Finding a consensus on the effects of tropical legume silages on intake, digestibility and performance in ruminants: A meta-analysis

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Animal Nutrition and Rangeland Management in the Tropics and Subtropics

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Feeding ruminants with forage legumes

The temperate experience

Compared with grasses:
- Higher crude protein content
  - Lower fiber content
- Higher digestibility
- High voluntary intake

*Medicago sativa*

*Trifolium pratense*
Feeding ruminants with forage legumes

The tropical experience

Compared with grasses and whole crop cereals:

- Higher crude protein content
  - Lower fiber content
- Higher digestibility
- High voluntary intake

*Lablab purpureus*  *Stylosanthes guianensis*
Feeding ruminants with forage legumes

The tropical experience

The classical legume feeding experiment

Is it the legume... Or the protein?
Finding a consensus
Literature search

Conditions

- Legumes fed as silage
- \textit{In vivo} studies with ruminants
- In tropical/subtropical regions
- Proportion of legume in the diet, and diet composition
- Measure of dispersion and/or number of observations
Database summary
Overview

Studies and treatments
- 51 publications
  - 62 trials
  - 218 treatments
    - (56 controls, 162 legumes)

Distribution of treatments by level of legume inclusion

Legume proportion in the diet (g/100 g DM)

0 5 10 15 20 25 30

% 20 30 40 50 60 70 80 90 100

METHODOLOGY
Database summary
Legume species

Most common species

- 23 species found
- Herbs, shrubs and trees

Number of trials

<table>
<thead>
<tr>
<th>Legume species</th>
<th>Cattle</th>
<th>Small ruminants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stylosanthes</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Soybean</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Lablab</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Leucaena</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Glicicidia</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

29 trials with small ruminants
33 trials with cattle
Effects of the proportion of legume in the diet

- Regression of diets containing legumes

Comparison of diets without legumes and with legumes at varying levels:

- Control
- 100 to 400 g/kg DM
- 401 to 800 g/kg DM

Two statistical approaches
Results
Tropical legume silage feeding effects on intake

Dry matter intake per kg metabolic bodyweight

(g/kg BW^{0.75})

- High crude protein
- Low crude protein

Low       High
Legume proportion in the diet

RESULTS INTAKE
Tropical legume silage feeding: Effects on intake

Dry matter intake per kg metabolic bodyweight

(g/kg BW^{0.75})

- **High crude protein**
- **Low crude protein**

**Results Intake**

- **Fiber content and characteristics**
- **Secondary plant compounds**
- **Silage fermentation products**
- **Digestibility**

**INTRODUCTION │ METHODOLOGY

| RESULTS INTAKE |
| RESULTS DIGESTIBILITY |
| RESULTS PERFORMANCE |
Tropical legume silage feeding
Effects on apparent total tract digestibility

Organic matter

<table>
<thead>
<tr>
<th>Legume proportion in the diet (g/kg DM)</th>
<th>(g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>600</td>
</tr>
<tr>
<td>100-400</td>
<td>650</td>
</tr>
<tr>
<td>&gt;400</td>
<td>700</td>
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</tbody>
</table>

Fiber content and characteristics

Passage rate, buoyance
Tropical legume silage feeding
Effects on apparent total tract digestibility

Crude protein

- Excessive heating during storage in silo
- Fiber bound nitrogen
- Secondary plant compounds

![Graph showing the effects of legume proportion on apparent total tract digestibility](chart)

**RESULTS DIGESTIBILITY**
Average daily gain

Legume proportion in the diet (g/kg DM)

Tropical legume silage feeding effects on performance

Results intake

Results digestibility

Results performance
Tropical legume silage feeding
Effects on performance

Milk yield and feed conversion efficiency (FCE)

**Milk yield**

<table>
<thead>
<tr>
<th>Legume proportion in the diet (g/kg DM)</th>
<th>kg/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>100-400</td>
<td></td>
</tr>
<tr>
<td>&gt;400</td>
<td></td>
</tr>
</tbody>
</table>

**FCE**

<table>
<thead>
<tr>
<th>Legume proportion in the diet (g/kg DM)</th>
<th>kg milk/kg DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>100-400</td>
<td></td>
</tr>
<tr>
<td>&gt;400</td>
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</tbody>
</table>
Results
Tropical legume silage feeding

Enhancement of microbial protein synthesis
Rumen ammonia-N
N-Energy synchronization
Urea recycling

Supply of dietary nutrients
Changes in fermentation pattern

INTRODUCTION  │  METHODOLOGY
INTAKE  │  RESULTS
DIGESTIBILITY  │  RESULTS PERFORMANCE
Final remarks
The consensus

- Tropical legumes fed as silage
  - Lower intake and digestibility
  - Maintain or increase the performance
    - Inclusion rates up to 400 g/kg DM

- Mechanisms of action are still to be understood
  - Further research

- Focus on promising legumes
The (other) classical legume feeding experiment

Enterolobium cyclocarpum

Not mechanizable

Low biomass
Final remarks
The consensus

• Tropical legumes fed as silage
  • Lower intake and digestibility
  • Maintain or increase the performance
    • Inclusion rates up to 400 g/kg DM

• Mechanisms of action are still to be understood
  • Further research

• Focus on promising legumes
  • Quality, quantity, mechanization
    • Lablab, stylosanthes, soybean, cannavaalia
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Thank you very much!

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