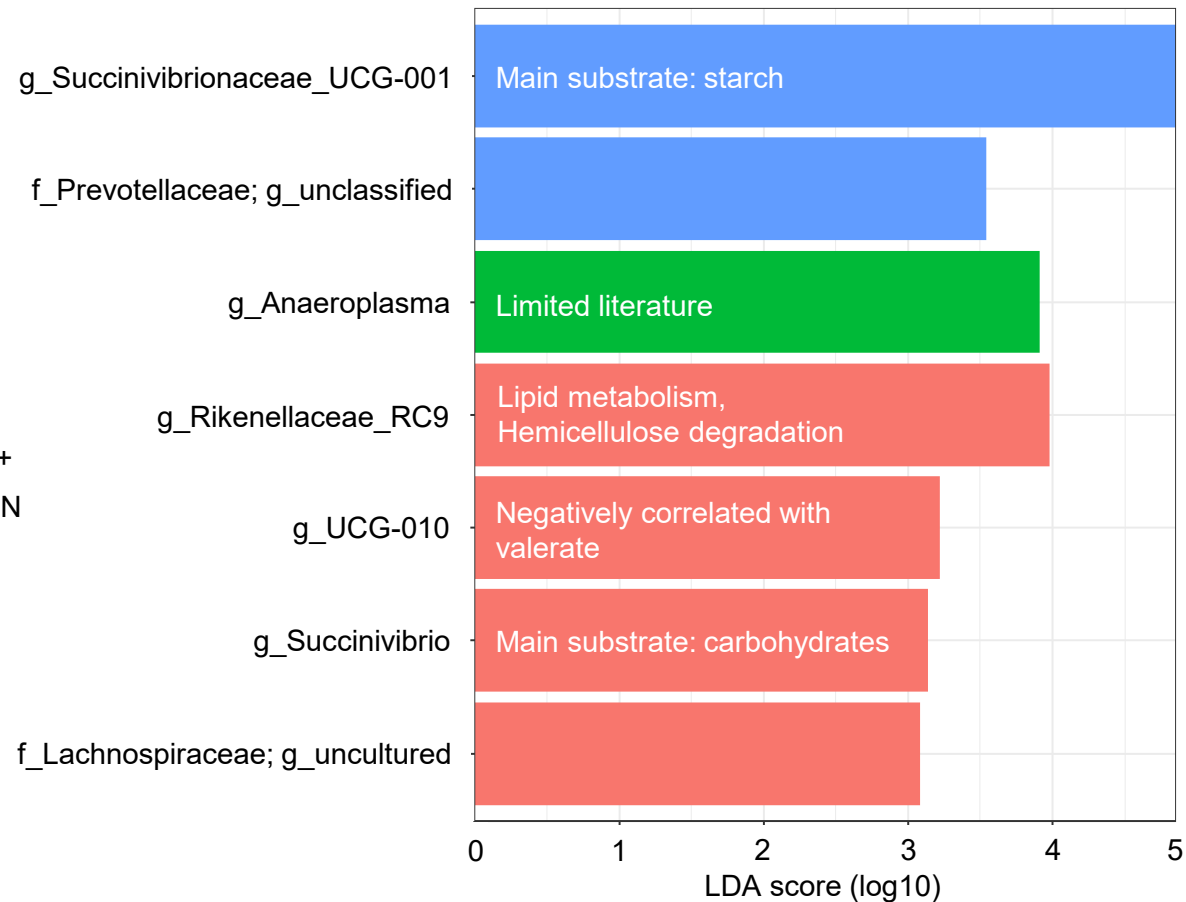


Results – rumen microbiota

Spring



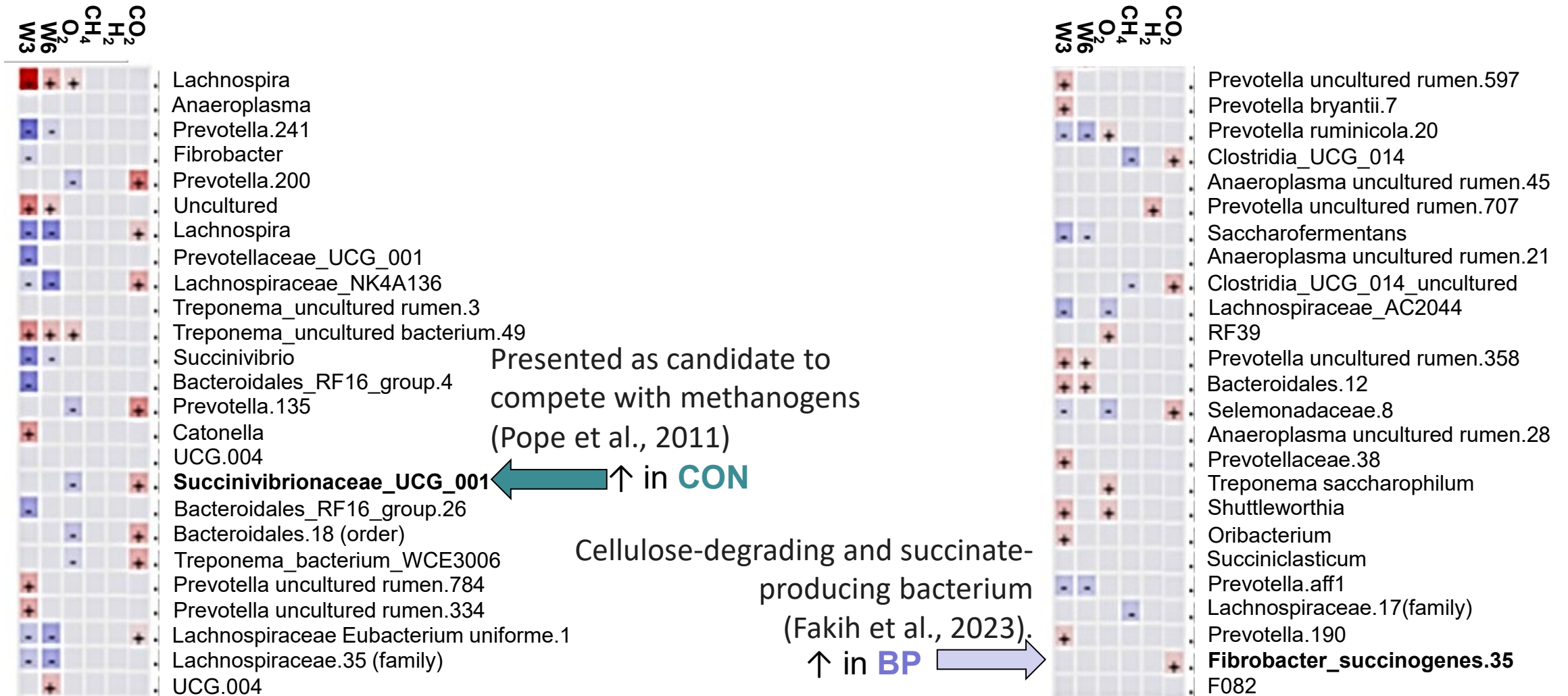
Autumn





Results – Gas Emissions associated microbiota

Top 50 ASVs correlated with gas emissions and time points



Pope et al., 2011. <https://doi.org/10.1126/science.1205760>; Fakih et al., 2023. 10.1128/msystems.01027-22



Conclusion

Replacement of 55% of cereals by bakery products in early lactating dairy cows:

- Does not affect animal DMI, regardless of the presence of cocoa bean shells.
- Does not increase the risk of sub-acute rumen acidosis.
- Only in spring, increased the abundance and the biodiversity of rumen bacteria, but cocoa bean shells mitigated this effect.
- The hypothesis that cocoa bean shells could have reduced gas emissions was not confirmed.

The use of bakery products in concentrates for early lactating dairy cows is promising and could improve the sustainability of the livestock.

