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INDIRECT TRAITS FOR FEED EFFICIENCY

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Requirements for an „Efficient Cow“

Breeding goal:

- high milk yield
- high feed efficiency/nutrient efficiency
- good fertility - one calf every year
- longer productive life to minimize replacement costs
- good milk quality - healthy udder
- no or few claw problems
- no or few problems with metabolism

…

Other requirements:

- low ecological footprint
- low use of drugs

…

many demands/challenges

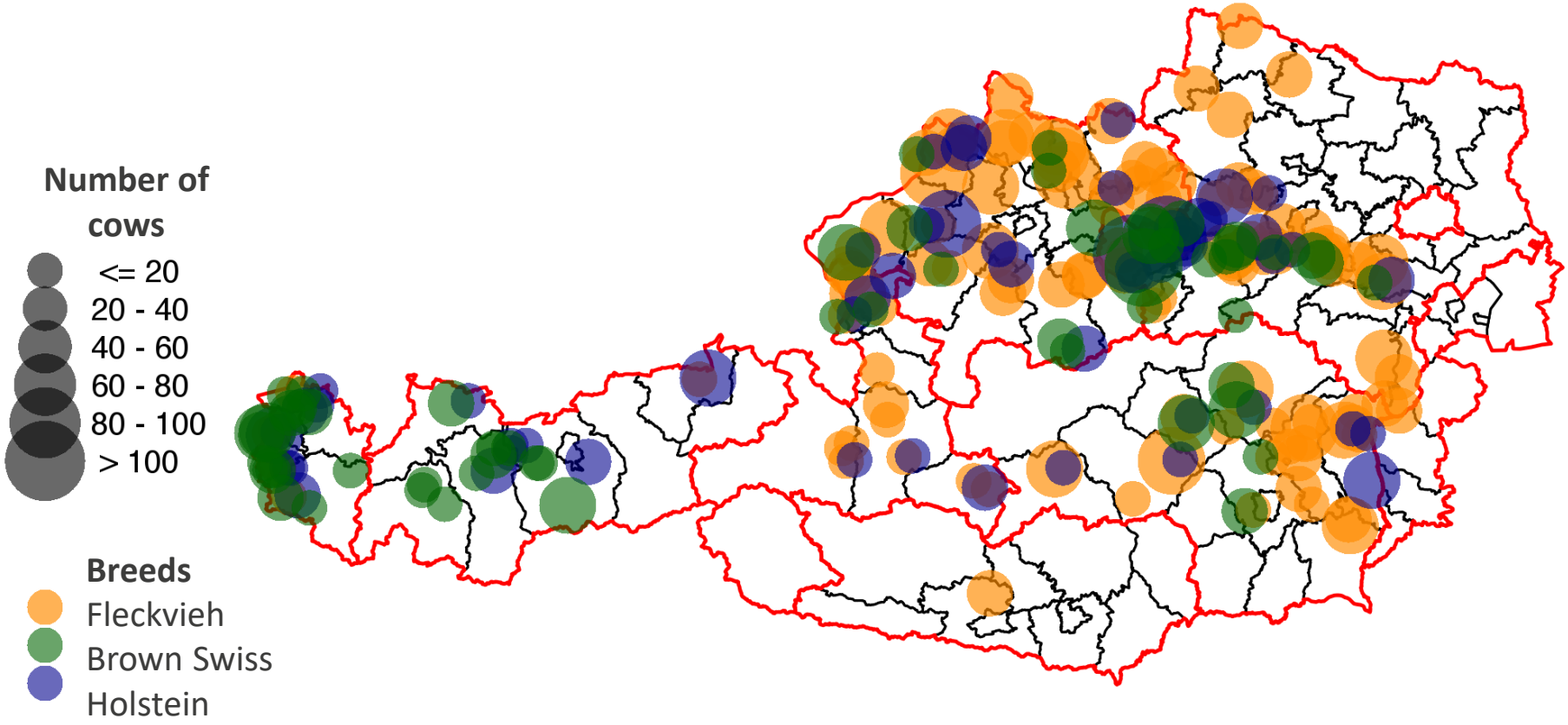
Challenge feed efficiency - number of phenotypes from station limited, especially for smaller breed!

