Structure of the presentation

- Introduction & preliminary remarks
- Function and role of AREC Raumberg-Gumpenstein
- Material & methods
- Results of the Austrian silage project(s)
- Summary & conclusions

Mountainous - alpine regions
arable land 1,375,823 ha (41.2%)
grassland 909,407 ha (26.8%)
extensive grassland 900,980 ha (29.7%)
vineyard, orchard 63,877 ha (2.3%)

211,461 ha (22%)
267,523 ha (26%)
19,885 ha (2%) 319,999 ha (32%)
2,342 ha (25%)
243,642 ha (79%)
264,734 ha (97%)
380,505 ha (97%)
100,296 ha (97%)

mountainous area (52% of all farms, 58% of AA, 69% of all dairy farms)
small area 1995, 1997

less favoured area: 69.4% of the total AA
approx. 70% of all farms

Unfavourable site conditions

• High altitude & strong slope inclination ⇒ expensive production
• Short vegetation period & long winters with snow cover (up to 5 months) ⇒ long indoor feeding period with forage conserves
• Low average yearly temperature & high precipitation rate ⇒ difficult conditions for hay and silage making

Unfavourable site conditions

• 54% of all meadows & pastures > 600 m altitude
• 71% are smaller than 1 ha
• 30% are steeper than 25%
Small-scaled structure of grassland & dairy farms

- Small family enterprises:
  - Farm size: 18.6 ha LN
  - Number of dairy cows/farm: 13

- Highest proportion of organic farms in EU-27
- High costs for special mechanisation

Milk yield & composition of feed ration

- High proportion of farms with low & medium yielding cows
- < 10% of farms with high yielding cows

- High proportion of forage in the feed rations
- Low input of (external) concentrates
- High milk performance from forage (up to 5,200 kg year⁻¹)

Strategies on Austrian grassland & dairy farms

- Low Input Farming System (LIFS)
- Sustainable & optimal use of farm internal resources:
  - Environmentally friendly and efficient use of farm manure
  - Optimal use of homegrown forage
  - Improve forage quality – pasture, hay and silage!

⇒ main intention and field of activity of AREC Raumberg-Gumpenstein
Function and role of AREC Raumberg-Gumpenstein

- Government department (ministry of agriculture & forestry, Vienna)
- 4 institutes – plant production and cultural landscape

Laboratory experiments, field trials & field studies on:
- Grassland establishment (grass and clover breeding, variety testing, seed mixtures)
- Weed control and grassland renewing
- Fertilization, manure efficiency, nutrient fluxes
- Forage quality – hay and silage production:
  - Silage experiments (testing of silage additives, silage techniques, use of mowing conditioner, pre-wilting, chopping length, compaction level, ...)
  - Field studies on silage quality in practice

Forage conservation in Austria (RESCH, 2010)

Abdication of silage production in Austria

- Special (voluntary) measure within the Austrian agri-environmental program ÖPUL
- Milk for hard cheese production in defined areas
- Only hay production possible resp. allowed
Austrian silage monitoring project

- Initiated by AREC Raumberg-Gumpenstein
- In co-operation with the regional extension service and with the feed stuff laboratory Rosenau, lower Austria
- Including most of the Austrian federal states (7 of 9)
- High number of participating farms – silage samples from different grassland regions (total n = 3,700)

- Standardized sampling procedure in combination with surveys and interviews on farms (farm and silage management)
- Chemical analyses (crude nutrients, DOM, energy concentration, mineral and trace elements, fermentation properties)
- Sensorial evaluation (odour, colour, texture)
- Data processing and analyses ⇒ reports for working groups and farmers

### Fixed effects used in the silage project

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLM – procedure</td>
<td>Statgraphics-Plus, version 5.1</td>
</tr>
<tr>
<td>Fixed effects + quantitative factors</td>
<td></td>
</tr>
<tr>
<td>Descriptive statistics based on SPSS (version 12.0)</td>
<td></td>
</tr>
</tbody>
</table>

