TROPICAL PASTURES IN A CHANGING ENVIRONMENT. DEVELOPMENT OF AN INTERNATIONAL RESEARCH COLLABORATION IN LATIN AMERICA AND THE CARIBBEAN

Forage conservation strategies in the form of silage and hay for critical periods

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Forage conservation strategies in the form of silage and hay for critical periods

• To be consistent with the current realities of livestock, it is necessary to expand these concepts:
  • Include protein plants and their conservation in the form of flour.
  • Include agro-industrial byproducts and agricultural waste in the concept.
  • Validate in this group of foods the technologies developed for forages
  • Keep in mind that some of them can also be offered to monogastric species.
The biggest challenge of tropical livestock is to have enough food all year round.

Advances in technologies aimed at optimizing the use of local resources and animal nutrition do not have reciprocity in the application of results and knowledge transfers.
What situations does livestock face?

• Unstable periods of rainfall due to climate change that negatively affect forage availability.
• Diets with nutritional deficit in quantity and quality.
• Does not apply feeding programs that guarantee satisfactory productions.

Solutions

• Introduce appropriate feeding systems.
• Use surplus pastures and fodder.
• Incorporate crop residues and agro-industrial by-products as food.
• Apply the knowledge and technologies developed.
What decides the technology to use?

Animals

Category

Number

Production expected

Time of supplementation
Food Balance

Requirements

- Dry Matter
- Metabolizable Energy
- Crude Protein
- Minerals
## REQUIREMENTS

<table>
<thead>
<tr>
<th>Category</th>
<th>Sex</th>
<th>Weight (Kg)</th>
<th>Ingestion capacity (Kg MS)</th>
<th>Weight gain (g/a/d)</th>
<th>CP (g/a/d)</th>
<th>ME (Mcal/a/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fattening</td>
<td>Male</td>
<td>150</td>
<td>4,5</td>
<td>600</td>
<td>492</td>
<td>12,47</td>
</tr>
<tr>
<td>Final Fatt.</td>
<td>Male</td>
<td>350</td>
<td>8,6</td>
<td>600</td>
<td>863</td>
<td>17,47</td>
</tr>
<tr>
<td>Cows (7L)</td>
<td>Female</td>
<td>400</td>
<td>12,0</td>
<td>1 458</td>
<td>1458</td>
<td>25,80</td>
</tr>
<tr>
<td>Ram</td>
<td>Male</td>
<td>30</td>
<td>1,7</td>
<td>100</td>
<td>140</td>
<td>1,82</td>
</tr>
</tbody>
</table>

### Needs of food conserved for six months of non-rainy period

<table>
<thead>
<tr>
<th>Category</th>
<th>Silage</th>
<th>Hay</th>
<th>Protein Plants</th>
<th>Flour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fattening</td>
<td>3</td>
<td>0,5</td>
<td>0,45</td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>5</td>
<td>1,0</td>
<td>0,60</td>
<td></td>
</tr>
<tr>
<td>Ram</td>
<td>1</td>
<td>0,2</td>
<td>0,25</td>
<td></td>
</tr>
<tr>
<td>Goat</td>
<td>1,5</td>
<td>0,3</td>
<td>0,35</td>
<td></td>
</tr>
</tbody>
</table>
Forage Conservation
Main Forage Conservation Technologies

- Silage
- Dehydration

Hay

Flours of proteic plants
How to guarantee an adequate quality in the conservation?

**Silage**
- Grass
  - Grazing: 6-7 weeks
  - Cut: 9-10 weeks
  - Dry matter: 30 - 35%
  - Chopped: 2 - 4 cm
- Mixed silages
  - Grasses / Protein plants
    - (70-60: 30-40)
  - Corn and sorghum, grains in milky state

**Hay**
- Grazing grasses
  - Mow 6-9 weeks
  - Vegetative state or beginning to glean
  - Manufacture on days with low probability of rain, high temperatures and strong breezes
  - Do not expose forages more than 3 days
  - Make a turn at 6 hours cut
  - Do not use herbaceous or arboreal legumes

**Flours of proteic plants**
- Arboreal and shrubby
  - Foliage and tender stems
    - Between 8-10 weeks
- Herbaceous legumes
  - Beginning of flowering
  - Drying in the sun, in the shade in roofed installations or solar dryers
  - Blade mill
  - Pack in bags that transpire
  - Store in fresh and dry places
Technologies for large farms

Silage
- Silos ≥ 20 t

Hay
- Mowers
- Spinning machines
- Balers
- Storage

Protein plant meal
- Solar dryers
- Blade mill
- Mixer
- Pelletizer
Technologies for small farms

Silage
- Silos ≤ 5 t
- Ring / Bag

Hay
- Manual wrapping machines

Protein plant meal
- Solar dryers
- Blade mill
- Mixer
- Pelletizer
Cutting machine
**Subproducts**

Conservation technologies according to their bromatological characteristics

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**Dry matter:** 15-25 %
Por capas

