ICAR 2015 – Technical Workshop
10-12 June 2015, Kraków, Poland

EFFICIENT COW
Strategies for on-farm collecting of phenotypes for efficiency traits

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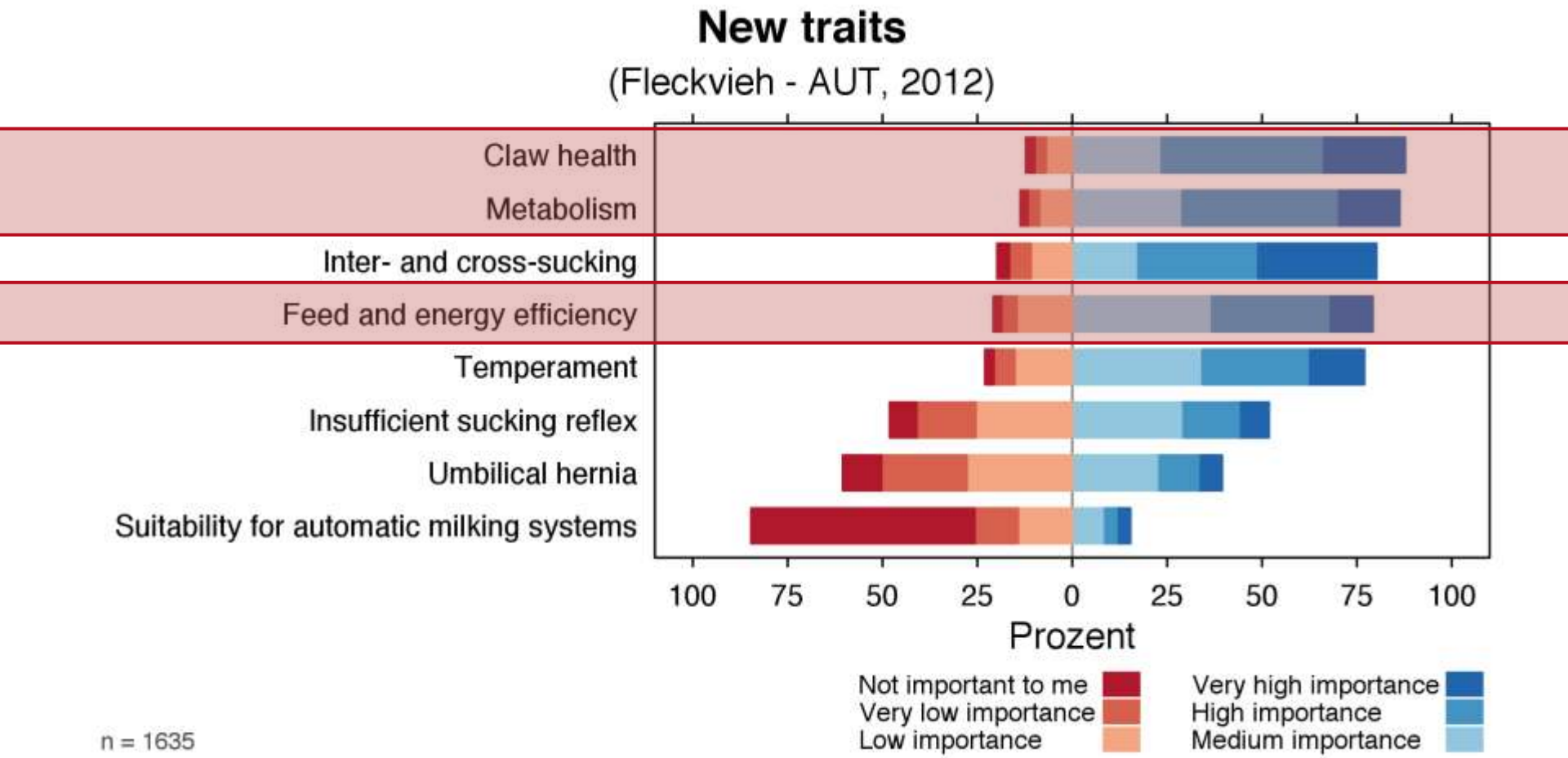
Environmental circumstances

- World human population is expected to reach 9,6 billion people in 2050 (UN, 2013)
- Expected increase in demand for animal products and pressure on resources (land, water, energy,..)
- Reduction of environmental footprint of cattle; reduction of emissions
- Economic interest in efficient use of resources
- Expected increase in prices for concentrates, energy,..

