Concern over greenhouse gas (GHG) emissions has created a need to quantify emissions from agricultural operations and seek ways to reduce emissions or provide offsets to emissions through carbon sequestration. Cattle industry efforts to address this challenge could potentially lower production costs and increase efficiency. A key question in the process of lowering industry emissions is, are cattle ranches a carbon source or sink? To address this question we established a method for quantifying emissions from a Florida cattle ranch, using Buck Island Ranch (BIR) in Lake Placid as a test case. Buck Island Ranch, the location of MacArthur Agro-Ecology Research Center (MAERC), represents a typical cow-calf operation of south-central Florida, featuring 10,500 acres and maintaining a heard of approximately 3,000 cross-bred cows, 2,300 calves, and 150 bulls of mixed Angus, Charolais, and Brahma heritage. We used standard greenhouse gas accounting protocols and 11 years of production data from Buck Island Ranch, to calculate average annual emissions from Buck Island Ranch’s cattle operation. In the future, we hope to develop a cattle production carbon footprint calculator for AgroClimate.org that anyone may use to replicate our calculations for their own ranch.

A typical cattle operation releases a variety of greenhouse gases, including carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), carbon monoxide (CO), and other nitrogen oxides (NOX). These emissions come from both the cattle themselves, in their digestive processes and waste, and from farm management, including pasture burning, chemical application, and tractor operations. Cattle digestion naturally produces methane as a waste product of enteric fermentation, the process through which microbes in the rumen break down plant fiber. How much methane cattle produce depends on feed quality and quantity, and varies from animal to animal with the particularities of each digestive system (EPA, 2008).
On March 24 ranchers from throughout the state will once again gather at Yarborough's Ranch in Geneva, Florida for the 2011 Spring Ranchers Forum. This Forum includes teaching by University of Florida Professors and County Livestock Agents. The event is hosted by the Yarborough family, cooking a steak dinner provided for all pre-registered attendees. This on-ranch, field teaching event began 13 years ago by the Central Florida Livestock Agents Group (CFLAG) in cooperation with Ed and Imogene Yarborough.

Yarborough Ranch is a picturesque “old Florida” ranch located on the banks of the Little Econ River. Members of the Yarborough family, along with the UF/IFAS Livestock Agents from across central Florida, work hard to plan what has now become the largest private, on-ranch, University Extension field teaching event of it’s kind in Florida. Private Allied industry members partner by covering the cost of this event each year as well as providing giveaways.

Accommodations and directions are available by contacting the Orange County/University of Florida IFAS Extension Education Center at 407-254-9200. Pre-registration with your Livestock Extension Agent assures you of a steak lunch. Registration fee is $12.

Pre-registration guarantees a steak lunch. Fee is $12 and includes lunch. Please contact your County Extension Office no later than Thursday, March 17 to make reservations. Persons requiring special accommodations per the ADA should contact Dennis Mudge at least 48 hours in advance of the program. Make checks payable to CFLAG. Additional donations for give-aways at $5 each. For more information contact Ruth Howard at 407-254-9218.
digestion, cattle waste continues to emit GHGs. Decomposition by microbes directly emits methane and nitrous oxide. Waste indirectly emits other forms of nitrogen, transported as liquids in run-off and leaching, and volatilized as various gases, as may occur during treatment, storage, and transportation. How much gas cattle waste emits depends upon its composition, the microbial community, oxygen and liquid content, temperature, and how the waste management strategy or lack thereof impacts volatilization, run-off, and leaching. Most wastes on cattle ranches are deposited on open range where the amount of GHG emissions from the waste can be variable depending on all the conditions noted above.

Farm operations produce GHG emissions from a variety of sources. While managed burns of pastures produce CO2, new growth essentially takes up the same amount of the gas through photosynthesis, so we omitted this CO2 from our calculations. However, incompletely burned plants may emit other GHGs, including CO, N2O, CH4, and NOx, which we did include (IPCC, 2006). Synthetic fertilizer and lime produce carbon and nitrogen-based GHGs following application, and during transportation and storage, through similar processes to cattle waste emissions, and also during the manufacturing process. The burning of gasoline and diesel fuel, in transportation of fertilizer, lime, and molasses feed, and in tractor use on the ranch, produces mainly CO2, but also some N2O and CH4. We considered only CO2, in accordance with EPA methods.

