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Dry matter intake in dairy cows – new insights

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ECVCN Residents Meeting, 4th September 2018, Munich

ESVCN Congress 2003, Hanover

What bovine practitioners need to know on dairy cow nutrition?

Dr. Jürgen Rothert, in Germany well known successful bovine practitioner:

HOW TO MAXIMIZE THE DRY MATTER INTAKE of Dairy Cows!

High yielding dairy cows – the discrepancy in the capacity for feed intake and for milk production –

➡ relative size of the udder and of the cow's rumen ?

Influences on dry matter intake of dairy cows

Feed intake capacity
- Body weight/breed
- Rumen volume/size
- Energy requirement
- Body fat stores (start of lactation)
- Lactation stage (max.: 10th - 12th week)

Ration composition

Roughage
- Digestibility (crude fibre content)
- DM content, structure; palatability

Concentrates
- Type/content of nutrients
- Supplement suitability; palatability

DM-INTAKE

Management/Animal diseases
- Social stress, cows' comfort
- Climatic influences (pasture, stable)
- Possibility to move
- Diseases/injuries/pain (claws!)
- Metabolic disorders (feed off, ketosis)

Feeding technique
- Technique: TMR/separate offer
- Shares basic/concentrated feed
- Distribution/availability of feed
- "Freshness" of the feed/diet
- Water supply/quality

Do you have an idea on the "normal range" of DM intake in cattle?

Values in kg DM per 100 kg BW ("thumbrules") using feeds/a ration common for ruminants/cattle!

dairy cows	at maintenance:	~ 1.8 – 2.0
	at peak lactation:	~ 3.8 – 4.0
	at end of dry period:	~ 1.4 – 2.0
beef cattle (corn silage plus concentrates)	start of fattening (150 kg BW)	~ 2.3
	mid of fattening (350 kg BW)	~ 2.0
	end of fattening (550 kg BW)	~ 1.7

Detailed data on DM intake of dairy cows – why these values are essential ones?

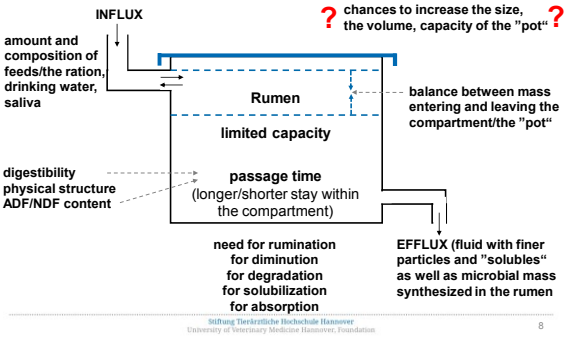
- **required to formulate a suitable ration!**
  for example: > 50 % of total DM intake from roughage!
  50 % of what? → you need data in kg
- **necessary to set values of concentrations**
  for example: there is a need of x g sodium per cow per day
  x g sodium in 15/20/25 kg DM → higher/lower concentrations
- **helpful when you are faced to "insufficient performance/feed intake"**
  for example: due to diseases, non-professional management,
  poor feed quality?

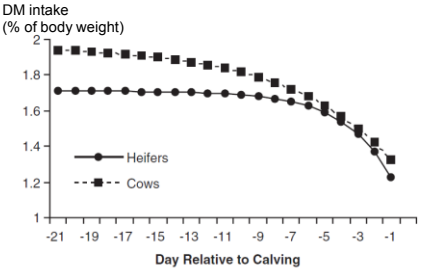
The DM intake of dairy cows – a key information for bovine practitioners

- **Level of DM intake in high yielding dairy cows determines the risk for "production diseases"**
  - direction: ketosis or ruminal acidosis
  - further indirect effects of both: fertility/claw health …
- **Level of DM intake indicates the "management quality"**
  - housing/feeding/cow comfort/hygiene …
  - maximizing feed intake needs farm specific measures
- **Level of DM intake in the different phases (dry period/early/peak/late lactation)**
  - consequences may become obvious with a delay of some weeks
  - for example: high BCS at calving → prolonged negative energy balance

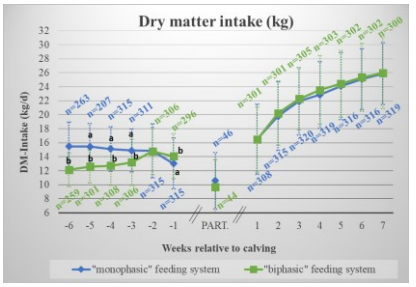
The dry matter intake of dairy cows – ideas regarding "limits"

"The pot is covered"





DM intake of dairy cows (primiparous and multiparous) during the last 3 weeks before calving (GRUMMER et al. 2004)



DM intake of multiparous dairy cows (German Holstein, mean body weight one day after calving: 722 kg) in the dry period and early lactation, fed a TMR based on corn- and grass-silage (MEETSCHEN et al. 2018)

JENSEN et al. (2015): (Livestock Science 176, 91 – 103) **Evaluation of five models predicting feed intake by dairy cows fed mixed rations**

"The GRUBER MODEL, which predicted DMI most accurately did so due to its negligible systematic error …"

use the GRUBER model from Austria on farms with TMR

How to predict the DM intake of dairy cows during lactation? → According to GRUBER et al. (2004)

Variation of DM intake is related to

- **impact of the animal with its:**
  - breed
  - number of lactations
  - stage of lactation
  - daily milk yield
  - body weight
- **impact of the ration/feeding concept**
  - proportion of concentrate
  - energy density of roughage

At a given breed: body weight, milk yield, amount of concentrates, NEL of roughage: $r^2 = 0.870$!

