SHREDLAGE technology: a key to expanding grain sorghum silage.

Leandro O. Abdelhadi - leandroabdelhadi@hotmail.com
Nicolas Di Lorenzo - ndilorenzo@ufl.edu
### Crops evolution in Argentina (thousands hectares)

<table>
<thead>
<tr>
<th>Year</th>
<th>Corn</th>
<th>Sorghum</th>
<th>Sunflower</th>
<th>Soybean</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>2.781</td>
<td>670</td>
<td>2.205</td>
<td>5.817</td>
<td>11.473</td>
</tr>
<tr>
<td>1998</td>
<td>3.751</td>
<td>920</td>
<td>3.511</td>
<td>7.176</td>
<td>15.358</td>
</tr>
<tr>
<td>2002</td>
<td>3.061</td>
<td>591</td>
<td>2.050</td>
<td>11.639</td>
<td>17.341</td>
</tr>
<tr>
<td>2004</td>
<td>2.988</td>
<td>545</td>
<td>1.847</td>
<td>14.527</td>
<td>19.907</td>
</tr>
<tr>
<td>2007</td>
<td>3.570</td>
<td>700</td>
<td>2.440</td>
<td>16.100</td>
<td>22.810</td>
</tr>
<tr>
<td>2016-17</td>
<td>5.800</td>
<td>950</td>
<td>1.465</td>
<td>19.800</td>
<td>28.015</td>
</tr>
</tbody>
</table>

 Increased 144%

**Same picture all over the world:**

“Agriculture concentrates and displace cows to marginal areas”
To produce yield and quality forage in poor lands, sorghum is the key!
Argentina Sorghum Breeding Program

New technologies for a new sorghum crop

transgenic Herbicide Resistance
(specially post emergence graminicides)

History

Near future

Thanks Vicente Trucillo & Advanta co-workers.
Sorghum was born in Africa!
So has enough rusticity to colonize marginal lands around the world!
Basically one problem has limited grain sorghum silage utilization:

Whole grain in silage
Whole grain in feces
Small and physically complex grain:

- Pericarp
- Tannins
- Endosperm

Seed

Coat
Small and physically complex grain:

- Corneous endosperm
- Floury endosperm
Remember: not only grains goes through the crackers, we have the stover, so particle size need to be reduced to close rolls gap and hence crash small berries!
The consequence of reducing TLC:

“No effective fiber available in grain sorghum silage”
Since 2008, a new idea on processing technology was developed for corn silage.
Original ideas from Olson & Dale 2008:

1) Longer fiber in corn silage to reduce straw in diets (Chopped length 26-30mm at 2-3mm rolls gap).

2) Better grain processing when compared to conventional crackers.

3) Increase fiber utilization in conventional corn crops (because rolls works as molars in cows shredding the silage and hence creating additional areas for rumen microbes to work on).
Interesting results for corn silage by UW:

**Corn Shredlage: Equipment, storage and animal perspectives**

L.F. Ferraretto, L. Salvati, G.S. Dias

### 3.5% FCM Yield by Week

![3.5% FCM Yield by Week](image)

**Week × Treatment Interaction (P < 0.03)**

### Milk Yield by Week on Treatment

![Milk Yield by Week on Treatment](image)

**Week × Treatment Interaction (P < 0.01)**

#### Experimental Diets (DM basis)

<table>
<thead>
<tr>
<th>Diet</th>
<th>SHRD</th>
<th>KP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shredlage</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>KP Silage</td>
<td>----</td>
<td>50%</td>
</tr>
<tr>
<td>Alfalfa Silage</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Ground Dry Shelled Corn</td>
<td>10.3%</td>
<td>10.3%</td>
</tr>
<tr>
<td>Corn Gluten Feed</td>
<td>7.4%</td>
<td>7.4%</td>
</tr>
<tr>
<td>SBM 48%, solvent</td>
<td>6.9%</td>
<td>6.9%</td>
</tr>
<tr>
<td>SBM, expeller</td>
<td>9.3%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Rumen-Inert Fat</td>
<td>1.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Min/Vits</td>
<td>4.2%</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

