Management practices to improve the sustainability of integrated cattle and grain operations at the Dudley Smith Farm

Dudley Smith Initiative
Spring 2014 Review

CURRENT WORK

- Randomized fall strip and continuous grazing experiments
Our fall grazing integrates several aspects of both crop and livestock production.

- Cattle performance
- Grazing behavior
  - GPS data
- Forage selectivity
- Interrelationships among:
  - Cattle spatial occupancy
  - Soil characteristics
  - Crop yield

Objective

- Cattle producer incentives well documented
- How is the integrated system effected?
  - Soil properties, crop growth, development, & yield
- Study the effects of grazing method (continuous vs. strip vs. ungrazed) on cow performance, soil physical and chemical properties, and crop yield.
Grazing management included 3 treatments with 3 replicates each and 36 mature Angus cows (648 kg), at 3 cows/ha.

Soil sampling was conducted before and after the grazing study.
Our grazing studies have been replicated twice.

- **Year 1 (2012)**
  - Corn harvested August 21st
  - Grazed: Sept. 27th - Nov. 8th
    - Cows supplemented 3 days/week corn gluten feed/soybean hulls

- **Year 2 (2013)**
  - Corn harvested October 16th
  - Grazed: Nov. 2nd - Dec. 15th
    - Cows supplemented 3~5 days/week corn gluten feed/soybean hulls
    - Freezing temps and snow required increase in supplementation

Soils were sampled to depth of 50 cm (20 in.).

- Analyzed for:
  - Penetration Resistance (compaction)
  - Bulk Density
  - Nitrogen (NO3 & NH4)
  - Available Phosphorous
  - Moisture Content
Preliminary results show strip grazed cattle outperformed continuously grazed cattle in body weight while both maintained body condition scores.

<table>
<thead>
<tr>
<th>Item</th>
<th>Continuous</th>
<th>Strip Grazed</th>
<th>SE</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial BW, kg</td>
<td>679</td>
<td>680</td>
<td>1.4</td>
<td>0.66</td>
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<tr>
<td>Final BW, kg</td>
<td>694</td>
<td>708</td>
<td>4.3</td>
<td>0.05</td>
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<td>BW Change, kg</td>
<td>15</td>
<td>29</td>
<td>3.8</td>
<td>0.04</td>
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<tr>
<td>Initial BCS</td>
<td>5.8</td>
<td>5.9</td>
<td>0.1</td>
<td>0.56</td>
</tr>
<tr>
<td>Final BCS</td>
<td>5.7</td>
<td>5.8</td>
<td>0.1</td>
<td>0.65</td>
</tr>
<tr>
<td>BCS Change</td>
<td>-0.1</td>
<td>-0.1</td>
<td>0.04</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Preliminary results for year 1 suggest:

- Strip & continuous had greater bulk densities than control
- CG & SG had increased PR in top 10 cm. Only CG had greater PR than CT at greater depths
- No significant differences in P, NO₃, & NH₄
  - Highly variable in soils
Preliminary Findings (Year 1)

Increase in bulk density and penetration resistance are not yet of agronomic importance.

- All values of bulk density and penetration resistance are within optimal values on silt loam soils
- Strip grazing requires increase in labor, but resulted in significant increase in body weight.
- More years of research is needed to evaluate permanency of soil effects.
Cattle spatial occupancy was uneven throughout strip and continuously grazed paddocks.

Randomized fall grazing study

Strip grazing management has significant impacts on the spatial distribution pattern of animal locations.

2012 Fall
First Period:
09/27-10/02 and 10/11-10/12
Strip grazing management has significant impacts on the spatial distribution pattern of animal locations.

2012 Fall
First Period: 09/27-10/02 and 10/11-10/12
Second Period: 10/12-10/16 and 10/25-10/26

Strip grazing management has significant impacts on the spatial distribution pattern of animal locations.

2012 Fall
First Period: 09/27-10/02 and 10/11-10/12
Second Period: 10/12-10/16 and 10/25-10/26
Third Period: 10/26-11/08
Preliminary results show that corn yield has little impact on the spatial occupancy of cattle.

2012 fall
Dudley Smith Initiative Farm
(North)

CURRENT WORK

- Model development and data analysis
We have investigated the effects of number of animals monitored on representations of cattle group movement characteristics and spatial occupancy.

Decisions regarding selection of an appropriate subset group size for monitoring a group of cattle depend on the specific use of data for subsequent analysis.

Monitoring a relatively small group of animals may be enough for identifying areas visited by cattle.
Periodic movement patterns (e.g. associated with water) can be identified using data mining.

Example: 2011 summer cattle movement GPS data

Periodic pattern associated with water visitations

Period (associated with water) detected: P~ 24.8 hours

An agent-based model has been developed to simulate cattle movement on crop residue lands under continuous and strip grazing management practices.
Two journal manuscripts are in process.

- A manuscript (submitted to PLOS ONE) – “Effects of number of animals monitored on representations of cattle group movement characteristics and spatial occupancy”.
- A manuscript (preparing) – “Modeling spatial distribution of fall grazing cattle on crop residue lands using multi-agent simulation”

Given future validation of the model, we anticipate to test scenarios and identify future strategies for grazing management.
CURRENT WORK

- Methane emission estimates using the Ruminant Emission Measurement System (REMS)

The Ruminant Emission Measurement System (REMS) supports research on the relationships between nutrition, genetics, and different management strategies, and their subsequent effects on beef cattle CH₄ emissions.
Methane Emission Rate (ER) relative and absolute expanded standard uncertainties \((k = 2; 95\% \text{ C.I.})\) was found to be about 6% for ERs greater than 4.0 g h\(^{-1}\).

