Developing Management Tools for Crops, Animals, and Greenhouse Gasses

What we have done

- Cattle response
- Histograms and/or heat maps for cattle locations from fall study (Tong)
- Temperament slides from ASABE (Green)
- Equip
- Flux Chambers (Dr. Green, Gui, and Jacob)
- Design (Gui, Ben)

What we have done...

...in the area of cattle responses to GPS units

We have been successful working with cattle and implementing GPS collars.

- Proactive training protocol:
- Move through the chute
- Wear the strap/collar
- Allow observations and adjustments in the field
- Be rewarded!
Success came slowly for us, but it has continued into our fall 2010 studies.

- Fall 2009: 12 cows trained
  - No broken fences, equipment, etc.
- Fall 2010: 30 cows trained
  - No broken fences, equipment, etc.
  - Collected data on 7 cows/hecmen
- Challenges with GPS:
  - Sunury data
  - Missing data
  - Durability

There are several concerns for working with cattle in open fields.

- Aggressiveness in open field
- Importance of dominance hierarchy
- Potential problems with frequent chute handling
- Negative associations for handling cows
- Impacts on grazing behavior

Can we take advantage of what the cows naturally want to do in order to make our jobs easier?

- Developed and revised protocol to:
  - Minimize time to train
  - Maintain longer time of effectiveness for rewards
  - Reduce number of ‘problem’ cows
  - Reduce number of people required for maintaining active units in field

Preliminary results suggest distinct and repeatable patterns in cattle self-selection.

What we have done...

... in regards to cattle location within the field.
Our initial static GPS static test shows some variability among units. Initial results show that 90% of the coordinates lie within a radius of 5.8 meters.

We have applied a Density Analysis to the cattle movement data.

- **Definition:** The density of point features around each output raster cell.
- **Neighborhood:** A neighborhood is defined around each raster cell center, and the number of points that fall within the neighborhood is totaled and divided by the area of the neighborhood.

Source: ArcGIS Desktop 10.3 Help - Point Density

We have also implemented a Hot Spot Analysis using ArcGIS Spatial Statistics Tools.

Source: ESRI Mapping Center, Hot Spot Analysis of 911 Calls: Introduction
http://mapping.esri.com/esri/idc6380559 hotspot911
An updated circuit board design has been prepared.

- Third generation GPS collars currently under construction
- 60 complete units

Accelerometers are currently under development for summer 2011.

- Behavior and activity, in addition to and correlated with location/position within the field
- Previously used to determine standing, lying, walking, foot stomping
- Currently assessing options and determining reliability and needs
- Commercial units
- Custom units
RFID is under development for summer 2011.

- Assess usage of specific resources (e.g., water, mineral blocks, supplemental feeder) in addition to location and behavior
- Make use of ear tags already in place
- Reader depends on application
- Off-the-shelf with datalogging capabilities
- Collaborating with USDA MARC to implement a custom reader and datalogging system

We visited the Meat Animal Research Center, where a similar headbox metabolism chamber is in use.

Our Headbox Design

Our objectives at the Dudley Smith Farm are as follows.

- Maximize production per acre
- Harvest corn grain
- Utilize co-products and corn residue for cattle
- Compare strip-grazing management
- Move fence every week or every other week
- Evaluate effects on subsequent crop yield

What we have done...

...in regards to a fall 2010 grazing study at the Dudley Smith Farm.
We implemented a grazing study grazing corn crop residues.

- Grazed from 9/25 - 11/6 (6 weeks)
- Treatments
  - Fence moved every week
  - Grazing area divided into 6 strips
  - 2 replications (2 steer/each)
  - Fence moved every 2 weeks
  - Grazing area divided into 3 strips
  - 2 replications (2 steer/each)
- All heifers were supplemented with 7 lbs of co-product blend
- 50/50 corn gluten feed/soy hull blend
- This feed was easy to handle

Heifer performance results indicated that there was no difference in strip grazing management.

<table>
<thead>
<tr>
<th>Item</th>
<th>Fence every week</th>
<th>Fence every 2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial FW, lbs</td>
<td>1097</td>
<td>1006</td>
</tr>
<tr>
<td>Final FW, lbs</td>
<td>1143</td>
<td>1156</td>
</tr>
<tr>
<td>BW Change, lbs</td>
<td>47</td>
<td>41</td>
</tr>
</tbody>
</table>

Conclusions

- All heifers gained 1.5 to 2 lbs/day
- No difference in strip-grazing management
- Weather can greatly impact residue grazing

What we have done

- Visit to MARC (Col and Jacob)
- Anaerobic (Greene and Qi)
- Dudley Smith Fall Grazing Study (Dr. Shuler)
- Strip grazing at different rates
- Waiting for yield maps
- Cattle numbers are a concern

What we have done...