*Ferraretto and Shaver, 2012*

### Experimental Diets (DM basis)

<table>
<thead>
<tr>
<th>Diet</th>
<th>SHRD</th>
<th>KP</th>
<th>KPH</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMR Shredlage</td>
<td>45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMR KP Silage</td>
<td>----</td>
<td>45%</td>
<td>35%</td>
</tr>
<tr>
<td>Alfalfa Silage</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Chopped Dry Hay</td>
<td>----</td>
<td>----</td>
<td>10%</td>
</tr>
<tr>
<td>Ground Dry Shelled Corn</td>
<td>14.2%</td>
<td>14.2%</td>
<td>17.7%</td>
</tr>
<tr>
<td>SBM, expeller</td>
<td>5.0%</td>
<td>5.0%</td>
<td>4.2%</td>
</tr>
<tr>
<td>SBM 48%, solvent</td>
<td>8.8%</td>
<td>8.8%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Corn Gluten Feed Dried</td>
<td>11.1%</td>
<td>11.1%</td>
<td>9.6%</td>
</tr>
</tbody>
</table>

*Vanderwerff et al., 2015*
Because it has a great contact surface, 110 and 145 teeth rolls, works at 50% speed difference and as closely as 1mm rolls gap; in 2016 the idea that Shredlage could work with grain sorghum silage was born!
We worked together with:

**Aim:** to evaluate the effect of Multicrop Shredlage® (MS) compared with a conventional sorghum cracker (SC) or no cracker (NC) at all, on particle size, *in vitro* OM, *in situ* DM and Starch digestion of grain sorghum crop.
Materials & Methods

Crop and treatments

- Sorghum crop at dough stage of grain maturity was used.
- Harvested occurred at ground level on May 23 (2016), with a precision chop harvester (Claas 960) equipped with 9 meters Orbis header and 28 Knife drum.
- Three treatments at 15mm theoretical length of cut (TLC) were applied depending on type of grain cracker:
  - NC = No-cracker.
  - SC = Sorghum cracker with 250mm rolls* (125-150 teeth’s working at 40% speed difference).
  - MS = Multicrop Shredlage® with 250mm rolls* (110-140 teeth’s working at 50% speed difference).

*Rolls gap spacing for SC and MS was manually set to 1mm.
**Sampling**

- Cartoon boxes were fixed at ground level with staples in the line over which the discharge spout was going to leave the chopped sorghum.

- When harvest occurred, total chopped sorghum collected in each box constituted a sample (m1, m2,.....etc).

- We had 3 blocks over which 3 treatments were randomized and 3 samples were taken (27 samples). On farm design:
Argentina on farm trial – May 2016
Argentina laboratory trial – May 2016
- Two ruminally cannulated Angus crossbred steers were used to get ruminal fluid.

- Polypropylene pipes of 100 ml were used for incubation at 39°C for 24 h.

- 0.7 g substrate by pipe + 50 ml of inoculum (mix 4:1 buffer McDougal : ruminal fluid) was used. Grain sorghum was dried at 55°C and ground through a 6 mm sieve.

- After 24 h of incubation, pepsin and HCl was added and incubated until 48 h to simulate gastric digestion.
Univ. Florida *in vitro* trial – August 2016

Ruminal fluid collection

In vitro incubation

Buffer McDougall’s

Pepsin addition

Anaerobic incubation

Constant agitation
- Two ruminally cannulated Angus crossbred steers were used for bags incubation.

- Dacron bags of 60 micron pores containing ground grain sorghum samples (6mm sieve) were incubated for 24 or 48 hs.

- DM and starch digestibility were measure using dry and ground residue (2mm sieve).