Traits related to „**efficiency**“
increase in importance!

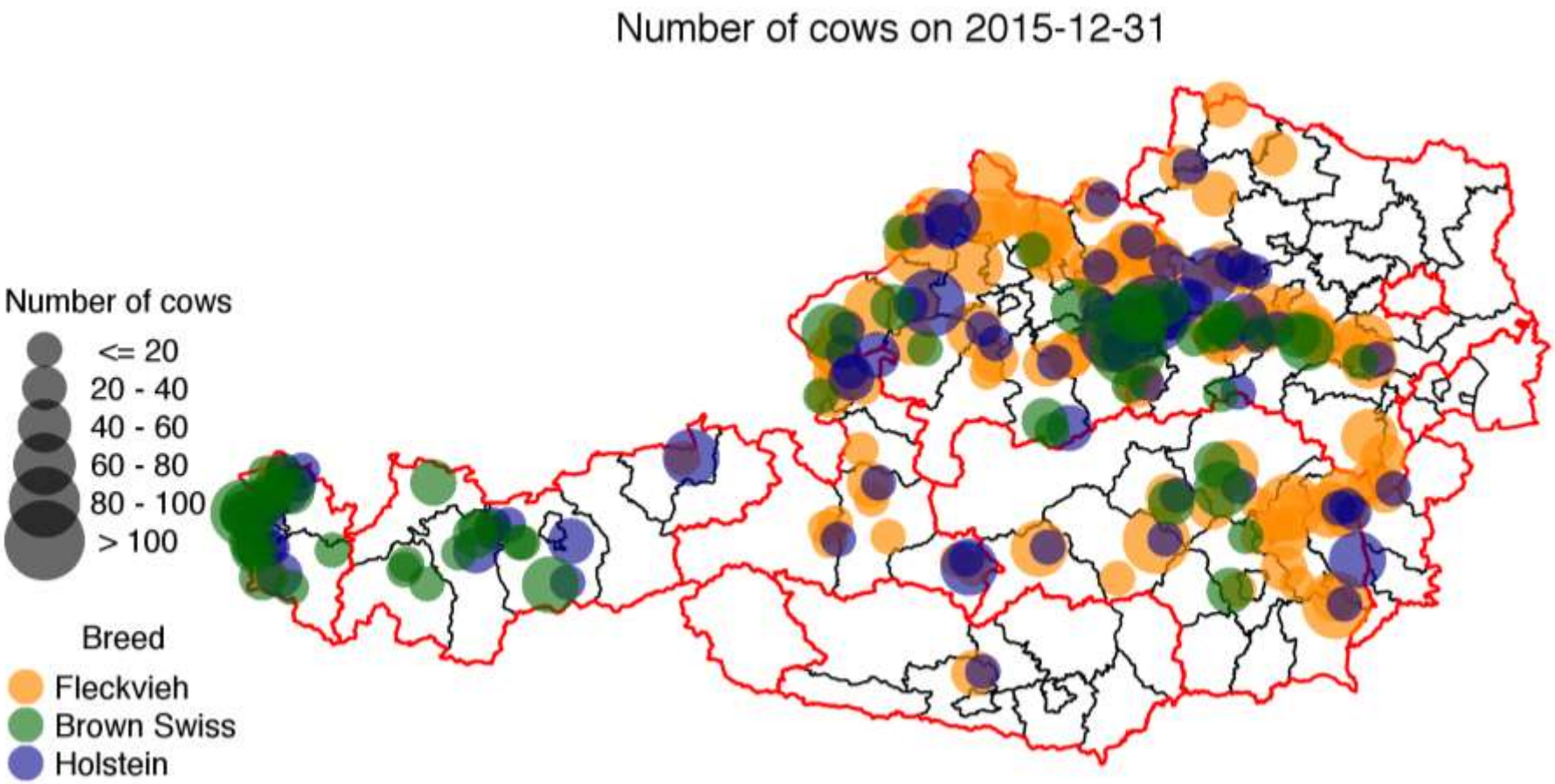


Steininger et al., 2013

Efficient Cow - project aims/measures

- Elaboration of **efficiency parameters**
- Analyses of **genetic possibilities** to **improve** production efficiency
- Evaluation of the **optimal body weight** to achieve the highest nutrient and energy efficiency
- Relationship between **efficiency** and **functional** traits
- Analyses of **environmental impact** of cattle production under Austrian conditions