...in preparation for genetic testing.
The requirements for establishing a baseline in soils studies involve two key factors.

- Management history of the sites to be compared must be reasonably similar in:
  - Previous planting regime,
  - Previous herbicide, pesticide, and fertilizer application.
  - Microbial composition.
- The reasonable expectation that future treatments will have a demonstrable impact on soil carbon balances.
  - Our preliminary results suggest that during the fall of 2010 there may have been uneven field utilization in the paddocks south of Windsor Avenue.

Soil sampling procedures have been established.

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What we have done...

...in regards to generation of additional funding.

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Three proposals have been submitted and one letter of intent has been submitted for a future proposal.

- Proposals Submitted
  - NASA Carbon Cycle Science
    - Developing Greenhouse Gas Mitigation Tools for Integrated Agricultural Systems
  - USAID Collaborative Research Support Programs, Adapting Livestock Systems to Climate Change
    - Maintaining productivity while minimizing impact with integrated agricultural systems
- Letter of Intent
  - USDA Management in Agroecosystems
    - Developing Management Tools for Crops, Livestock, and Greenhouse Gases

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What we have done...

...in regards to adding new personnel.

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We have hired three new students, a postdoc, and several undergraduate students.

- Students
  - 1 PMS
    - Tom Little, Af
  - 1 Post-Doc Fellow
    - Giuseppe Del Nero, Masi
- Undergraduate Students
  - 3
  - Sara Allarie
  - Silas Delp
  - Sam Johnson
  - Brian Ramirez
  - Kevin Taylor
  - Xia Xue
What we plan to do...

...in the presentation and publication of our work.

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We will update conference papers this year; we will submit our first two peer-reviewed publications this summer.

- Our first peer-reviewed publication will be a study on the differences in cattle behavior that we can identify using GPS data.
- The current goal is to submit this for peer-review in summer 2011.
- Also preparing a technical note for the upgrade to the GPS system, including undergraduate co-authorship.
- The current goal is to submit this for peer-review in summer 2011.
- ASABE paper/presentation and summary.
- Implementation of GPS monitoring system for cows on pasture.
- BAE this summer.
- An initiation and handling protocol for implementation of GPS collars for monitoring feedlot cattle grazing behavior.
- ASABE this summer.
- Visibility of the infra-red photonic system on the measurement of greenhouse gases and impacts.
- Cattle movement monitoring for the assessment of impacts on pasture based systems.
- Dudley Smith, Field Day Commission.

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What we plan to do...

...in regards to spring and summer 2011 grazing studies.

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Several trials are planned for the upcoming spring and summer.

- Spring Grazing studies at the University of Illinois and Dudley Smith will help us answer the following questions.
  - Is the data provided by our equipment truly representing what the cattle are doing in the field?
  - How many animals need to be studied to represent the overall behavior?
  - What length of time to the animals need to be observed to characterize various behaviors?
  - Can the data generated be useful for the modeling of cattle movements and behavior?

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What we plan to do...

...in regards to generation of funding.

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Several proposals are planned for the upcoming summer and fall.

- USDA—Climate Change—Climate Change Mitigation and Adaptation in Agriculture
  - The 2011 RFP will focus on systems involving cattle
- USDA—Foundational
  - Management in Agroecosystems
  - Animal Production
- NASA, USDA—Carbon Cycle Science
  - If this opportunity is offered again, we may consider a submission.
What we plan to do…

...in regards to enhancing set of equipment.

What we plan to do

- RFID
- Accelerometers
- Flux Chambers
- GPS

Additional resources which could benefit the project.

- At this time we have not received the full year-one allotment of funding.
- What is the anniversary date of this project?
- Confident access to farms or fields would greatly improve the scale study.
- What is happening with the energy case study?
- Other?
- It has occurred to us that panneauled for the metabolism, and particularly for the flux chambers may be necessary to adequately maintain the system over the long-term.
- If there are space resources for storage and management of equipment generated it would be helpful.