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FEEDING STUFF

Protein-effizient dairy cattle feeding

New feeding strategies are necessary in order to simultaneously feed in a performance-oriented and cost-efficient manner, to reduce nutrient excretion and to comply with limit values.

In order to feed as compatible with environment and performance-based as possible, attention should be paid to nitrogen (N) efficiency in ration design.

In this way, emissions of N-containing air pollutants can be reduced, animal health promoted and resources and thus also costs are saved.

For this, the crude protein content of the ration in connection with the urea content in the milk is a suitable control instrument.

IN A NUTSHELL:

Advantages of protein efficient feeding:

- cost savings
- animal health
- environmental protection by reducing NH3-emissions

Milk urea content as an indicator of protein supply in line with requirements:

- target value 15-20 mg/dl (Brown Swiss 17-22 mg/dl)
- regular monitoring on a herd basis using results from tank milk

Implementation of protein-efficient feeding:

- sufficient energy supply for an efficient use of the protein (mind the energy-protein-ratio in the ration)
- use of rumen-protected proteins
- matching the ruminal nitrogen balance (RNB) by:
  - replacing protein components with energy components if urea levels are too high
  - supplement staple feed with high-energy silage or hay at grazing (in autumn)
- consideration of the different protein requirements at different stages of lactation
- consideration of different protein contents in different grassland growths

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Nitrogen (N) efficiency

What is N-efficiency?

- Control parameter for the conversion of nitrogen from feed to milk.
- The higher the N efficiency, the more feed-N the animal was able to convert into milk protein.

$$\frac{\text{milk per day x protein content / 6,38}}{\text{d.m.-uptake x crude protein – content of complete TMR / 6,25}} \times 100$$

- Target value: ≥ 30% efficient use. Values ≥ 30% indicate that the cows efficiently convert the ingested protein amount into milk protein.
- Too low → more feed protein is needed per kg N in milk.

Milk urea content

Indicator for a needs-based protein supply

- Target value: 15-20 mg/dl (Brown Swiss 17-22 mg/dl).
- RNB (ruminal nitrogen balance) of the ration from 0 to -0.8 corresponds to a urea content in the milk of about 17-20 mg/dl.
- Consider on a herd basis.
- Use urea values from the milk test ring for the tank milk or the milk performance test for the regular monitoring. (Fig. 1).
- Other influencing variables: animal-specific (lactation stage, breed, weight) and management-related factors (frequency of feeding and milking).

FPR ≤ 1,4	Optimal energy supply D Protein deficiency	**Optimal energy supply** E Optimal protein supply	Optimal energy supply F Protein excess
FPR > 1,4	Energy deficiency A Protein deficiency	Energy deficiency B Optimal protein supply	Energy deficiency C Protein excess
	150	urea content (mg/l)	250

▲ Fig. 1: The 6-field-table according to Losand et al. (2016) assesses energy supply according to the fat/protein ratio (FPR).

Advantages of an improved N-efficiency

Economy

Cost savings for protein feed through optimal protein use.

e.g.: In a project work, an annual cost saving of € 2920 per farm was calculated with an nXP reduction of 1%. (0,08 €/cow and day x 100 cows x 365 days).

Animal health

Detoxification of surplus via the liver. This costs energy and can lead to pregnancy and claw problems.

Environment

Reduction of Ammonia(NH3)-emissions.

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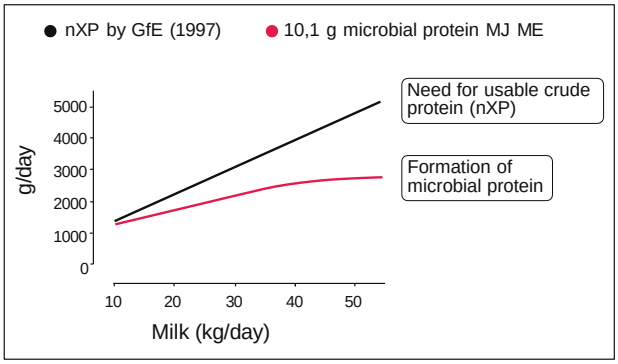
Protein metabolism of the cow

Ruminohepatic cycle:

Through the ruminohepatic cycle, the dairy cow is able to level out a slight N- and thus protein deficiency. Ammonia (NH3) produced in the rumen is "recycled" in the liver and partly reaches the rumen via the saliva, where it is available for protein re-synthesis or amino acid synthesis (Fig. 2).



