



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

uNDF₂₄₀ and fiber digestibility as important parameters for balancing diets: comparison of wheat hay vs. wheat straw in high producing dairy cows

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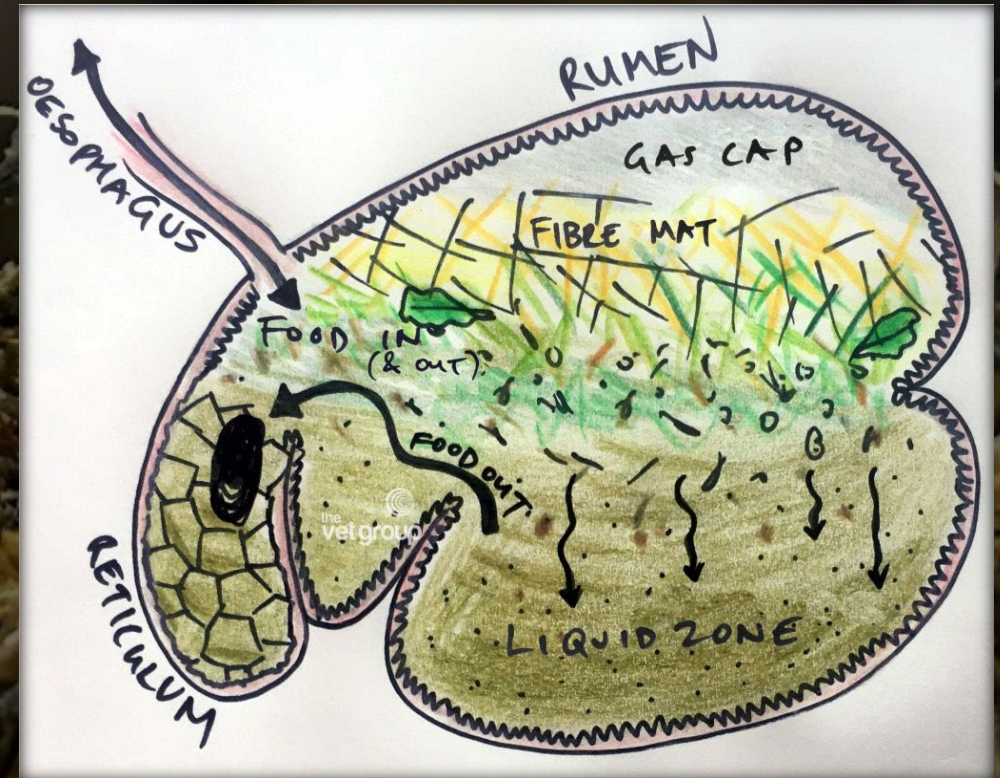
The filling effect of forages