Overview

- Project „Efficient Cow“ – field data approach
- Indicator traits for feed efficiency
  - Dry matter and nutrient intake information from practice
  - Body weight estimation
  - Body Condition Score (BCS) as additional information
- Conclusions

Project „Efficient Cow“ - participating farms

167 farms – app. 6,500 cows



Efficient Cow (EC) – data recording

- Simmental / Brown Swiss / Holstein
- **167 farms approx. 6,500 cows**
- Routine data from DHI and storage of **MIR (infrared) spectra**
- **General information** about the farm (areas, keeping, feeding,...)
- **Direct health data** (veterinary diagnosis/observations)
- Documentation and recording of **claw trimming**
- BHB (ß-hydroxybutyrate) **Ketosis Test Milk**
- **Linear description** of all lactations
- For each DHI in the calendar year 2014 **body weight, body measurements, body condition (BCS), lameness scores, feeding information -** (approx. 50,000 weighings, lameness, BCS.....)
- Further (3,000 genotypes via Gene2Farm)

Efficiency traits

ECM	= Energy corrected milk
BW	= Body weight
DMI	= Dry matter intake
INEL	= Energy intake

$ECM/BW^{0,75}$	**= Body weight efficiency**
ECM/DMI	**= Feed efficiency**
ECM/INEL	**= Energy efficiency**

Efficient Cow – efficiency traits

Fleckvieh (Koeck et al. 2017)

	ECM	BW	DMI	INEL	ECM/BW^{0,75}	ECM/DMI	ECM/INEL
ECM	**0.13**	-0.22 (0.10)	0.66 (0.06)	0.72 (0.06)	0.88 (0.02)	0.89 (0.02)	0.89 (0.03)
BW		**0.43**	0.50 (0.07)	0.40 (0.08)	-0.66 (0.06)	-0.57 (0.08)	-0.56 (0.08)
DMI			**0.18**	0.99 (0.01)	0.27 (0.10)	0.24 (0.10)	0.23 (0.11)
INEL				**0.13**	0.37 (0.10)	0.33 (0.10)	0.32 (0.11)
ECM/BW^{0,75}					**0.18**	0.97 (0.01)	0.96 (0.01)
ECM/DMI						**0.13**	0.99 (0.01)
ECM/INEL							**0.11**

ECM/BW^{0,75} : energy corrected milk / metabolic body weight; **ECM/DMI:** ECM related to feed intake; **ECM/INEL:** lactation energy related to energy intake

Genetic variation of feed and nutrient intake information available on farm - useful additional information!

Body weight as indirect trait for nutrient efficiency

Fürst et al. 2017

Ledinek et al. 2018

Body weight indirect trait for nutrient efficiency ?

- Maintenance requirement essential factor influencing total nutrient requirement (metabolic body weight) – **body weight indirect estimator of feed efficiency?**
- Body weight data not available frequently in practice - prediction of the body weight from auxiliary measurements - **genetic relationships and prediction accuracy?**
- Body weight and metabolism - **link to health ?**

EBV correlation and difference in reliability between INEL, ECM and ECM+BW (Fürst et al. 2017)

	Number	EBV correlation		Diff in reliability	
Breeds	Bulls	only ECM	ECM+BW	only ECM	ECM+BW
Fleckvieh	274	0.79	0.95	-13.2	-2.7
Brown Swiss	127	0.75	0.94	-19.0	-5.4
Holstein	126	0.80	0.91	-10.8	-4.8

INEL: energy intake; **ECM**: energy corrected milk; **BW**: body weight;

To consider: direct body weight was used, if predicted by body measurements correlation might be lower!

Genetic parameters – Fleckvieh (Fürst et al. 2017)

Estimation based on 3.329 Fleckvieh-cows and 20.905 body weight information

	BW	BG	CG	MU	BCS	HR	HW	BL	BD	RL	FS
Body weight	**0.42**	0.83	0.89	0.43	0.50	0.59	0.70	0.76	0.78	0.80	0.74
Belly girth		**0.34**	0.77	0.36	0.49	0.35	0.49	0.49	0.84	0.57	0.52
Chest girth			**0.43**	0.40	0.51	0.54	0.64	0.54	0.77	0.78	0.67
Muscularity				**0.19**	0.75	-0.14	0.07	0.00	0.07	0.14	-0.02
BCS					**0.22**	-0.03	0.16	0.12	0.30	0.31	0.07
Height at rump						**0.59**	0.58	0.73	0.61	0.69	0.97
Hip width							**0.22**	0.60	0.42	0.53	0.71
Back length								**0.24**	0.65	0.60	0.80
Body depth									**0.29**	0.69	0.71
Rump length										**0.29**	0.76
Frame score											**0.56**

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Use of body measures for prediction of body weight?

