Production and utilization of silages in tropical areas

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&

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Scope of the presentation

*Particular reference to Brazil and South America*

- Climate facts

- Aspects of silage production and utilization

- Final remarks
Central-southern: Major site of agriculture

70% of GDP in South America
Dry regions are aligned to middle latitudes

Source: https://qjjb.weebly.com/map.html
Amazon: A rain factory
Brazil is an important player to supply the global market

• Agriculture comprises the largest single sector of the economy (24% of GDP & 40% of exports)
  o 2nd largest cattle herd (~ 220 million head) and meat exporter
  o 4th largest milk producer
  o Large producer and exporter of soybeans, corn, sugar, ethanol, orange, coffee, cotton, poultry, etc.

• Big domestic market

• Still having ability to increase production efficiency and expand the planted area (8%) without deforestation (e.g. over degraded pasture areas)
Typical climate in Central-Southern of South America

Average precipitation: ~1400 mm/year

Source: INPE / CPTEC
Forage sources in Brazilian beef feedlots

Source: Pinto and Millen (2016)
Ensiled forages in Brazilian dairy farms

![Bar chart showing frequency of farms using different forages.](chart)

- **Corn**: 83%
- **Sorghum**: 20%
- **Tropical grasses**: 15%
- **Sugarcane**: 10%
- **Others**: 2%

~ 2.25 million ha of corn silage (source: CONAB)

Source: Bernardes and do Rêgo (2014)
## Corn silage composition (2017 data set)

<table>
<thead>
<tr>
<th>Item</th>
<th>USA</th>
<th>Brazil</th>
<th>Source: 3rlab® / Rock River®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch, % DM</td>
<td>33.8 ± 6.8</td>
<td>30.4 ± 6.6</td>
<td></td>
</tr>
<tr>
<td>In vitro starch digestibility-7 h, %</td>
<td>78.5 ± 10.3</td>
<td>75.7 ± 8.7</td>
<td></td>
</tr>
<tr>
<td>NDF, % DM</td>
<td>37.9 ± 6.0</td>
<td>42.8 ± 6.0</td>
<td>+</td>
</tr>
<tr>
<td>Total-tract NDF digestibility, %</td>
<td>43.0 ± 5.3</td>
<td>38.8 ± 5.4</td>
<td>-</td>
</tr>
<tr>
<td>pH</td>
<td>4.00 ± 0.23</td>
<td>3.93 ± 0.17</td>
<td></td>
</tr>
<tr>
<td>Lactic acid, % DM</td>
<td>3.24 ± 1.76</td>
<td>3.62 ± 1.39</td>
<td></td>
</tr>
<tr>
<td>Acetic acid, % DM</td>
<td>1.56 ± 1.03</td>
<td>2.26 ± 0.91</td>
<td>+</td>
</tr>
<tr>
<td>Lactic:Acetic ratio</td>
<td>2.08</td>
<td>1.60</td>
<td></td>
</tr>
</tbody>
</table>
Many farmers are harvesting corn silage with low DM content (% as fed).

Mode: 29.4%

Source:
Assuming 11 kg DM of silage intake with +5%-units = 0.55 kg of starch

~ 1.2 kg/d of HMC

Source: [Image]
Pull-type represents ~90% of forage harvesters

Source: Bernardes and Do Rêgo (2014)
Dent corn

Flint corn

Vitreousness of Brazilian hybrids ~ 73%

Source: Corrêa et al. (2002)
### Impact of corn endosperm vitreousness on the nutritive value of whole-plant corn silage

<table>
<thead>
<tr>
<th>Item</th>
<th>Dent</th>
<th>Flint</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM intake (kg/d)</td>
<td>23.0</td>
<td>23.2</td>
<td>0.82</td>
</tr>
<tr>
<td>Milk yield (kg/d)</td>
<td>34.2</td>
<td>34.6</td>
<td>0.82</td>
</tr>
<tr>
<td>Starch-D (%)</td>
<td>89.7</td>
<td>91.7</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Source: Corrêa et al. (2003)
Prolamin decreases during fermentation of HMC

Source: Fernandes (2014)
Bacteria are the main contributor to proteolysis in corn grain silage

Source: Junges et al. (2017)
Use of grain silages in Brazilian dairy farms

Source: Bernardes et al. (2018)
Ensiling corn grain improves feed efficiency in beef cattle

<table>
<thead>
<tr>
<th>Item</th>
<th>Dry</th>
<th>Ensiled</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG (kg/d)</td>
<td>1.53</td>
<td>1.53</td>
<td>0.92</td>
</tr>
<tr>
<td>DM intake (kg/d)</td>
<td>11.6</td>
<td>10.5</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Feed efficiency (G:F)</td>
<td>0.129</td>
<td>0.150</td>
<td>+16%</td>
</tr>
<tr>
<td>Fecal starch (% DM)</td>
<td>8.11</td>
<td>3.27</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Source: Da Silva and Jobim (2015)
Aerobic deterioration

... is an important but not a unique problem of hot areas
Warmer temperature during fermentation and longer storage improve aerobic stability

Source: Nishino and Wang (2012)

<table>
<thead>
<tr>
<th>Storage temp</th>
<th>Stability test</th>
<th>10 days</th>
<th>30 days</th>
<th>90 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°C</td>
<td>5°C</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>15°C</td>
<td>15°C</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>25°C</td>
<td>25°C</td>
<td>X</td>
<td>X</td>
<td>O</td>
</tr>
<tr>
<td>25°C</td>
<td>25°C</td>
<td>X</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>25°C</td>
<td>25°C</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>35°C</td>
<td>25°C</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>35°C</td>
<td>35°C</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

- ○: Stable (≥ 7 days)
- X: Unstable

Source: Nishino and Wang (2012)
Sealing greatly impacts animal performance

Only edible silage was offered to the cows

Milk yield (kg/d)

<table>
<thead>
<tr>
<th></th>
<th>PE 200 µm</th>
<th>PE + Oxigen barrier</th>
<th>PE + SC bagasse</th>
</tr>
</thead>
<tbody>
<tr>
<td>inedible silage</td>
<td>7.4%</td>
<td>3.9%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

Source: Amaral et al. (2014)
Applying inoculants in hot zones

Approx. \( \frac{1}{4} \) of farms use silage inoculants in Brazil

Source:
Novinski (2013)
Bernardes and Do Rêgo (2014)
Da Silva et al. (2016)
High temperatures (>35°C) of inoculant-water mixes potentially reduce the numbers of viable LAB

\[ \Delta M - E = \text{enumerated cfu of viable LAB minus the calculated cfu of expected LAB} \]

Fonte: Windle and Kung (2016)
Insulating the tank might alleviate the problem.

Courtesy: O. Queiroz
VOC in sugarcane silages

High content of sol. sugars
(>35% of DM)

High count of yeasts
(>6 log cfu/g)

High content of ethanol
and other VOC
(up to 20% of DM)
Sugarcane silage (without additive) had **9x more ethanol**
and **13x more ethyl acetate** than corn silage.

Source: Daniel et al. (unpublished)
Additives can mitigate VOC emissions in sugarcane silage

Source: Daniel et al. (2015)
Additional info on silage made in hot regions
Final remarks

• Much knowledge on silage in the tropics has been transferred from traditional centers located in temperate zones.

• In recent decades, there has been significant scientific progress on tropical silages, including the formation of new silage scientists.

• Farmers need more extension services and more cooperative actions (machinery, consumables, technical support).

• Silage market is a window of opportunity in tropical areas.
Thank you for your attention!