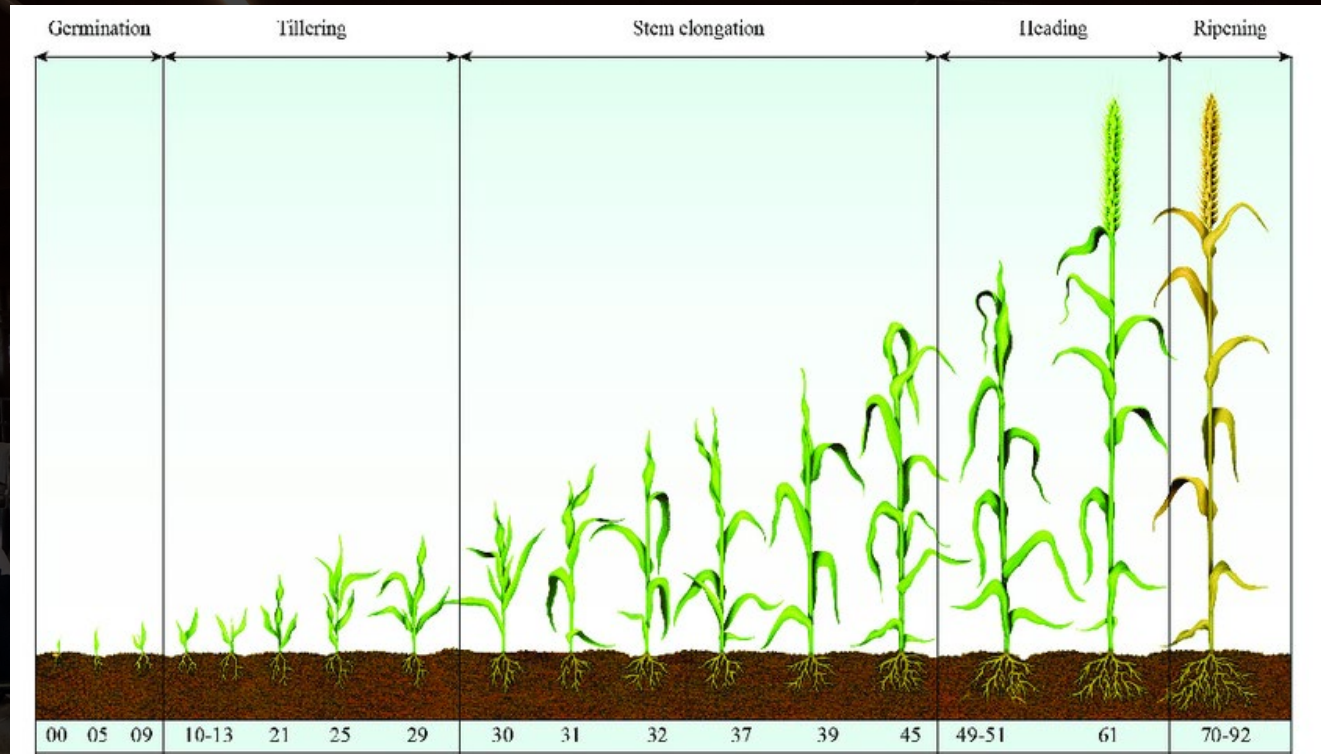
aNDF_{om}

fNDF

peNDF

uNDF







Goal

To test the impact of substitution of **wheat hay** by **wheat straw** on **performance, behavior, and total-tract nutrients digestibility** in isonitrogenous, isoenergetic, and iso-uNDF240 diets fed to **high yielding lactating dairy cows**.



DIETS

Experimental Diets (kg, as-fed basis)	0 Straw	1 Straw	2 Straw	4 Straw
Alfalfa hay, kg as-fed	7.0	7.0	7.0	7.0
Wheat hay, kg as-fed	8.1 ↓	5.8 ↓	3.6 ↓	0 ↓
Wheat straw, kg as-fed	0 ↑	1.0 ↑	2.0 ↑	4.0 ↑
AMS concentrate	5.0	5.0	5.0	5.0
Mix corn-sorghum	7.0	7.0	7.0	7.0
Wagon concentrate	3.7 ↑	4.8 ↑	5.9 ↑	7.5 ↑
Soybean meal solv. 48% CP	0.1 ↑	0.4 ↑	0.6 ↑	0.8 ↑
Min. Vit. Mix	0.1	0.1	0.1	0.1
Sodium bicarbonate	0.1 ↓	0.075 ↓	0.05 ↓	0 ↓
Forage:Concentrate	49:51	45:55	41:59	35:65

FORAGES

Composition (% DM)	Alfalfa Hay	Wheat Hay	Wheat Straw
Number of bales	15	6	8
Crude Protein*	20.58	12.14	3.79
Sugar (WSC)	7.87	9.61	3.32
aNDFom*	36.44	54.87	76.48
ADF	32.03	33.21	52.08
ADL	7.04	3.58	7.11
uNDFom24	23.93	25.93	45.39
uNDFom240*	19.33	14.01	24.4
pdNDF	20.27	41.3	48.17
kD, %.h ⁻¹	7.04	5.8	4.35
kD Fast Pool, %.h ⁻¹	11.4	9.81	7.96
kD Slow Pool, %.h ⁻¹	0.28	0.68	0.35