The REMS has undergone a comprehensive and systematic validation process to reliably quantify methane emissions.
Studies conducted using the REMS have explored:

- **Effects of nutrition on methane production**
  - Fat from corn distillers solubles
    - Dr. Jacob Segers
  - Forage or grain diets
    - Blake Lehman
  - Gestational plane of nutrition on calves
    - Bain Wilson

- **Feed Efficiency**
  - Relationship between feed efficiency and methane production
    - Bain Wilson

Steers were fed a corn control and coproduct blends with increasing concentrations of dietary fat from condensed corn distillers solubles (CDS).

**Methane Emission Measurement**

There is no effect ($P \geq 0.37$) of corn distillers solubles inclusion on methane production.
Expected outcomes include journal papers, conference abstracts and posters.

- **Engineering aspect:**
  - A two part series to document the unique design and methodology to quantify the calculated emission and associated combined standard uncertainty
  - A technical note regarding the design, construction, and validation a low-cost instrument for accurate volumetric flow rate measurement
  - A technical note exploring the effects of sampling interval and the initial start time of sampling on daily methane emissions

- **Animal science aspect:**
  - Papers regarding from the nutritional studies

Lessons learned:

- Many potential sources of uncertainty exist in these complex systems requiring a comprehensive and well-documented design and commissioning
- Applying a systematic approach and rigorous procedure to the REMS validation has greatly enhanced the quality and reliability of methane production estimates
CURRENT WORK

- Effects of Summer Supplement Feeding Frequency on Performance of Grazing Beef Replacement Females

Infrequent supplementation of low fat co-products to developing heifers will perform similarly to daily supplementation, thus reduce labor costs.
Summer supplementation was studied by grazing cool season grass pasture for 55 days between June 24th and August 20th.

- 64 bred Angus heifers (17 mo.)
- 1 of 2 treatments
  - High Frequency
  - Low Frequency
- Weighed and assigned body condition score

Two treatments were applied during the summer supplementation study.

- High Frequency
  - Fed 6 days/wk
  - 2.3 kg/hd Corn gluten feed/Soybean Hulls

- Low Frequency
  - Fed 3 days/wk
  - 4.5 kg/hd Corn gluten feed/Soybean Hulls

- BOTH treatments received 13.6 kg/hd/wk
Statistical Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>Low</th>
<th>High</th>
<th>SE</th>
<th>$P$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial BW, kg</td>
<td>462</td>
<td>462</td>
<td>1.2</td>
<td>0.82</td>
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<tr>
<td>Initial BCS</td>
<td>5.9</td>
<td>5.8</td>
<td>0.1</td>
<td>0.16</td>
</tr>
<tr>
<td>Final BW, kg</td>
<td>498</td>
<td>493</td>
<td>0.9</td>
<td>0.08</td>
</tr>
<tr>
<td>Final BCS</td>
<td>5.8</td>
<td>5.7</td>
<td>0.1</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Summer supplementation experiment

BW Change

Heifer BW Change

- **Low Treatment**: 36 kg
- **High Treatment**: 31 kg
- $P = 0.21$
No significant differences were observed in neither body weight nor body condition score.

- Preliminary results suggest heifers can be fed infrequently with co-products and perform similarly to daily fed heifers.
- Infrequent supplementation may result in lower labor and equipment costs.

FUTURE WORK
The USDA-NIFA Foundational Program in Agroecosystem management has a focus on enhancing ecosystem services (provisioning, regulating, supporting or cultural) that we intend to apply towards these integrated cattle-grain systems.

• Tong Liu, PhD ABE, is currently preparing a prelim exam proposal “Developing models and decision support capability for sustainable management of integrated crop-livestock systems.”
  – Tasks include data collection on soil characteristics, forage quality, crop yield, cattle performance, and greenhouse gas generation.
  – The key opportunity is to expand our scope to other experimental sites.
    • Dixon Springs?

An educational module is currently in development.

The module features:
  – A fun and interactive activity for kids of all ages to learn about animal science, environmental science, and technology
  – Take home material and fact sheets for students
  – Age/audience appropriate poster about gas production and importance of measurement
  – Age/audience appropriate handouts with information similar to the poster and link the science to potential career paths in agriculture
“REMS Mobile” will feature an interactive interface and real-time CO₂ monitoring.

REMS Mobile includes:
- A replicate of a REMS chamber
- Measures CO₂ production from person inside the chamber
- Visual display compares CO₂ production between the person in the chamber, cow, car, and average human

Potential venues are:
- Student recruitment events
- Youth science programs
- Open houses (e.g. Explore ACES and Engineering Open House)
- National events (e.g. FFA Convention)
- Field days

Publications

- Articles in journals

- Conference proceedings and presentations
  - Ramirez, B.C., Undergraduate Poster Competition, ASABE International Conference. “Ventilation Quantification Using a Orifice Meter for Livestock” July 2012
  - Ramirez, B.C. Summer Research Symposium, University of Illinois at Urbana-Champaign. “Design and Validation Methods of a Methane Emission Measurement System Implemented In A Metabolic Flux Chamber for Beef Cattle” July 2012
Thank you!