Different GHGs have different relative strengths in their contributions to the greenhouse effect, called global warming potential (GWP), which is standardized against carbon dioxide’s greenhouse effect. For example, methane has 21 times the global warming effect of the same mass of carbon dioxide, giving methane a GWP of 21; nitrous oxide has a GWP of 310. In comparisons and compilations involving multiple greenhouse gases, we multiplied each gas by its GWP to convert it to its carbon dioxide equivalent (CO2eq), a standard unit for global warming effect.

To calculate emissions of each gas from each process, we used data compiled by Buck Island Ranch on its cattle operations, including records of calf production, pasture burning, and lime and fertilizer application from 1998 to 2008. From this data, we could track numbers of bulls, calves, pregnant cows, lactating cows, and cows neither pregnant nor lactating, all categories that vary significantly in emissions. Our methodology came from the UN Intergovernmental Panel of Climate Change (IPCC 2006) in its 2006 Guidelines for Greenhouse Gas Inventories, the US Environmental Protection Agency (EPA) in the Inventory of United States Green House Gas Emissions and Sinks: 1990-2006 (EPA, 2008), and other literature sources (Brown et al., 1996; Lal, 2004). We used data relevant to Buck Island Ranch from these sources for the many variables affecting GHG production not measured by BIR, ranging from milk fat content to fraction of applied synthetic fertilizer that volatilizes, considering these variables constant through the years studied. Because we did not measure GHGs directly, our results represent a comparatively cost-effective estimate, and true emissions values may differ.

Table 1 shows how much each process on the ranch contributed to GHG emissions, in carbon dioxide equivalent terms. Over the years, over 80% of emissions came from cattle and their waste, including the approximately 60% of all emissions produced by enteric fermentation. Calves younger than seven months do not contribute significantly to enteric fermentation (EPA, 2008), and feed quality, which determines emissions of adult cattle, varied little over these eleven years. So, the number of cows and bulls determined the majority of Buck Island Ranch’s GHG emissions. Methane emissions alone yielded this enteric fermentation figure, but cattle waste, which produced almost a quarter of BIR’s overall emissions (Table 1), generated nearly equal quantities of nitrous oxide and methane. However, since nitrous oxide has nearly 15 times the GWP of methane, nitrous oxide accounted for all but a small fraction of this emission category.

Of farm operations, mixed GHGs from fertilization and liming accounted for most emissions, 8% of the total. Production, transportation, and storage of the
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(Continued from page 66)

Table 1. Annual GHG emissions per emission category during 1998 to 2008 at MacArthur Agro-ecology Research Center located at Buck Island Ranch in Lake Placid, FL. All emissions are shown in equivalent in metric tons carbon dioxide. Percent contribution to total emissions by each emissions category is shown in the last row.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fermentation</th>
<th>Livestock</th>
<th>Tractor</th>
<th>Pasture</th>
<th>Fertilizer</th>
<th>Waste</th>
<th>Feed concentrate</th>
<th>Sum</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999/00</td>
<td>6753.4</td>
<td>2690.2</td>
<td>497.5</td>
<td>264.0</td>
<td>534.6</td>
<td>0.0</td>
<td>441.8</td>
<td>10894.4</td>
<td>59.7</td>
</tr>
<tr>
<td>2000/01</td>
<td>7057.5</td>
<td>2773.5</td>
<td>794.1</td>
<td>214.6</td>
<td>477.8</td>
<td>677.0</td>
<td>80.56</td>
<td>12075.1</td>
<td>23.6</td>
</tr>
<tr>
<td>2001/02</td>
<td>7064.5</td>
<td>2775.6</td>
<td>448.3</td>
<td>193.8</td>
<td>513.1</td>
<td>794.4</td>
<td>42.20</td>
<td>11831.9</td>
<td>5.7</td>
</tr>
<tr>
<td>2002/03</td>
<td>6883.5</td>
<td>2694.8</td>
<td>759.7</td>
<td>181.1</td>
<td>253.1</td>
<td>1057.2</td>
<td>326.7</td>
<td>12156.0</td>
<td>1.6</td>
</tr>
<tr>
<td>2003/04</td>
<td>6505.1</td>
<td>2607.2</td>
<td>599.6</td>
<td>172.6</td>
<td>1056.1</td>
<td>1403.3</td>
<td>49.05</td>
<td>12393.0</td>
<td>447.6</td>
</tr>
<tr>
<td>2004/05</td>
<td>7000.4</td>
<td>2761.4</td>
<td>975.5</td>
<td>169.2</td>
<td>140.0</td>
<td>307.4</td>
<td>152.447</td>
<td>11506.3</td>
<td>11546.6</td>
</tr>
<tr>
<td>2005/06</td>
<td>7092.0</td>
<td>2790.4</td>
<td>653.1</td>
<td>174.5</td>
<td>0.0</td>
<td>952.8</td>
<td>41.807</td>
<td>11704.6</td>
<td>15.6</td>
</tr>
<tr>
<td>2006/07</td>
<td>7332.5</td>
<td>2868.7</td>
<td>1150.4</td>
<td>214.6</td>
<td>0.0</td>
<td>0.0</td>
<td>386.8</td>
<td>11953.0</td>
<td>263.1</td>
</tr>
<tr>
<td>2007/08</td>
<td>7456.5</td>
<td>2915.5</td>
<td>683.8</td>
<td>150.0</td>
<td>0.0</td>
<td>0.0</td>
<td>49.4</td>
<td>11255.3</td>
<td>115.7</td>
</tr>
</tbody>
</table>