* Wet analysis

FORAGES

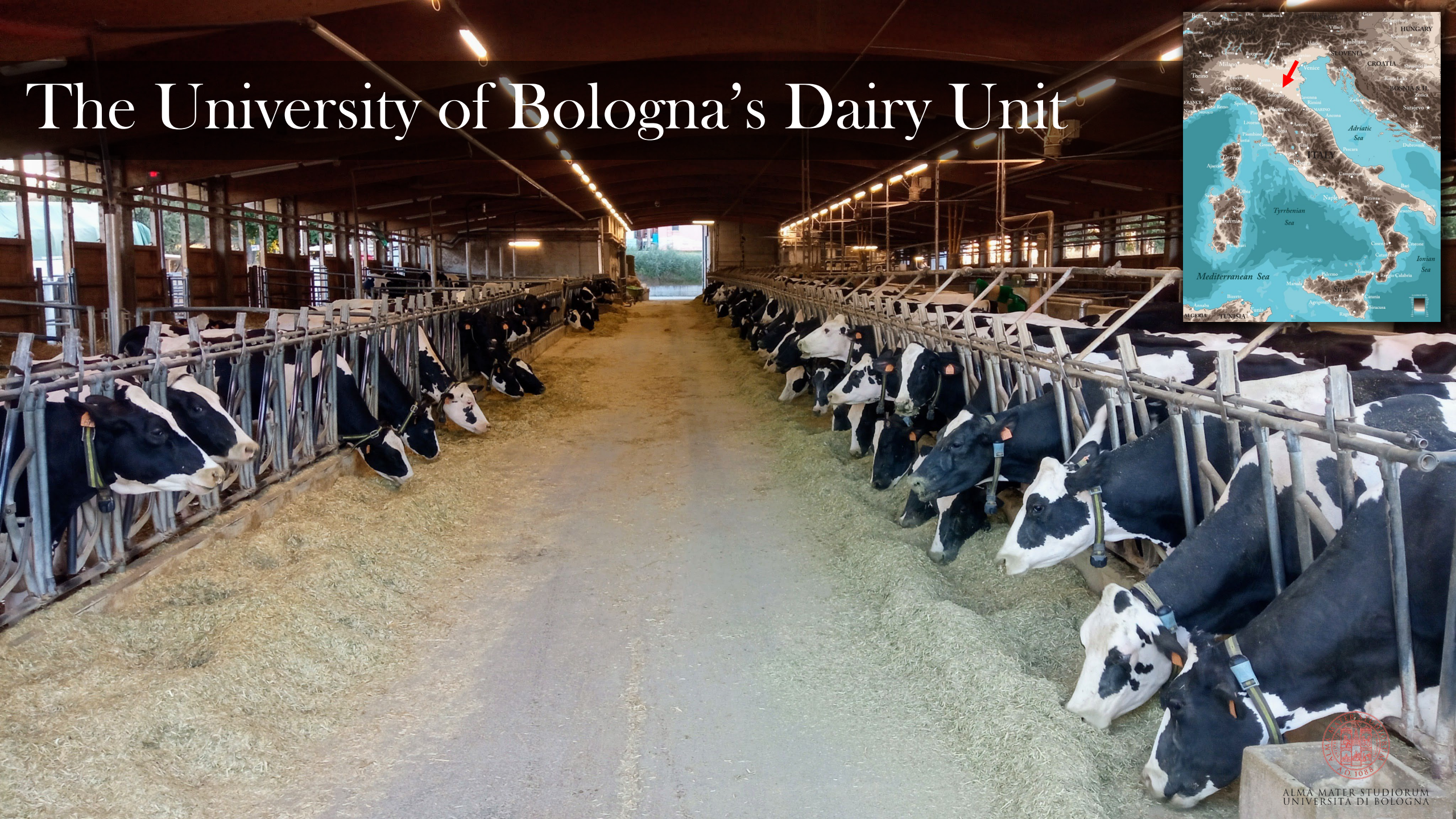
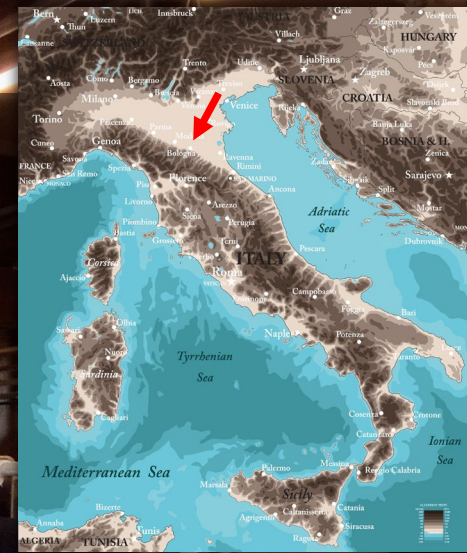
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Alfalfa hay, kg as-fed	7.0	7.0	7.0	7.0
Wheat hay, kg as-fed	8.1 ↓	5.8 ↓	3.6 ↓	0 ↓
Wheat straw, kg as-fed	0 ↑	1.0 ↑	2.0 ↑	4.0 ↑
    				
pef >8 mm PSPS	0.24±0.01	0.24±0.02	0.23±0.08	0.22±0.01
pef >1.18 mm Ro-tap	0.50±0.03	0.48±0.04	0.47±0.05	0.44±0.03