	Fleckvieh (n=513 bulls)		Brown Swiss (n=174 bulls)	
	reliability (-diff.)	corr	reliability (-diff.)	corr
Body weight (all)	44.7		44.9	
Body measures*	-10.8	0.78	-14.6	0.78
Body measures + muscularity	-7.9	0.82	-7.9	0.86
Body measures + muscularity + chest girth	**-3.9**	**0.88**	**-0.4**	**0.98**

*Fleckvieh: height at rump, hip width, back length, body depth, rump length
Brown Swiss: height at rump, chest width, body depth, rump length, hip width

→ Fürst et al. 2017: chest girth would bring improvement

Fuerst et al. 2017

BCS as auxiliary information

Koeck et al. 2017, 2018

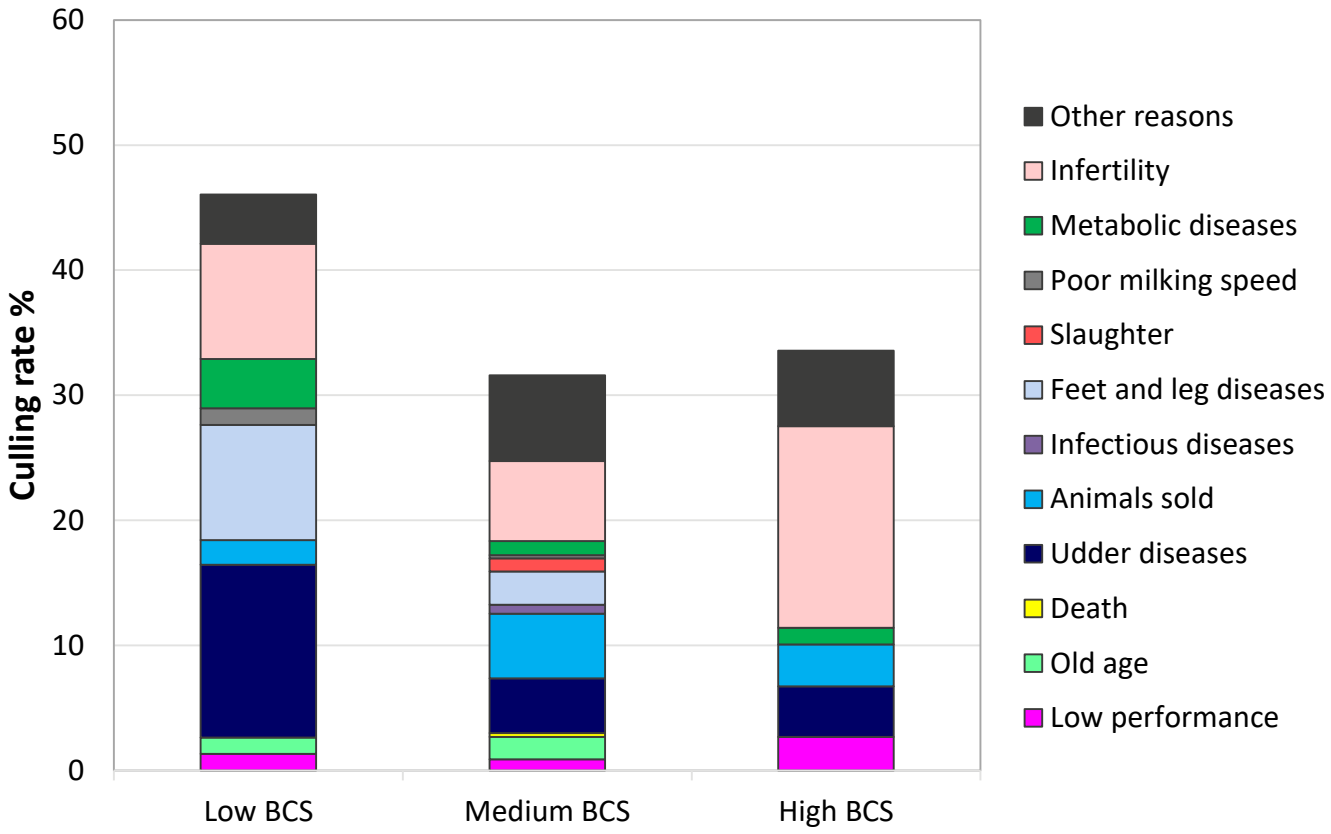
Genetic correlations BCS and efficiency traits

(Köck et al.,2018)