**Fresh sunflower**
- Orange
- Pineapple
- Mango
- Vegetables
- Pseudo banana stem
- Similar

83 %

**Absorbent material**
- Hay
- Straw bean
- Bagasse of cane
- Corn whole plant

10 %

**Urea**

4 %

**Lactic Ferments**
- Whey

3%

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**Silage**

**Ground and mixed raw materials**

**Direct Presecado**
- Immature fruits
- Bananas
- Avocado
- Cherimoyas
- Papaya
- Mango
- Similar

70 %

**Foliage**
- Yucca
- Sweet potato
- Potato?
- Malanga?

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**Absorbent material**
- Yucca
- Sweet potato
- Malanga

100 Kg + 200 L water

**2 L Natural Yogurt**

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**Absorbent material**
- Wheat bran,
- Hay
- Straw bean
- Bagasse of cane

30 %
Hay

- Materials ≥ 80 % DM

**Packing after picking the main crop**
- Large extensions: Specialized machinery
- Small extensions: Manual or semi-manual

**Straws of rice**
**Straw of beans**
**Peanut straw**
**Sesame straw**
**Whole silver corn**

Ammonify?

**Subproducts**
Conservation technologies according to their bromatological characteristics

Flours

- Materials ≥ 60 ≤80 DM

Blade mill
Dehydrate
  - To the sun
  - In the shade in roofed installations
  - Solar dryers

Non-commercial waste of:
- Yuca, Sweet potato, Malanga, Green banana, Shellfish shells, Fish,
- Wastes from the silkworm breeding
Economic factors

Benefits obtained

Costs:
Acquisition + Transportation + Treatment + Storage

Cost effectiveness
Use of silages

They can not be the only food
They need to be supplemented with energy and protein

To overcome these difficulties:
1. Carry out restricted pastures (4-6 hours)
2. Supplement with hay (10% of total consumption)
3. Concentrate (1-2 kg / anima / day)
4. Provide fodder (30% of total consumption)
Supplementation technology according to the pastel procedure

1. Place a layer of hay equivalent to 0.5 kg/animal in the feeder.
2. Place fresh or silage fruit skins 4 or 5 kg/animal.
3. Sprinkle diluted urea, according to food balance.
4. Incorporate the protein supplement according to the food balance.
5. Add mineral salts, to regulate the speed of consumption.
Diet

- Restricted grazing (4-6 horas)
- Housing
- Supplementation

- Silage
  - Hay
  - Forage
  - Concentrated
  - Byproducts
Hay
Mowing with machetes, scythes or similar.

**Preparation of the bales:**
- Wooden or plastic box of 100x50x40 cm.
- Place two long strings on the bottom that fall on both sides.
- Deposit a layer of hay and compress with your feet.
- Introduce successive layers until filling the box.
- With the people over to love the bale.

**Another procedure:**
- Divide a 200 L tank into two halves and join it with sliding hinges.
- Place two strings from the bottom that protrude the edges.
- Introduce successive layers of hay and compact with the feet.
- Fill the tank to the edge and tie the ropes.

Place the bale in a covered, ventilated and dry place.
Avoid storing for more than 6 months.
Protein plant meal
Protein plant meal

• Perennial plants with high levels of crude protein in their foliage.
• Their nutritional characteristics allow them to be included in unconventional concentrates.
Contribution of nutrients of one ton of flour from tree plants and a cereal concentrate.

<table>
<thead>
<tr>
<th>Tree species</th>
<th>DM (t)</th>
<th>CP (t)</th>
<th>FB (t)</th>
<th>EM ($10^3$ Mcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Leucaena leucocephala</em></td>
<td>0.90</td>
<td>0.18</td>
<td>0.17</td>
<td>1.93</td>
</tr>
<tr>
<td><em>Gliricidia sepium</em></td>
<td>0.98</td>
<td>0.24</td>
<td>0.28</td>
<td>2.17</td>
</tr>
<tr>
<td><em>Albizia lebbeck</em></td>
<td>0.96</td>
<td>0.23</td>
<td>0.26</td>
<td>2.05</td>
</tr>
<tr>
<td><em>Morus alba</em></td>
<td>0.97</td>
<td>0.24</td>
<td>0.13</td>
<td>2.36</td>
</tr>
<tr>
<td><em>Concentrado comercial</em></td>
<td>0.86</td>
<td>0.16</td>
<td>0.05</td>
<td>2.39</td>
</tr>
</tbody>
</table>
# Milk Cows and Bulls Ceba

<table>
<thead>
<tr>
<th>Raw materials</th>
<th>Non-convencional Concentrate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moringa + Morera + Tithonia (%)</td>
</tr>
<tr>
<td>Moringa</td>
<td>37,00</td>
</tr>
<tr>
<td>Morera</td>
<td>25,00</td>
</tr>
<tr>
<td>Tithonia</td>
<td>36,00</td>
</tr>
<tr>
<td>Pre-mezcla mineral</td>
<td>2,00</td>
</tr>
</tbody>
</table>

## Bromatological analyzes

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein (%)</td>
<td>23,20</td>
</tr>
<tr>
<td>Crude fat (%)</td>
<td>6,19</td>
</tr>
<tr>
<td>Metabolizable Energy (Mcal/Kg MS)</td>
<td>3,16</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>10,47</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>1,74</td>
</tr>
<tr>
<td>Phosphorus (%)</td>
<td>0,44</td>
</tr>
</tbody>
</table>
Example of diets
Feeding bulls

Effect of protein supplementation on weight gain in silage diets.