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Cows and Facilities

8 Holstein multiparous cows
4x4 replicated Latin Square



Covariate Period (7d average):

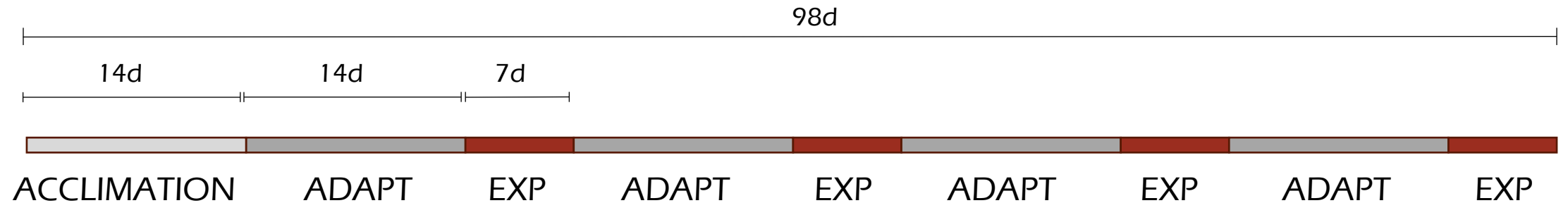
- Days in Milk 78.0 ± 12.75
- Lactation Number 2.9 ± 1.1
- Milk yield 47.7 ± 3.6 kg (Fat $3.41 \pm 0.27\%$, Protein $3.27 \pm 0.08\%$)
- Body weight 652.0 ± 40.7 kg
- Rumination 505.0 ± 73.8 min
- Reticular pH 5.81 ± 0.19



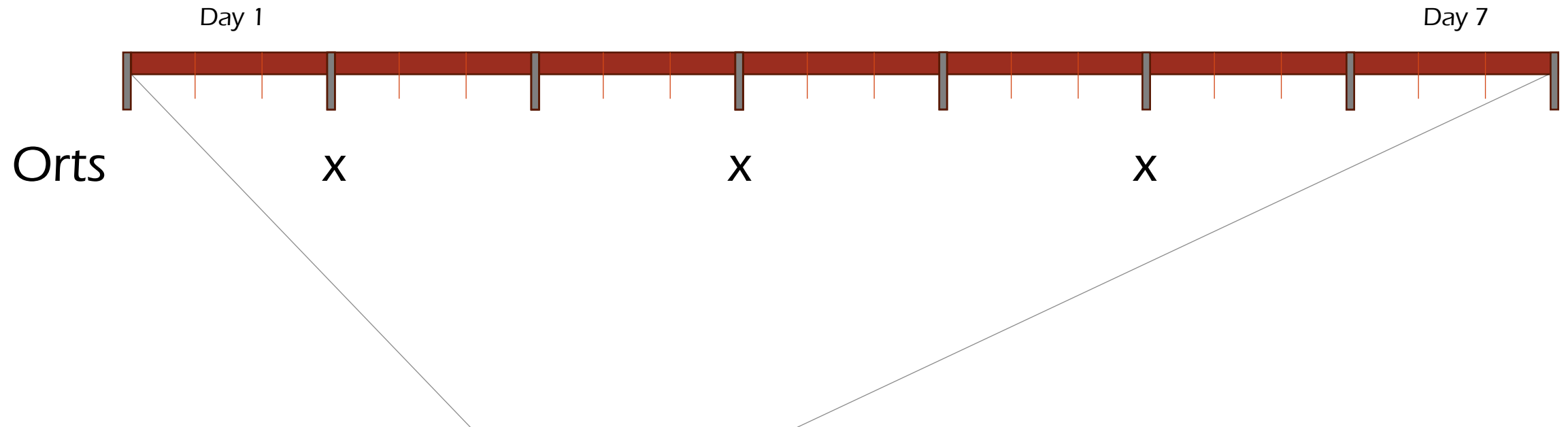
Experimental Design

Automatic data:

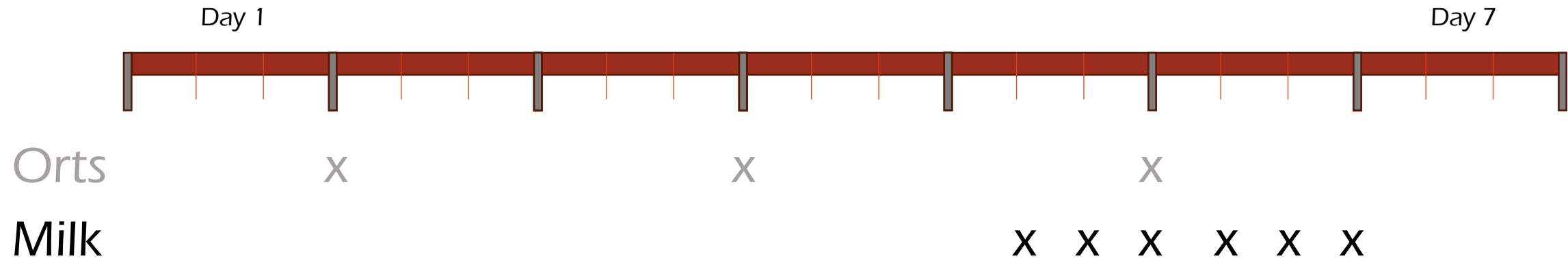
- Milk yield (3x/day)
- Dry Matter and Water Intake
- Rumination
- pH
- Body Weight