Distribution of farms across Austria



Participating Farms

	Farms	Cows		
		Fleckvieh Simmental	Brown Swiss	Holstein
Lower Austria	53	1029	436	390
Upper Austria	39	1097	142	217
Salzburg	17	266	2	93
Tyrol	13	2	173	126
Vorarlberg	17	34	357	126
Styria	27	658	171	79
Carinthia	1	25	0	0
	167	**3111**	**1281**	**1031**

Number of cows on 2014-12-31

Complex data collection of on-farm information

Recorded data – Fleckvieh / Simmental

	COWS	N	LACT 1	LACT 2	LACT >=3
WEIGHT	3,984	29,763	685 (±79)	734 (±83)	776 (±84)
WAIST	3,981	30,031	251 (±14)	259 (±14)	265 (±13)
CHEST	3,982	30,039	208 (±10)	212 (±10)	217 (±10)
MUSC 1-9	3,977	29,866	5.58 (±1.21)	5.72 (±1.33)	5.89 (±1.4)
BCS 1-5	3,981	30,044	3.32 (±0.52)	3.33 (±0.55)	3.37 (±0.62)
LAME 1-5	3,981	29,768	1.13 (±0.43)	1.2 (±0.52)	1.42 (±0.77)

Many different efficiency traits

- ratio traits of efficiency (milk production per unit intake)
  - milk production per kg body mass (ECM / weight^{0,75})
  - feed conversion efficiency (FCE)
  - adjusted feed conversion efficiency (FCEadj)
    - includes body tissue change
- residual traits of efficiency currently replaces ratio traits
  - residual feed intake (RFI)
    - difference between energy intake and demand
    - estimated as the residuals from regression model
    - difficult to measure the individual animal feed intake
- production efficiency
  - including information on reproduction, health, ...

Useable efficiency traits in this project

- limiting factors
  - data collection on farms, so measuring daily individual feed intake in general not possible
  - many details of feeding are collected, so feed intake is estimated using the evaluation formula of Gruber et al. (2004)
- possible efficiency traits
  - milk production per kg body mass (ECM / weight^{0,75})
  - feed conversion efficiency (FCE)
  - adjusted feed conversion efficiency (FCEadj)
  - partial efficiency of milk production (PEMP)

Estimation of individual feed intake is scheduled for summer. Therefore only simple efficiency traits, like ECM / weight$^{0.75}$ can be presented so far.

First results

Feedback for farmers

ECM / $LM^{0,75}$

Plots for comparing cows

Used formulas / models

$$\text{ECM / weight}^{0.75} = \frac{(0.38 * \text{fat\%} + 0.24 * \text{protein\%} + 0.816) * \text{milk yield}}{3.14 * \text{weight}^{0.75}}$$

(1) $\text{weight} = \text{lactday} + \text{pregday} + \text{pregday}^2 + \text{lactgroup} + \text{calving age} + \text{farm} + \text{farm:cow}$