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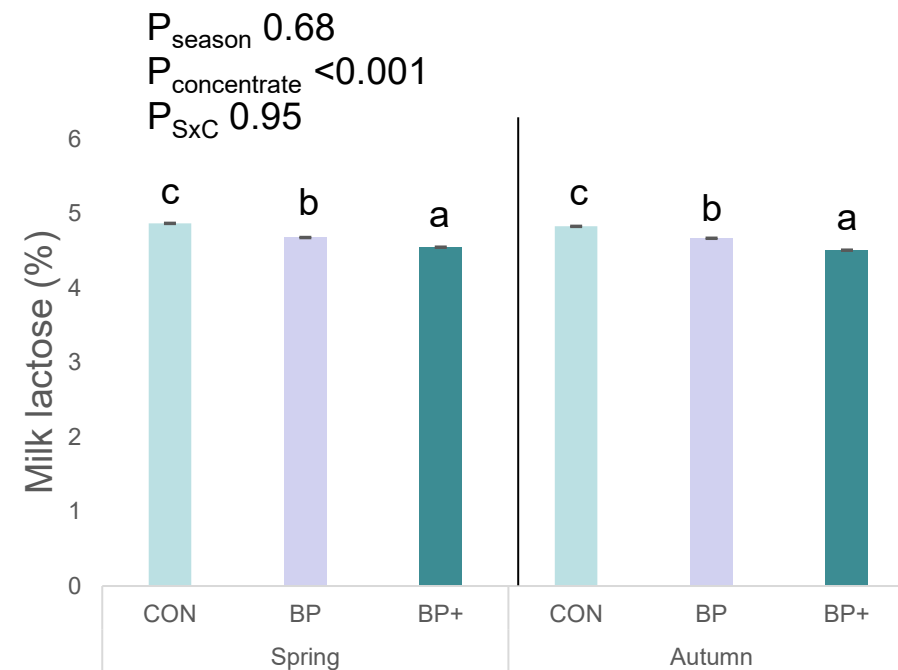
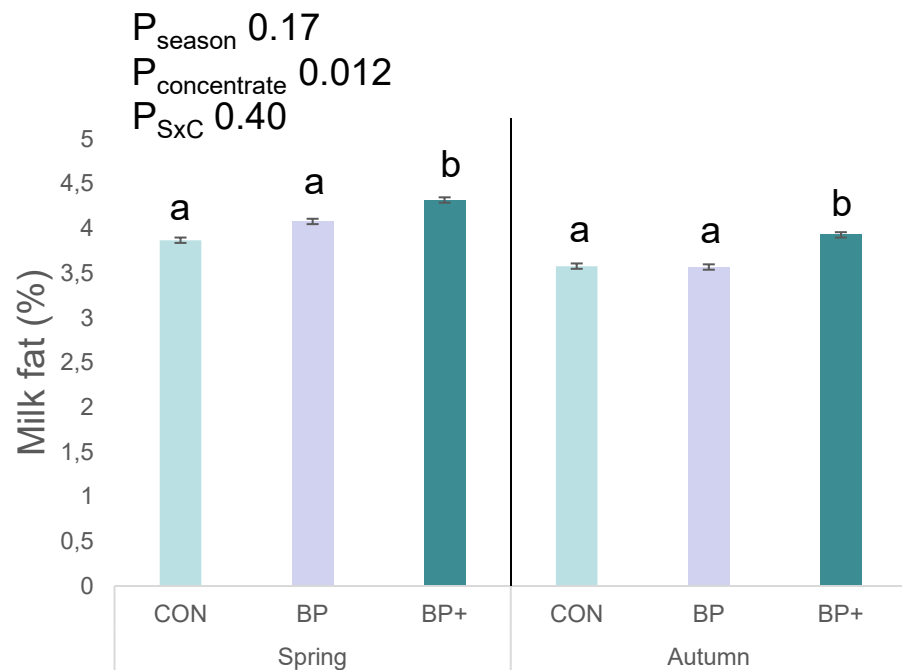
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Photo:

Anna-Marie Reiche (Agroscope)



Results – milk quality



BP+ increased milk fat in both Spring and Autumn trials

CON had higher lactose content compared to BP and BP+ in both Spring and Autumn trials

No diet effect on
Milk yield, ECM yield, protein, urea and somatic cells