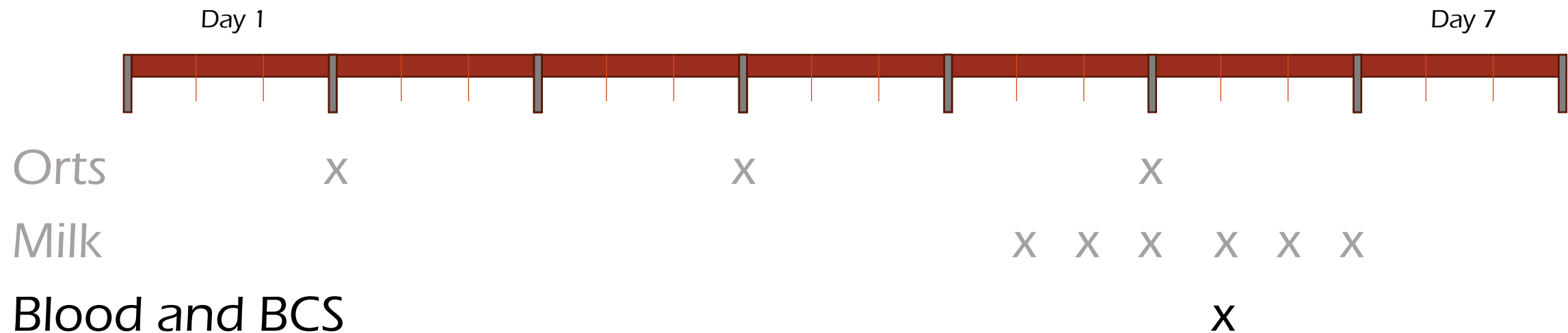
Experimental Design



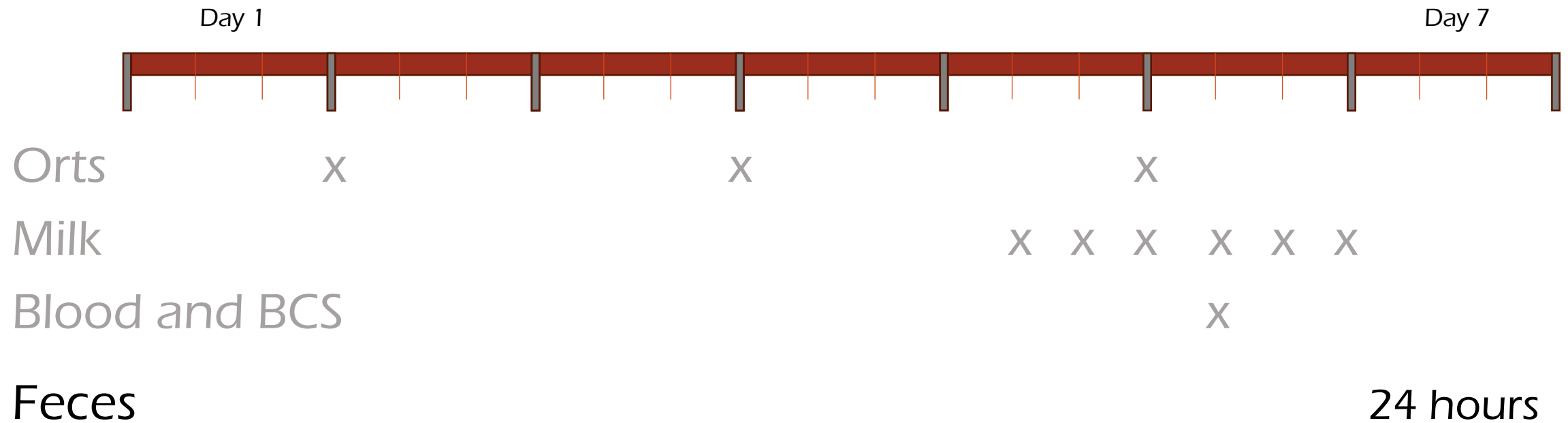
Experimental Design



Experimental Design



Experimental Design



Diet Characteristics (PMR+AMS concentrate)

	0 Straw	1 Straw	2 Straw	4 Straw	SEM
Dry matter, %	88.99	89.63	88.62	89.58	1.98
Crude protein, % DM	14.71	14.80	14.92	15.09	0.58
TFA, % DM	2.53	2.51	2.49	2.60	0.16
WSC, %DM	10.25	10.47	10.63	10.45	0.53
Starch, % DM	22.63	23.18	23.77	25.07	1.35
aNDFom, % DM ¹	35.75	35.47	34.57	33.45	1.28
fNDFom, % DM	22.49	20.89	19.46	18.03	1.57
ADF, % DM	25.57	25.13	24.17	23.63	1.62
ADL, % DM	5.12	5.12	5.05	4.93	0.20
uNDF ₂₄₀ , %DM ¹	12.36	12.35	12.13	12.11	0.41
ME, Mcal/kg	2.55	2.54	2.53	2.51	0.05

¹ Wet analysis



Dry Matter Intake

DM, kg/day	0 Straw	1 Straw	2 Straw	4 Straw	p-value
Total DM intake	30.43	30.41	30.66	30.40	0.99
PMR intake	25.93	25.89	26.13	25.93	0.99
AMS concentrate intake	4.50	4.52	4.53	4.46	0.59
Forage intake ¹	15.24 ^A	13.97 ^{AB}	12.93 ^B	11.09 ^C	<.01
Concentrate intake ¹	15.19 ^C	16.44 ^{BC}	17.73 ^B	19.31 ^A	<.01

¹ Calculated



Fiber Fractions' Intake

DMI, kg/day	0 Straw	1 Straw	2 Straw	4 Straw	p-value
uNDF ₂₄₀ intake	3.46	3.42	3.38	3.26	0.59
forage uNDF ₂₄₀ intake	2.38	2.28	2.25	2.12	0.09
peNDF >1.18mm intake	4.36 ^A	4.00 ^A	3.83 ^A	3.06 ^B	<.01
peuNDF >1.18mm intake	1.41 ^A	1.31 ^A	1.26 ^{AB}	1.01 ^B	<.01

Forage uNDF240: 0.36% BW



Reticular pH and Rumination

Parameter	0 Straw	1 Straw	2 Straw	4 Straw	p-value
Reticular pH, daily average	5.73	5.75	5.72	5.74	0.99
Rumination, min/day	549	542	535	529	0.89
Rumination/aNDFom intake, min/kg	49.95	48.99	51.81	52.80	0.28
Rumination/peNDF intake, min/kg	110.10 ^B	111.58 ^B	120.50 ^B	135.30 ^A	<.01
Rumination/fNDFom intake, min/kg	77.25 ^C	80.66 ^{BC}	88.53 ^{AB}	95.34 ^A	<.01