### Target values of silage and fermentation parameters

<table>
<thead>
<tr>
<th>Parameter/Unit</th>
<th>Target Value/Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-wilting level (g DM kg FM⁻¹)</td>
<td>300 - 400</td>
</tr>
<tr>
<td>crude fibre (g kg DM⁻¹)</td>
<td>≤ 270</td>
</tr>
<tr>
<td>crude protein (g kg DM⁻¹)</td>
<td>&gt; 120</td>
</tr>
<tr>
<td>ash (g kg DM⁻¹)</td>
<td>≤ 100</td>
</tr>
<tr>
<td>digestibility of organic matter (%)</td>
<td>&gt; 70</td>
</tr>
<tr>
<td>energy concentration (MJ NEL kg DM⁻¹)</td>
<td>&gt; 5.8</td>
</tr>
<tr>
<td>lactic acid (g kg DM⁻¹)</td>
<td>20 - 60</td>
</tr>
<tr>
<td>acetic acid (g kg DM⁻¹)</td>
<td>max. 30</td>
</tr>
<tr>
<td>butyric acid (g kg DM⁻¹)</td>
<td>max. 3</td>
</tr>
<tr>
<td>protein degradation (% of total N)</td>
<td>&lt; 10</td>
</tr>
<tr>
<td>DLG (silage quality points)</td>
<td>&gt; 70</td>
</tr>
</tbody>
</table>
Impact of fixed effects & quantitative factors on silage quality

- well pre-wilted silages (60% within the target range of 30-40% DM)
- sufficient crude protein content for permanent grassland (≥ 148 g DM⁻¹)
- young, well fermentable material (≥ 262 g crude fibre DM⁻¹)
- average ash content of 104 g DM⁻¹, significantly influenced by cutting height
- 70% of the silages fulfilled the target requirements of > 5.8 MJ NEL kg DM⁻¹

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean Value</th>
<th>Prior-Ranking Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH value</td>
<td></td>
<td>374.3</td>
</tr>
<tr>
<td>Lactic acid</td>
<td></td>
<td>148.3</td>
</tr>
<tr>
<td>Acetic acid</td>
<td></td>
<td>262.2</td>
</tr>
<tr>
<td>Butyric acid</td>
<td></td>
<td>103.6</td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
<td>5.96</td>
</tr>
<tr>
<td>DLG-value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviation</td>
<td></td>
<td>74.1</td>
</tr>
<tr>
<td>R² in %</td>
<td></td>
<td>16.8</td>
</tr>
</tbody>
</table>

Quantitative factors

- dry matter (p-value) 0.000
- crude protein (p-value) 0.000
- crude fibre (p-value) 0.543
- ash (p-value) 0.000

- the overall average pH-value corresponds well with the critical pH-value for silages pre-wilted between 30 and 40% DM
- crude fibre (vegetation stage) and crude ash (contamination) content significantly influenced pH-value and butyric acid concentration
- two third of the samples met the recommended range of lactic (20-60 g kg DM⁻¹) and acetic acid (< 30 g kg DM⁻¹ concentration)
- only 25 % of all samples were below the upper limit of butyric acid concentration (3 g kg DM⁻¹)

Increase of 1% (= 10 g DM⁻¹) crude fibre caused:
- reduction of 4 g crude protein kg DM⁻¹
- reduction of 0.1 MJ NEL kg DM⁻¹
- reduction of compaction level – minus 3 kg DM m⁻³

Increase of 1% (= 10 g DM⁻¹) crude ash caused:
- reduction of 3.9 g crude protein kg DM⁻¹
- reduction of 0.1 MJ NEL kg DM⁻¹
Impact of fixed effects & quantitative factors on fermentation parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>pH value</th>
<th>Lactic Acid</th>
<th>Acetic Acid</th>
<th>Butyric Acid</th>
<th>Ammonia</th>
<th>DLG-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>[g/kg DM]</td>
<td>[g/kg DM]</td>
<td>[g/kg DM]</td>
<td>[% of total N]</td>
<td>(0-100)</td>
<td></td>
</tr>
<tr>
<td>Mean Value</td>
<td>4.48</td>
<td>43.8</td>
<td>11.6</td>
<td>10.9</td>
<td>8.4</td>
<td>75.8</td>
</tr>
</tbody>
</table>