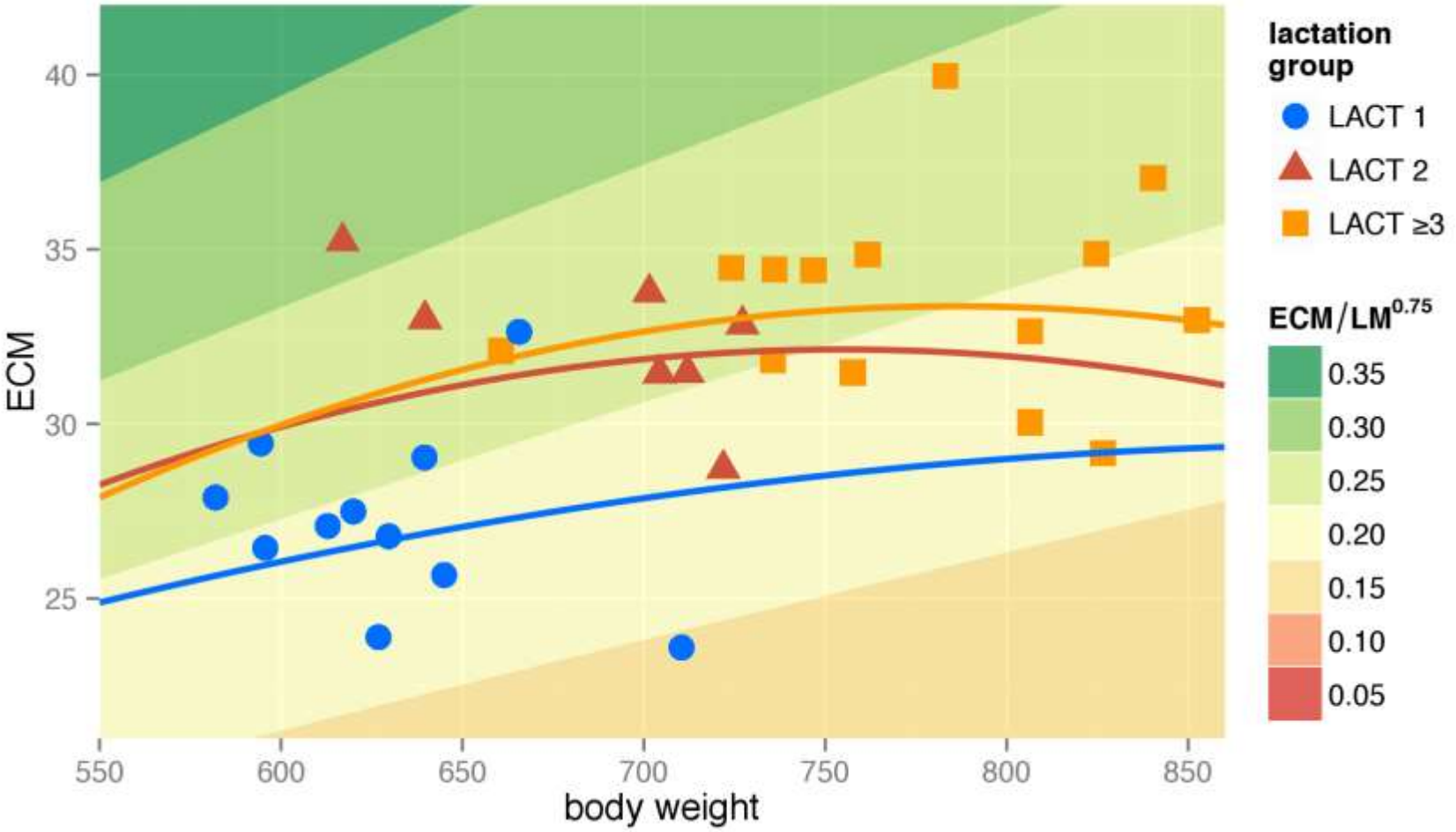
(2) $\text{ECM} = \text{weight} + \text{weight}^2 + \text{lactday} + \text{lactday}^2 + \text{pregday} + \text{calving age} + \text{fodder} + \text{fodder:farm} + \text{fodder:farm:cow}$

- Models (1) and (2) were calculated for each breed separately.
- Modell (2) were calculated for the 3 lactation groups separately.
- Nested random effects are marked, all others used as fixed effects.