▲Fig. 2: according to Breves et al. 2016; lactation, milk production, nutrient fluxes and regulation.

kg DM/ cow and day	25 kg milk	30 kg milk	35 kg milk	40 kg milk
20	130	151		
22		137	157	
24			143	161

◀ Tab. 1: Protein requirements in the total ration (nXP in g/kg DM): 700 kg liveweight and 3.4% protein; according to GfE (2001), Energy and Nutrient Requirements of Agricultural Livestock.

Feeding stuff	DM [g]	NEL [MJ]	XP [g]	nXP [g]	UDP [%]	RNB [g]
Meadow grass, 1st cut, elongation	160	6,70	195	144	10	8
Meadow grass, 1st cut, shooting	180	6,33	175	142	15	5
Meadow grass, 2nd and further cuts, elongation	170	6,28	180	136	10	7
Clover grass, 1st cut, in buds	160	6,37	215	149	15	11
Grass silage wilted, 1st cut, begin elongation	350	6,65	190	149	15	7
Grass silage wilted, 1st cut, begin shooting	350	6,36	180	143	15	6
Grass silage wilted, 2nd and further cuts, begin elongation	350	6,20	188	141	15	7
Grass silage wilted, 2nd and further cuts, begin shooting	300	5,96	174	136	15	6
Mais silage, dough stage, average share of grains	300	6,55	84	133	25	-8
Meadow hay, 1st cut, mid-flowering	860	5,27	98	118	25	-3
Meadow hay, 2nd and further cuts, mid-flowering	860	5,31	120	121	20	0
Dried pulp	906	7,32	83	142	45	-10
Brewer's grain silaged	247	6,69	249	188	40	10
Barley 4-row (in kg DM)	880	8,14	125	164	25	-6
Wheat (in 1000 g DM)	880	8,53	137	170	20	-5
Rapeseed extraction meal (in 1000 g DM)	890	7,16	387	252	35	22
Soybean extraction meal 44% crude protein (in 1000 g DM)	880	8,64	500	291	30	34
Soybean extraction meal , rumen-protected (in 1000 g DM)	880	8,64	500	438	65	10

▲ Tab. 2: Protein content of feed: 700 kg liveweight and 3.4 % protein; according to LfL (2021) Gruber table for feeding dairy cows, breeding cattle, sheep, goats.

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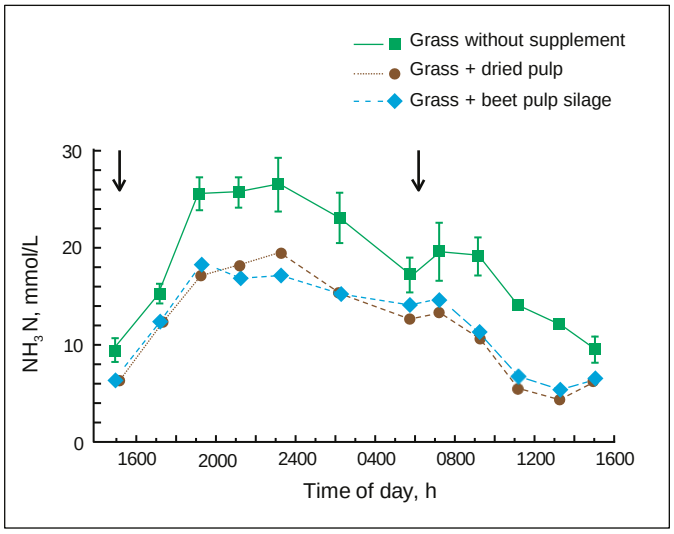
Implementation of protein-efficient feeding

Goal: Optimize the protein content of the ration to a level in line with requirements while maintaining or even increasing performance (increase in protein efficiency).

