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!
New traits
(Fleckvieh - AUT, 2012)

- Claw health
- Metabolism
- Inter- and cross-sucking
- Feed and energy efficiency
- Temperament
- Insufficient sucking reflex
- Umbilical hernia
- Suitability for automatic milking systems

Prozent

Not important to me
Very low importance
Low importance
High importance
Very high importance

n = 1635

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

Number of cows on 2015-12-31

Number of cows
- <= 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- > 100

Breed
- Fleckvieh
- Brown Swiss
- Holstein
# Participating Farms

<table>
<thead>
<tr>
<th></th>
<th>Farms</th>
<th>Fleckvieh</th>
<th>Simmental</th>
<th>Cows Brown</th>
<th>Swiss</th>
<th>Holstein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Austria</td>
<td>53</td>
<td>1029</td>
<td>436</td>
<td>390</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Austria</td>
<td>39</td>
<td>1097</td>
<td>142</td>
<td>217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salzburg</td>
<td>17</td>
<td>266</td>
<td>2</td>
<td>93</td>
<td></td>
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</tr>
<tr>
<td>Tyrol</td>
<td>13</td>
<td>2</td>
<td>173</td>
<td>126</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vorarlberg</td>
<td>17</td>
<td>34</td>
<td>357</td>
<td>126</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styria</td>
<td>27</td>
<td>658</td>
<td>171</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carinthia</td>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>167</strong></td>
<td><strong>3111</strong></td>
<td><strong>1281</strong></td>
<td><strong>1031</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of cows on 2014-12-31
Complex data collection of on-farm information

Land: pasture, silage, hay,...-resources of farm

Farm: housing information, climate,..

Milking: yield, composition, MIR,..

Silo/Fodder supply: ration composition, nutrient profiles, ...

Management: health observations, veterinarian diagnoses, claw health, ...

Genotypes: 2,000 Simmental, 1,000 Brown Swiss

Others: body weight, BCS, lameness, body measures, conformation recording, intake, ...
## Recorded data – Fleckvieh / Simmental

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

\[
(0.38 \times \text{fat\%} + 0.24 \times \text{protein\%} + 0.816) \times \text{milk yield}
\]

ECM / weight^{0.75} = \frac{3.14 \times \text{weight}^{0.75}}{\text{3.14 } \times \text{weight}^{0.75}}

1. \quad \text{weight} = \text{lactday} + \text{pregday} + \text{pregday}^2 + \text{lactgroup} + \\
\quad + \text{calving age} + \text{farm} + \text{farm:cow}

2. \quad \text{ECM} = \text{weight} + \text{weight}^2 + \text{lactday} + \text{lactday}^2 + \text{pregday} + \\
\quad + \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

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Thank you for your attention!