Productive Performance

Parameter	0 Straw	1 Straw	2 Straw	4 Straw	p-value
ECM*, kg	43.21 ^B	43.67 ^{AB}	44.58 ^A	44.24 ^{AB}	0.03
Fat, %	3.29 ^A	3.31 ^A	3.09 ^B	3.05 ^B	<.01
Fat, g	1443	1456	1436	1426	0.58
Protein, %	3.14	3.16	3.15	3.10	0.22
Protein, g	1388 ^C	1412 ^{BC}	1480 ^A	1458 ^{AB}	<.01
Lactose, g	2104	2122	2238	2213	0.69
MUN, mg/dl	10.03	10.65	10.19	10.47	0.72
<i>De novo</i> , % FA	30.05	30.05	30.59	29.47	0.62
Mixed, % FA	37.44	36.86	37.67	36.04	0.39
Preformed, % FA	32.27	32.85	31.46	34.25	0.15

*Energy-Corrected Milk (Tyrrell and Reid 1965): $ECM = (0.327 \times \text{kg milk}) + (12.95 \times \text{kg fat}) + (7.2 \times \text{kg protein})$



Productive Performance

Parameter	0 Straw	1 Straw	2 Straw	4 Straw	p-value
ECM*, kg	43.21 ^B	43.67 ^{AB}	44.58 ^A	44.24 ^{AB}	0.03
Fat, %	3.29 ^A	3.31 ^A	3.09 ^B	3.05 ^B	<.01
Fat, g	1443	1456	1436	1426	0.58
Protein, %	3.14	3.16	3.15	3.10	0.22
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<i>De novo</i> , % FA	30.05	30.05	30.59	29.47	0.62
Mixed, % FA	37.44	36.86	37.67	36.04	0.39
Preformed, % FA	32.27	32.85	31.46	34.25	0.15
Body Weight, kg	678	667	676	674	0.98
BCS	2.94	2.81	3.00	2.81	0.13
BHB, mmol/L	0.403 ^{BC}	0.473 ^A	0.443 ^{AB}	0.399 ^C	<.01

*Energy-Corrected Milk (Tyrrell and Reid 1965): $ECM = (0.327 \times \text{kg milk}) + (12.95 \times \text{kg fat}) + (7.2 \times \text{kg protein})$



Total-tract Digestibility¹

% of each nutrient	0 Straw	1 Straw	2 Straw	4 Straw	p-value
OM	69.98	71.23	70.71	71.77	0.42
Starch	96.98	96.76	96.67	96.59	0.63
Crude Protein	68.77	69.65	69.74	71.40	0.14
aNDFom	43.01	44.19	41.10	40.98	0.49
ADF	41.41	42.67	39.57	41.19	0.61
pdNDF24	76.90	77.01	76.64	75.86	0.81
pdNDF240	63.12 ^A	62.29 ^A	58.82 ^B	58.11 ^B	<0.01

¹Digestibility^j (%) = (intake^j – fecal flow^j) × 100/intake^j



Conclusions

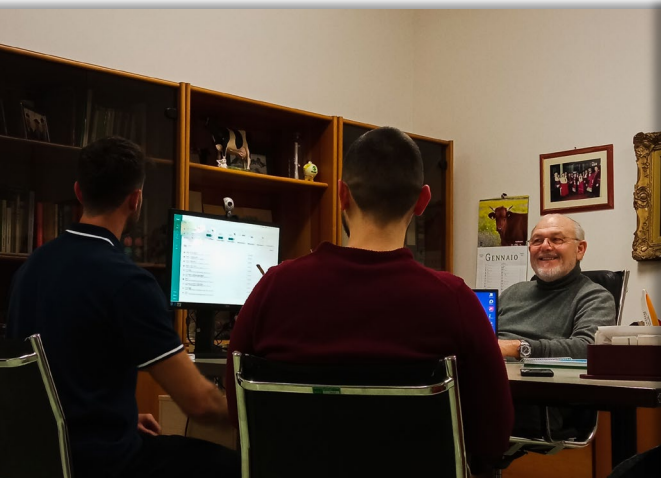
The diet with **3.6 kg of Wheat straw** induced the **same rumination** per kg of DM than the diet with **7.4 kg of wheat hay** (DM basis).

Total **uNDF₂₄₀** and forage **uNDF₂₄₀** were demonstrated to be kept in a **stable amount in the gastrointestinal tract**, which could be important to drive **dry matter intake** and keep **proper ruminal function**.

peNDF and **peuNDF** seem to not completely explain the “**dietetic straw effect**”.



Thank you!



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