AVG         6895.8  2719.4  661.0  188.1  447.6  472.0  160.7  11546.6
TOTAL       75853.7 29913.3 7271.4 2068.5 4923.9 5192.0 1767.7 126990.5
PERCENT     59.7    23.6    5.7    1.6    3.9    4.1    1.4

Over the 11-year study period, BIR’s emissions remained relatively constant, in spite of an increase in number of adult animals, due to a decrease in fertilizer and lime application (Fig.1). In spite of the large calf crop in 2004, that year led to a peak in emissions per unit production, of 29.0 kg CO2eq per kg live weight. Lower values of emissions per unit live weight in more recent years, on average 22.1 kg CO2eq per kg live weight per year since 2004, reflect the increased number of calves produced and the decreased use of synthetic chemicals. So, while the number of adult cattle accounted the majority of emissions, through the 59.7% due to enteric fermentation, variability in fertilizer and lime application steered overall variability in emissions across years.

The overall average annual emission per kg live weight at Buck Island Ranch, of 24.2 kg CO2eq, remains high in comparison to published values. Johnson et al. (2002) found that the American cattle industry emits an average of 15.5 kg CO2eq per kg live weight produced. However, the overall average annual emission per kg live weight at Buck Island Ranch, of 24.2 kg CO2eq, remains high in comparison to published values. Johnson et al. (2002) found that the American cattle industry emits an average of 15.5 kg CO2eq per kg live weight produced. However, emissions across years.

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Johnson et al.’s number comes from weight at slaughtering time, with 77% of emissions occurring in the cow-calf phase. Using this division of emissions and the typical slaughter weight for cattle, our estimated emissions from the cow-calf production at Buck Island Ranch would translate into an emission rate of 15.7 kg CO2eq/kg live weight at slaughter, which is in line with the 15.5 kg CO2eq established by Johnson et al. (2002).

Our estimate of greenhouse gas emissions from the cattle operation, of 11,544.6 metric tons CO2eq annually, did not account for the potential of the ranch ecosystem to sequester CO2 from the atmosphere. Given its size, Buck Island Ranch would have to sequester slightly more than one metric ton CO2eq per year per acre to make up for its emissions. Research conducted at Duda Ranch in central Florida showed that grazed, improved pastures sequestered 1.69 metric tons CO2eq per acre per year (Bracho et al., 2004). Based on this value and assuming that Buck Island Ranch was entirely improved pastures, we estimate that pastures at Buck Island Ranch could sequester 17,812 metric tons CO2eq per year. However, to make this estimation more accurate, research is needed to determine the sequestration from unimproved pastures, which make up about 50% of the land area on Buck Island Ranch, and from wooded areas. Other important areas of future research include measuring methane emissions from wetlands, and investigating the effect of grazing regime on C sequestration rates. The overall goal of these research projects is to inform ranch managers on the sources of emissions and in what areas of their operations emissions reductions will result in the greatest impact.

**Carbon Footprint… (Continued from page 66)**

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