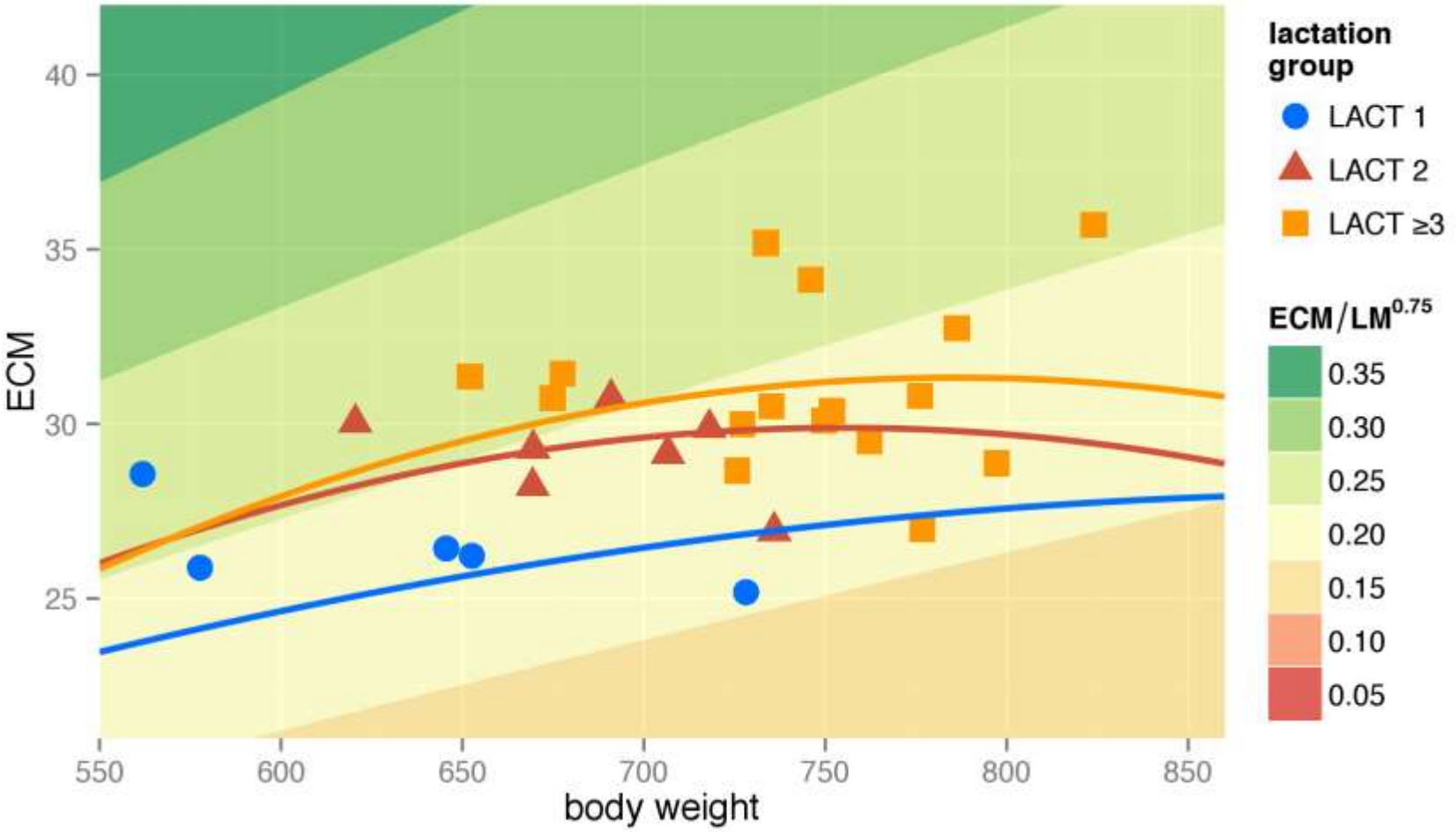
Plots for comparing cows

- ECM against weight, because it's easier to explain than the impact of ECM / weight$^{0.75}$
  - but reference lines for efficiency by ECM / weight$^{0.75}$
- standardized for lactation day 100 and no pregnancy
- estimated random effects of each cow for ECM and weight
- used software
  - R version 3.1.2 - R Core Team (2014)
  - R packages
    - lme4 – Bates et al. (2014)
    - data.table – Dowle et al.(2015)
    - ggplot2 – Wickham (2009)

Example farm 1 (with silage maize)



Example farm 2 (without any form of silage)



Conclusions data recording

- Data recording from about 5,300 cows under on-farm-conditions was a big challenge
- Recording of body weight was easier to handle than taking different body measures
- Positive feedback for management tools like lameness or body condition scoring
- Biggest difficulty was to record the feeding information per individual across the different feeding systems and ration compositions on-farm
- The advantage of this on-farm-trial is the availability of data from a large number of animals

Next steps

- Estimation of individual feed intake by the Austrian Agricultural Research and Education Centre Raumberg over summer 2015
- Calculation of more complex efficiency traits (FCE, FCEadj and PEMP) including feeding information
- Elaboration of measures for production efficiency
- Present and discuss the results with the farmers
- Genetic analyses

Acknowledgement

Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) in Austria, Federal States of Austria and the Federation of Austrian Cattle Breeders for the support within the projects „Efficient cow“.

Project partner within the project „Efficient Cow“.

Gene2Farm (EU-FP7-KBBE-2011-5-PNr.: 289592).

Thank you for your attention!