Equations of GRUBER et al. (2004) to predict the DM intake of dairy cows (including fixed factors and day of lactation as variable; values in kg DM)

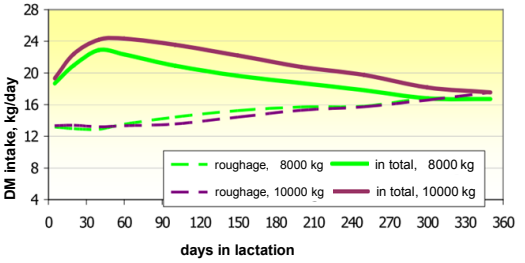
Feed offer Parameter		separately[1]	TMR[2]
Intercept		3.878	2.274
Breed			
- Simmental		- 2.631	- 2.169
- Brown		- 1.826	- 1.391
- German Holstein			
○ common management level		- 2.720	- 1.999
○ high management level		- 1.667	- 0.998
Number of lactation			
- 1		- 0.728	- 0.658
- 2 – 3		+ 0.218	+ 0.236
- 4		+ 0.000	+ 0.000
Day of lactation (t)		$a + b \cdot (1 - e^{-c \cdot t})$	
	a	- 4.287	- 5.445
	b	+ 4.153	+ 5.298
	c	+ 0.01486	+ 0.01838
Body weight (bw), kg		$(a + b_1 \cdot t + b_2 \cdot t^2) \cdot bw$	
	a	+ 0.0148	+ 0.0173
	b_1	- 0.0000474	- 0.0000514
	b_2	+ 0.0000000604	+ 0.0000000599
Milk yield (M), kg/day		$(a + b_1 \cdot t + b_2 \cdot t^2) \cdot M$	
	a	+ 0.0825	+ 0.2010
	b_1	+ 0.0008098	+ 0.0008080
	b_2	- 0.000000966	- 0.000001299
Concentrate amount (C_{kg}), kg DM		$(a + b_1 \cdot t + b_2 \cdot t^2) \cdot C_{kg}$	
	a	+ 0.6962	-
	b_1	- 0.0023289	-
	b_2	+ 0.0000040634	-
Concentrate proportion ($C_%$), % DM		$(a + b_1 \cdot t + b_2 \cdot t^2) \cdot C_%$	
	a	-	+ 0.0631
	b_1	-	- 0.0002096
	b_2	-	+ 0.0000001213
Energy density (E) of roughage, MJ NEL/kg DM		+ 0.8580 · E	+ 0.6990 · E
IT_a[3], kg DM	total =		
DM intake, corrected, kg DM		$0.47 + 0.930 \cdot IT_a$	$0.71 + 0.920 \cdot IT_a$

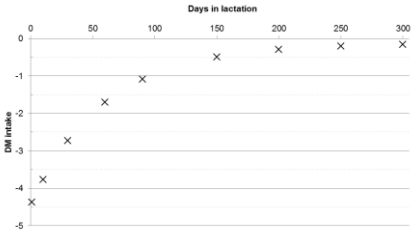
[1] R^2 = 86.7; RSD, kg DM/day = 1.32; CV, % = 7.10. [2] R^2 = 83.5; RSD, kg DM/day = 1.46; CV, % = 7.90
[3] IT_a: Intake predicted; calculated daily DM intake (before applying the correction factor)

In the equations of GRUBER et al. (2004) following information and data are required/necessary

- **related to the individual cow**
  - **breed (Holstein ↑, Simmenthal …)**
  - **body weight (ranges)** → **per 100 kg bw: + 1.3/+1.0/+0.8 kg increase**
  - **number of lactations** → **primiparous vs. cows in 2nd/3rd lactation: 1 kg DM**
  - **day of lactation** → **see specific figure**
  - **daily milk yield** → **per 1 kg milk: + 0.17 kg … > + 0.21 kg DM intake**
- **related to the ration composition**
  - **energy density (MJ NEL/kg DM/digestibility)** → **per 1 MJ NEL: + 0.86 kg DM**
  - **concentrate (amount and/or proportion in the ration)** → **per 1 kg + 0.64 kg DM**
  - **proportion of hay in the ration (% of roughage)**
  - **protein: energy ratio (g XP : 1 MJ NEL)**
- **related to farm specific conditions**
  - **feeding technique (TMR, partial TMR, separate offer of roughage/concentrates**
  - **management "level" (high vs. low level: 1 kg DM difference)**

Predicted feed intake (DM from roughage/in total) of dairy cows (German Holstein, ~ 700 kg bw) during lactation at 2 levels of performance (8,000/10,000 kg milk yield) based on the Equation of GRUBER et al. (2004)