→ Adapt the ration as closely as possible to the protein requirements of the animals and adjust it regularly on the basis of the urea content in the milk (Fig. 3).



▲ Fig. 3: NH_3-concentration in the rumen (Annelies Bracher SHL, Agroscope, 2011).

	DM Uptake (kg/day)	nXP (g/kg DM)	XP (g/kg DM)
Dry standing cows	11,5	115	120
Early lactation	19,0	150	155
Mid-lactation	21,0	145	150
Late lactation	17,0	130	135

▲Tab. 3: Protein requirement at different lactation stages: Protein requirement at different lactation stages at 8000 kg ECM per cow and year, energy requirement 43500 MJ NEL; DLG Merkblatt (2020).

Feed monitoring:

- Calculation of nutrient supply
- Control of feed consumption
- Ration composition + feed analyses

Measures (TMR feeding):

- Sufficient energy supply:

  » In case of NEL deficiency, there is no efficient use and conversion of protein → Losses of valuable N-sources via faeces and urine.

  » High contents in crude protein + low NEL-content → Protein surplus.

  » Pay attention to the energy-protein-ratio in the ration!

- Use of rumen-protected proteins: Improves quality and utilization of the protein.
- Harmonizing the ruminal nitrogen balance (RNB):

  » Proportionate replacement of protein components with energy sources, e.g.: cereal grains, maize meal, dried pulp, etc.

  » Targeted use of root crops, beet pulp, whole plant maize, maize cob meal, whole plant cereals, pomace, cereal grain and pure starch (with lower contents in crude protein).

  » Balance with staple feed: hay added to grazing in summer or high-energy silage.

- Take into account the different protein requirements at different stages of lactation (Tab. 3).

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Example ration

Guide values for rations with N-optimised feeding with reduced NH_3 emission potential:

→ nXP-content: > 15,0 bis 15,4% (best combination of good efficiency with highest milk production with 31 kg ECM and urea levels of approx. 20 mg/dl milk).

Feeding stuff	DM [g]	NEL [MJ]	Crude protein [g]	nXP [g]	UDP [%]	RNB [g]
Grass silage, 1. cut wilted., shooting	8,23	6,37	180	143	15	+6
Mais silage, wax maturity, 35% DM	5,95	6,66	82	134	25	-8
Barley straw	0,43	3,64	45	80	45	-6
Brewer's grain silage	0,86	6,69	249	188	40	+10
Barley, 2-row	2,20	8,21	125	165	25	6
Grain mais	1,06	8,38	102	166	50	-10
Rapeseed extraction meal	0,71	7,16	387	252	35	+22
Mineral feed cattle, dairy cow, 22% Ca, 2% P	0,14					
Cattle salt	0,03					
Milk performance feed 18-4	1,32	7,95	205	211		-1
Total ration	20,93	141,89	3,131	3,166	24	-5
per kg DM	38% DM	6,78	150	151	24	0

▲ Tab. 4: Example of an N-efficient ration. Calculated for a Simmental herd with a liveweight of 700 kg and a production of 28.5 kg milk/day (requires both, a high forage quality and a high forage intake).