- Starch concentration was analyzed using an enzymatic digestion assay, as described by Di Lorenzo et al. (2011).
Incubation of dacron polyester bags

UF graduate students and staff

Univ. Florida *in situ* trial – November 2016
Results

Physical characteristics of grain sorghum

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>NC</th>
<th>SC</th>
<th>MS</th>
<th>SEM</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper sieve, &gt;1.9cm</td>
<td>2.37</td>
<td></td>
<td></td>
<td>0.57</td>
<td>0.01</td>
</tr>
<tr>
<td>Middle sieve, 1.89 - 0.79cm</td>
<td>32.59</td>
<td>33.08</td>
<td>31.98</td>
<td>1.49</td>
<td>0.87</td>
</tr>
<tr>
<td>Lower sieve, 0.78 - 0.18cm</td>
<td>62.34</td>
<td>57.19</td>
<td>52.83</td>
<td>1.45</td>
<td>0.05</td>
</tr>
<tr>
<td>Bottom sieve, &lt;0.17cm</td>
<td>2.71</td>
<td>5.74</td>
<td></td>
<td>0.21</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Means within row followed by unlike superscripts differ.

Particulate size of grain sorghum dried crop harvested with no-cracker (NC), sorghum cracker (SC) or multicrop Shredlajge® (MS).

* NC= no cracker, SC= sorghum cracker and MS = multicrop Shredlajge®, all at 15cm theoretical length of cut.
In vitro OM digestibility at 24h for grain sorghum crop harvested at 15mm TLC with no-cracker (NC), sorghum cracker (SC) or multicrop Shredlage® (MS).

![Bar chart showing digestibility percentages for NC, SC, and MS treatments.]

- NC: a=30.08
- SC: b=34.36
- MS: b=33.17

Treatment effect, $P < 0.001$

a,b Means with unlike letters differs, $P < 0.05$. 
DM and starch content before *in situ* incubation in grain sorghum crop harvested at 15mm TLC with no-cracker (NC), sorghum cracker (SC) or multicrop Shredlage®(MS)

<table>
<thead>
<tr>
<th>Initial composition, %</th>
<th>Treatments*</th>
<th>SEM</th>
<th>P&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NC</td>
<td>SC</td>
<td>MS</td>
</tr>
<tr>
<td>DM</td>
<td>54.45</td>
<td>53.90</td>
<td>51.03</td>
</tr>
<tr>
<td>Starch (<em>on DM basis</em>)</td>
<td>22.17</td>
<td>19.96</td>
<td>16.24</td>
</tr>
</tbody>
</table>

*abc* Means within row follow by unlike superscripts differs

* NC= no cracker, SC= sorghum cracker and MS = multicrop Shredlage®, all at 15cm theoretical length of cut
In situ ruminal starch digestibility (mean between 24 and 48 hs) for grain sorghum crop harvested at 15mm TLC with no-cracker (NC), sorghum cracker (SC) or multicrop Shredlage® (MS); using ini-starch COV

![Graph showing digestibility percentages for NC, SC, and MS treatments]

- Treatment effect, $P < 0.04$
- Incubation time effect, $P < 0.01$
- Treatment x incubation time, $P = 0.76$

$$a = 46.48$$  
$$b = 59.6$$  
$$ab = 56.74$$

a,b Means with unlike letters differs, $P < 0.05$. 
Grain sorghum crop at the lower sieve of Penn State Separator

As a visual observation, differences like this disappeared after grinding samples at 6mm, so we suspect that differences due to processors will be greater when feeding because:

- sorghum berries are small, weighted and hard.
- if grains are whole, once in the rumen, goes down and pass.
- if passed, no rumination is expected and final destination will be feces.
Implications

- As the result of physical evaluations, MS was effective to achieve a longer particle size when compared to NC or SC, and as in SC gives more fine particles collected in the bottom sieve of the PSS.

- Harvesting grain sorghum without processor reduces *in vitro* OM digestibility when compared with processor treatments.

- Considering initial starch as covariate, *in situ* ruminal starch digestibility increased in SC when compared with NC without differences with MS at 36h of incubation.

- Although feeding trials are going to complete *in vitro* and *in situ* findings, it is interesting to think that Multicrop Shredlage® could be the only processor needed to give long fiber and processed grain both in corn and grain sorghum crops; finishing with the necessity of having/changing a particular processor depending on the crop we are going to harvest.
Acknowledgements

To all people that take part in this project:

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- Graduate students and staff of the University of Florida (UF-IFAS).
THANK YOU FOR YOUR ATTENTION

Leandro O. Abdelhadi - leandroabdelhadi@hotmail.com
Nicolas Di Lorenzo - ndilorenzo@ufl.edu