Influence of days in lactation on the dry matter intake (based on equations of GRUBER et al. 2004) expressed in difference – kg DM – to the maximum value, in comparison to the "maximum at the end of lactation"

Influences on the DM intake considered in the equations of GRUBER et al. (2004)

breed:	Holstein crossbred > old dual purpose breeds
lactation number:	multiparous > primiparous cows (~ 1 kg DM)
lactation day:	at early lactation: - 4.5 → - 1 kg DM compared to the maximum at late lactation
body weight:	per 100 kg bw: plus 1.3 → 1.0 → 0.8 kg
milk yield/day:	plus 0.1 → 0.17 → 0.21 kg DM per kg milk
concentrate:	plus 1 kg DM of concentrate → plus 0.64 kg DM intake in total (- 0.36 kg roughage)
energy density of roughage:	plus 1 MJ NEL/kg DM → plus 0.86 kg DM intake

Further factors of relevance with regard to DM intake of dairy cows

Management level:	high vs. common → about 1 kg DM
Offered amounts:	accept „refusals" of about 5 – 10 % of the offered amount → sorting increases the total DM intake → "shredlage" higher risk for sorting → wetting of concentrates before mixing the TMR (offering a "compact TMR")
Climate:	hours per day with a temperature of >/< 21 °C → high temperature plus high humidity: reduced DM intake → ability to maintain normal body temperature?
Roughage intake:	DM content around 35 % > 25 % intensively chopped > large size particles/roughly cutted only fermentation pattern: acetic acid > propionic/butyric acid secondary fermentation/warming: reducing effects digestibility (considered via energy density/NDF content)

Further factors of relevance when DM intake of dairy cows is on debate

- availability of space at the trough (number of cows/number of trough places)
- availability and quality of drinking water
- chances for selection in the offered ration (risk of sorting?)
- hygiene status of the feedstuffs/the silages/the TMR
- long term effects of the techniques/processes at harvesting/ensiling → consequences of an insufficient compaction at ensiling
- body temperature (sign of infection or thermal load?)
- technical faults/malfunction/accidents (electricity)?

Specific comments to the intake of silages (grass/corn)

- **Grass silage: favoring its intake**
  - highest intake at DM contents of 340 – 370 g DM/kg silage
  - at low levels of organic acids (especially of volatile fatty acids, C_2, C_3)
- **Corn silage: favoring its intake**
  - highest intake at DM content of ~ 310 – 340 g DM/kg (KHAN et al. 2015)
  - the higher the grade of diminution, the higher the intake (fine vs. coarse: ~ 1 kg DM)
  - without any sign of secondary fermentation (aerobe deterioration due to yeasts' activity → lactic acid ↓, pH ↑, temperature ↑, spoilage)
  - cut height at harvesting (short/long stubble on the field)

Effects of different cut height at harvesting corn to produce silage for high yielding dairy cows (STEINHÖVEL 2002)

Cut height/ stubble lenght, cm	DM content, %	Crude fiber content, %	Energy MJ NEL/kg DM	Yield/ha relative value, %
10	33.6	20.3	6.5	100
30	36.3	16.9	6.8	89
50	39.1	12.6	7.3	74

→ effects on DM intake, peNDF supply, energy density, losses in yield/ha

The main positive as well as negative influences regarding DM intake of silage/roughage in dairy cows
→ coefficients of correlation according to KRIZSAN et al. (2007)

Favoring DM intake contents	r		Reducing DM intake contents	r
DM	+ 0.630		ADF	- 0.373
NDF	+ 0.200		NH^3	- 0.373
lactic acid	+ 0.125		amine	- 0.436
soluble carbohydrates	+ 0.279		total acid	- 0.639
lactic acid: total acid ratio	+ 0.495		acetic acid	- 0.642
			propionic acid	- 0.740

➡ **silages with higher DM content, but lower levels of volatile fatty acids are preferred (risk for aerobe deterioration ↑)**

Secondary fermentation in silages due to aerobe exposure – found frequently in top quality silages – how to explain?

- **in silages with higher DM contents**
  - in grass silage: due to a long prewilting
  - in corn silage: of higher maturity stage

- **in silage with lower acid contents ("mild acidifaction")**
  - the higher DM content limits the microbial formation of acids
  - volatile fatty acids: preservation effects (moulds ↓, bacteria ↓)
- **in silages with lower compaction grades**
  - the dryer the more difficult the compaction
  - higher DM content and lower compaction: exposure to oxygen?

➡ **marked effects on DM intake due to lowered "palatability"!**

„Essentials for dairy vets"
J. Heinrichs and V. Ishler (2000)

➢ **evaluate forage quality at the farm by**
- visual appraisal (stage of maturity/leafiness/steminess)
- pH (related to dm content)
- dry matter content

➢ **during visual appraisal look at**
- the color (brown = heat fermentation)
- the smell (tobacco/vinegar/butyric acid/alcohol)
- any evidence of mould

➢ **the texture of the forage**
- length of cut / consistency (firm, soft, slimy)
- grain present (hard/soft)

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Thanks for your attention!

Your questions, and

your comments

are highly welcome!