**Quantitative Factors**

- **Dry Matter (p-value):** 0.000 0.000 0.000 0.000 0.000 0.000
  - Mean Value [g/kg FM]: 378.2 374.6 374.6 374.6 374.6 374.6
  - Regression Coefficient [pH value, g/kg resp. MJ NEL]: 0.001 -0.039 -0.018 -0.051 -0.015 0.073

- **Crude Fibre (p-value):** 0.000 0.000 0.165 0.000 0.000 0.000
  - Mean Value [g/kg DM]: 265.5 265.6 265.6 265.6 265.6 265.6
  - Regression Coefficient [pH value, g/kg resp. MJ NEL]: 0.003 -0.132 -0.009 0.089 0.048 -0.189

- **Ash (p-value):** 0.000 0.000 0.516 0.000 0.000 0.000
  - Mean Value [g/kg DM]: 103.2 103.7 103.7 103.7 103.7 103.6
  - Regression Coefficient [pH value, g/kg resp. MJ NEL]: 0.004 -0.130 0.005 0.070 0.032 -0.136

**Increase of 1% (= 10g DM⁻¹) crude fibre caused:**
- Increase of 0.03 units pH value
- Increase of 0.9 g butyric acid kg DM⁻¹
- Increase of protein degradation by 0.5 % of total N

**Increase of 1% (= 10g DM⁻¹) crude ash caused:**
- Increase of 0.04 units pH value
- Increase of 0.7 g butyric acid kg DM⁻¹
- Increase of protein degradation by 0.3 % of total N

Harvesting time - vegetation stage of plant stands

<table>
<thead>
<tr>
<th>Vegetation Stage</th>
<th>Frequency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 %</td>
<td>1st growth</td>
</tr>
<tr>
<td>20-24 %</td>
<td>Ear emergence</td>
</tr>
<tr>
<td>24-26 %</td>
<td>Flowering</td>
</tr>
<tr>
<td>27-30 %</td>
<td>End of flowering</td>
</tr>
<tr>
<td>&gt; 30 %</td>
<td></td>
</tr>
</tbody>
</table>

Target value < 27 % crude fibre

Influence of cutting height on the content of ash

<table>
<thead>
<tr>
<th>Cutting Height</th>
<th>Ash Content (g kg DM⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5 cm</td>
<td>130</td>
</tr>
<tr>
<td>5 to 7 cm</td>
<td>113</td>
</tr>
<tr>
<td>Above 7 cm</td>
<td>112</td>
</tr>
</tbody>
</table>

Influence of cutting height on the content of ash
Influence of animal vermins on the ash content of silages

![Graph showing the ash content of silages influenced by different activities of moles and voles on grassland.](image)

Influence of different silage systems on the compaction level

![Graph showing the compaction level of bunker silo, silo heap, tower silo, and bales.](image)

Influence of different farming systems on silage quality

![Graph showing the energy concentration of silage systems influenced by different farming systems.](image)
Evaluation of grass silages by selected target values

- Target range for crude fibre: 220 - 270 g kg DM⁻¹
- Target range for dry matter: 380 - 480 g kg FM⁻¹
- Optimum range: 579 of 3612 samples = 32%

### Summary and conclusions

- **Great importance of forage from pastures and meadows in mountainous and alpine regions**
- **Unfavourable site and climatic conditions – great challenge to produce high forage quality**
- Silage monitoring project indicates:
  - on average sufficient silage quality (DM, CP, CF, ash, energy concentration)
  - but strong variation & problems:
    - harvesting time (esp. 1st cut, still too late!)
    - ash content (cutting height, animal vermins)
    - butyric acid concentration! (misfermentation, clostridia)
    - compaction level (technique, logistic)
- Overall evaluation clearly indicates room for improvement!
- Need for more specific information and advisement in practice by leaflets, folders, papers and field days/demonstrations