### Graph

- **Kg/a/día**
- **Sin suplementación**: 0.411
- **Con suplementación**: 0.541

### Table

<table>
<thead>
<tr>
<th>Food</th>
<th>Supplementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With</td>
</tr>
<tr>
<td>Forage</td>
<td>14,90 ± 0,6</td>
</tr>
<tr>
<td>Silage</td>
<td>10,20 ± 0,7</td>
</tr>
<tr>
<td>Salt</td>
<td>0,04</td>
</tr>
<tr>
<td>Hay</td>
<td>1,00 ± 0,1</td>
</tr>
<tr>
<td>Urea</td>
<td>0,08</td>
</tr>
<tr>
<td>Distillery grains</td>
<td></td>
</tr>
<tr>
<td>Wheat bran</td>
<td></td>
</tr>
</tbody>
</table>
Feeding bulls
Comparison of weight gains by using fresh citrus skins or silage.

<table>
<thead>
<tr>
<th>Food</th>
<th>Silage</th>
<th>Hollejo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forage</td>
<td>14,80 ± 0,5</td>
<td>16,20 ± 0,4</td>
</tr>
<tr>
<td>Hollejo</td>
<td></td>
<td>20,30 ± 0,5</td>
</tr>
<tr>
<td>Silage</td>
<td>9,90 ± 0,4</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>0,05</td>
<td>0,05</td>
</tr>
<tr>
<td>Hay</td>
<td>0,50 ± 0,1</td>
<td>0,50 ± 0,1</td>
</tr>
<tr>
<td>Urea</td>
<td>0,02</td>
<td>0,05</td>
</tr>
<tr>
<td>Distillery grains</td>
<td>1,50</td>
<td>1,50</td>
</tr>
</tbody>
</table>

**Kg/a/día**

![Bar chart showing weight gains for Ensilaje and Hollejo]
Feeding bulls
Effect of supplying fresh or ensiled citrus husk by the cake process.

<table>
<thead>
<tr>
<th>Food (kg/a/día)</th>
<th>Silage</th>
<th>Hollejo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forage</td>
<td>11,80 ± 0,6</td>
<td>13,90 ± 0,8</td>
</tr>
<tr>
<td>Hollejo</td>
<td></td>
<td>16,01 ± 0,4</td>
</tr>
<tr>
<td>Silage</td>
<td>10,20 ± 0,5</td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>0,05</td>
<td>0,05</td>
</tr>
<tr>
<td>Hay</td>
<td>0,50 ± 0,1</td>
<td>0,50 ± 0,1</td>
</tr>
<tr>
<td>Urea</td>
<td>0,05</td>
<td>0,07</td>
</tr>
<tr>
<td>Norgol</td>
<td>0,80</td>
<td>0,80</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>1,10</td>
<td>1,10</td>
</tr>
</tbody>
</table>
Use of fresh or silage citrus skins using the cake for protein supplementation.

<table>
<thead>
<tr>
<th>Food</th>
<th>Silage</th>
<th>Hollejo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/a/día</td>
<td>kg/a/día</td>
</tr>
<tr>
<td>Forage</td>
<td>11,80 ± 0,6</td>
<td>13,90 ± 0,8</td>
</tr>
<tr>
<td>Hollejo</td>
<td>16,01 ± 0,4</td>
<td></td>
</tr>
<tr>
<td>Silage</td>
<td>10,20 ± 0,5</td>
<td></td>
</tr>
<tr>
<td>Sat</td>
<td>0,05</td>
<td>0,05</td>
</tr>
<tr>
<td>Hay</td>
<td>0,50 ± 0,1</td>
<td>0,50 ± 0,1</td>
</tr>
<tr>
<td>Urea</td>
<td>0,05</td>
<td>0,07</td>
</tr>
<tr>
<td>Grains of distillery</td>
<td>0,80</td>
<td>0,80</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>1,10</td>
<td>1,10</td>
</tr>
</tbody>
</table>
What to do?

• Create multisectoral groups able to develop strategies of feeding in the farms.
• Train producers in the preparation of feed and nutritional balances, instant and perspective, by animal category and time of year.
• To determine the needs of forage resources to cover deficits through immediate, medium and long-term solutions.
• Evaluate unconventional food sources in the environment and their utilization potentials.
• Contribute through the incorporation as food of agricultural wastes and by-products, to environmental decontamination.
• Train the producers in the technologies of conservation and use according to their nutritional requirements and economic possibilities.
• Have budgets to implement food and conservation systems.
Using the food resources offered by the tropics and the surrounding livestock areas is a necessity and a challenge. Both actions complement each other and it is up to us to couple them.
MUCHAS GRACIAS
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