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Implementation of a protein-efficient feeding

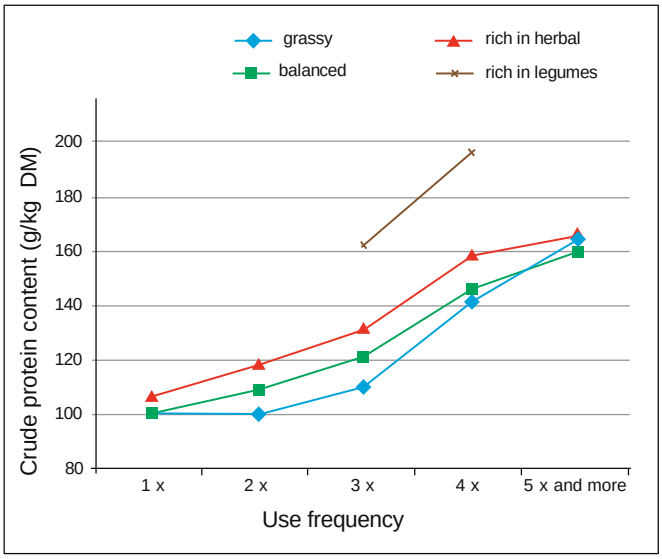
Measures specifically for grassland farms

- Supplementary feeding: Compensation for protein-rich green fodder.
- Mind/balance different protein contents in different growths:

  » Later stage of development - lower crude protein contents.

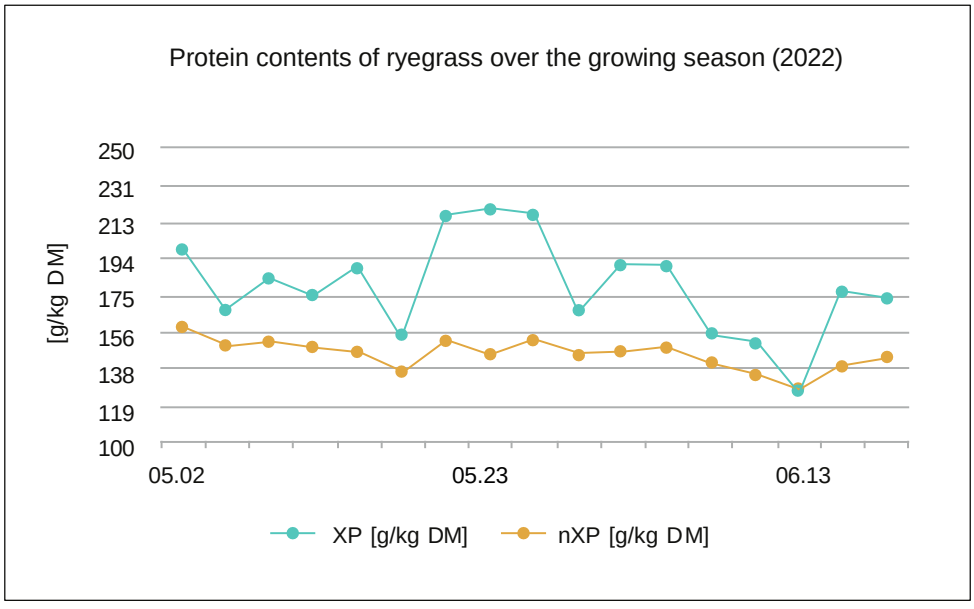
  » Protein content higher with more frequent cuts (Fig. 4).

  » Early forage analysis of silages to detect higher sugar contents and lower protein contents in later cuts and to mix the different cuts with each other if necessary.



▲Fig. 4: Interactions of crude protein x use frequency related to different quality parameters of grassland fodder in the 1st growth; Resch et al. (2015).

- Targeted utilization of diurnal variations in the sugar content of green fodder → higher sugar contents in afternoon and evening pastures.
- Grass varieties with lower sugar content tend to lead to higher milk urea contents. In addition, to a lower protein efficiency.
- Pay attention to the development of the crude protein and usable crude protein contents over the year: higher protein contents in autumn. Supplementary feeding in the barn with cereals or hay can be useful and increase performance (Fig. 5).



▲Fig. 5.: Protein content of ryegrass - measurements from the first half of the growing season. LAZBW Baden-Württemberg 2022.