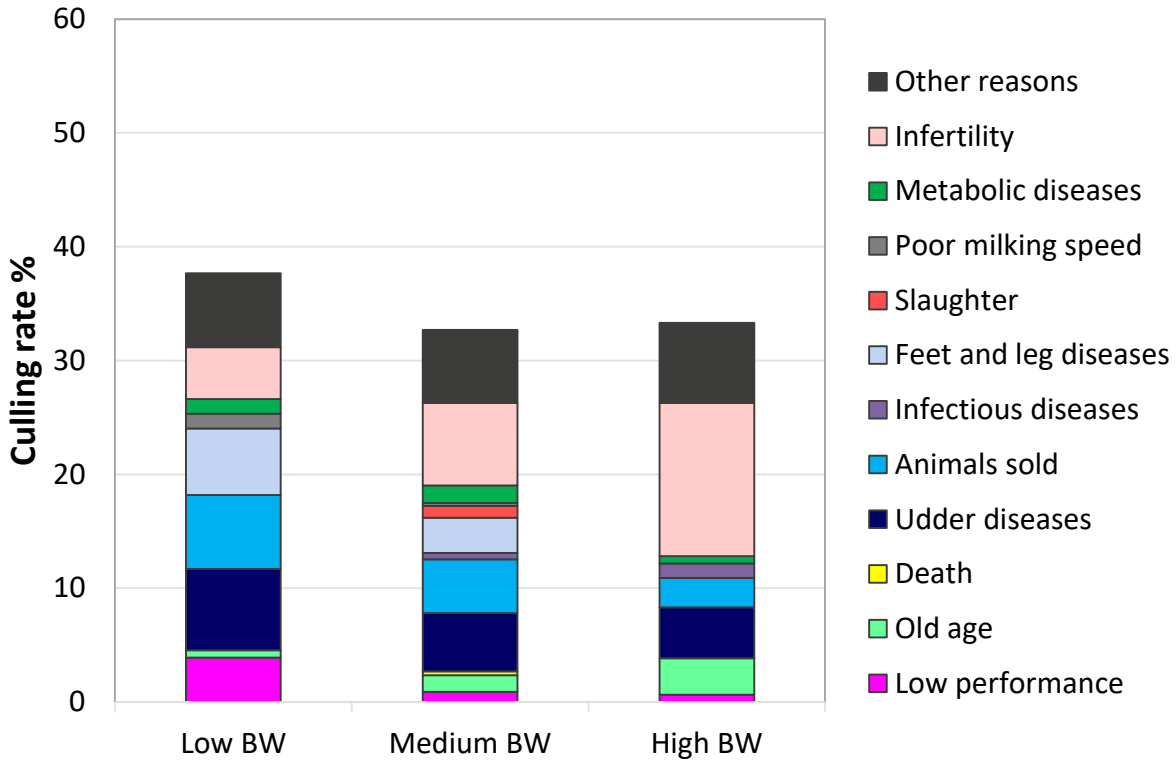
	Genetic correlations to BCS		
	Fleckvieh	Brown Swiss	Holstein
ECM	-0.45	-0.13	-0.46
BW	0.46	0.56	0.51
DMI	-0.04	0.41	-0.33
INEL	-0.10	0.35	-0.39
ECM/BW$^{0.75}$	-0.60	-0.44	-0.62
ECM/DMI	-0.56	-0.37	-0.44
ECM/INEL	-0.54	-0.36	-0.43

Due to the **positive correlation between body weight and BCS, the BCS also decreases with selection for lower body weight**, i.e. BCS (information on mobilization) valuable additional information for feed efficiency

Relationship between EBV for BCS and culling – Holstein (Koeck et al., 2018)



Relationship between EBV for body weight and culling – Holstein (Köck et al. 2018)



Lower body weight leads to a **higher proportion of culling due to feet and legs** and **culling due to udder diseases**. **Higher body weight** leads to more **culling due to infertility** (in Simmental cattle, high weight leads to more claw health problems)

Conclusions – indirect measures for feed efficiency

- **Feeding information on farm** can be used **as auxiliary information for feeding efficiency** - only realistic when automating data acquisition!
- **Body weight valuable indirect trait for feed efficiency** - maintenance requirement per product quantity and day of life essential for efficiency
- **Chest girth/belly girth important information** for more accurate extrapolation of body weight!
- **Lower body weight associated with lower BCS - higher mobilization**
- **Lower body weight and lower BCS** lead to **higher rates of culling due to health problems**
- When **breeding for feed efficiency consider** information on **mobilization**!

Acknowledgement

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Thank you for your attention