Farming in the Lone Star State: Agricultural Equipment Inventory for Texas

EPA Emission Inventory Conference

April 2009

Presented by:
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Overview

• Agricultural Equipment Survey
  • Telephone Survey of Over 2,000 Farmers in Texas
  • Equipment Population and Fuel Consumption
  • Temporal Allocations of Activity
  • Update Texas NONROAD model (TexN) with survey inputs
Survey Design

- Develop Sampling Plan
  - Who to survey?
  - How to stratify sample?
- Survey farming operations contributing to majority of fuel use/equipment activity
- Compiled Texas agricultural fuel expenditure and tractor population data from USDA 2002 Census of Agriculture
- Estimated crop-specific fuel by multiplying USDA 2005 estimates of planted acreage by diesel/gasoline fuel consumption per planted acre
### Table 1. 2002 Census of Agriculture Data for Texas

<table>
<thead>
<tr>
<th>Agricultural Sector (NAICS code)</th>
<th>Gasoline, Fuels, &amp; Oils ($1,000s)</th>
<th>Number of Ag Tractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef cattle ranching and farming (112111)</td>
<td>172,674</td>
<td>212,705</td>
</tr>
<tr>
<td>Oilseed and grain farming (1111)</td>
<td>88,506</td>
<td>26,558</td>
</tr>
<tr>
<td>Cotton farming (11192)</td>
<td>81,550</td>
<td>18,340</td>
</tr>
<tr>
<td>Sugarcane, hay, &amp; all other crop farming (11193, 11194, 11199)</td>
<td>58,755</td>
<td>51,550</td>
</tr>
<tr>
<td>Cattle feedlots (112112)</td>
<td>26,341</td>
<td>7,793</td>
</tr>
<tr>
<td>Animal aquaculture and other animal production (1125,1129)</td>
<td>24,672</td>
<td>31,112</td>
</tr>
<tr>
<td>Poultry and egg production (1123)</td>
<td>21,914</td>
<td>5,219</td>
</tr>
<tr>
<td>Greenhouse, nursery, and floriculture production (1114)</td>
<td>20,053</td>
<td>4,642</td>
</tr>
<tr>
<td>Vegetable and melon farming (1112)</td>
<td>12,985</td>
<td>4,455</td>
</tr>
<tr>
<td>Dairy cattle and milk production (11212)</td>
<td>9,425</td>
<td>3,621</td>
</tr>
<tr>
<td>Sheep and goat farming (1124)</td>
<td>7,917</td>
<td>12,255</td>
</tr>
<tr>
<td>Fruit and tree nut farming (1113)</td>
<td>4,934</td>
<td>9,292</td>
</tr>
<tr>
<td>Hog and pig farming (1122)</td>
<td>3,594</td>
<td>2,439</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>533,321</strong></td>
<td><strong>389,981</strong></td>
</tr>
</tbody>
</table>

### Table 2. 2005 Texas Diesel and Gasoline Consumption Estimates by Crop Type

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Diesel, gallons</th>
<th>Gasoline, gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton, all</td>
<td>115,911,120</td>
<td>25,691,640</td>
</tr>
<tr>
<td>Forage-land used for all hay, haylage, grass silage, greenchop</td>
<td>66,443,398</td>
<td>n/a</td>
</tr>
<tr>
<td>Wheat for grain, all</td>
<td>28,050,000</td>
<td>3,850,000</td>
</tr>
<tr>
<td>Sorghum for grain</td>
<td>21,320,000</td>
<td>6,150,000</td>
</tr>
<tr>
<td>Corn for grain</td>
<td>18,245,000</td>
<td>2,255,000</td>
</tr>
<tr>
<td>Rice</td>
<td>8,423,400</td>
<td>404,000</td>
</tr>
<tr>
<td>Peanuts for nuts</td>
<td>8,321,000</td>
<td>641,300</td>
</tr>
<tr>
<td>Oats for grain</td>
<td>3,519,000</td>
<td>483,000</td>
</tr>
<tr>
<td>Soybeans for beans</td>
<td>1,066,000</td>
<td>338,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>271,298,918</strong></td>
<td><strong>39,812,940</strong></td>
</tr>
</tbody>
</table>
Survey Design

Six Respondent Groups Established:
1) Beef Cattle Farming
2) Cotton Farming
3) Hay Farming
4) Wheat Farming
5) All Other Farming
6) Farming Support Services
## Sample Frame and Quotas for Statistically Representative Sample

<table>
<thead>
<tr>
<th>Quota Group</th>
<th>NAICS</th>
<th>Respondent Group</th>
<th>Available Sample</th>
<th>No. of Farms (Census 2002)</th>
<th>Target No. of Completed Surveys*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>111920</td>
<td>Cotton farming</td>
<td>1,683</td>
<td>6,321</td>
<td>362</td>
</tr>
<tr>
<td>2</td>
<td>111940</td>
<td>Hay farming</td>
<td>402</td>
<td>31,173</td>
<td>379</td>
</tr>
<tr>
<td>3</td>
<td>111140</td>
<td>Wheat farming</td>
<td>762</td>
<td>9,031</td>
<td>369</td>
</tr>
<tr>
<td>4</td>
<td>112111</td>
<td>Beef cattle ranching/farming</td>
<td>3,481</td>
<td>127,974</td>
<td>383</td>
</tr>
<tr>
<td>5</td>
<td>111+112</td>
<td>All other farming</td>
<td>18,106</td>
<td>54,427</td>
<td>376</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>24,434</td>
<td>228,926</td>
<td>1,869</td>
</tr>
</tbody>
</table>

*To achieve a confidence level of 95% and a confidence interval of +/- 5.
Survey Questionnaire

Agricultural Tractors
- Count and Fuel Use for Each of 10 Equipment Types (SCCs)
- 2-Wheel Tractors
- Mowers
- Sprayers
- Tillers
- Swathes
- Irrigation Sets
- Other Equipment

Combines

Balers
Survey Questionnaire (Cont’d)

- Operating schedules
  - Time of day
  - Weekday versus weekend day
- Equipment use by equipment type
  - Hours per week; weeks per year
  - Seasonal operating percentages
- Acres harvested or head of beef cattle
  - Surrogate to develop correlations to respondents’ equipment counts and fuel use
Survey Implementation

- Telephone Interview performed by subcontractor Ewald & Wasserman Research Associates, LLC
- Completed 2,309 total interviews during July and August 2008
- Targeted confidence interval of 5 percent - achieved between 3 and 7 percent confidence interval per quota group
- Many respondents engaged in and provided surveys for more than one type of farming
## Survey Implementation

<table>
<thead>
<tr>
<th>Respondent Group</th>
<th># Completed Surveys</th>
<th>Respondent Group</th>
<th># Completed Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>303</td>
<td>Cotton/Hay</td>
<td>14</td>
</tr>
<tr>
<td>Cotton</td>
<td>100</td>
<td>Cotton/Other</td>
<td>27</td>
</tr>
<tr>
<td>Hay</td>
<td>143</td>
<td>Cotton/Wheat</td>
<td>48</td>
</tr>
<tr>
<td>Other</td>
<td>208</td>
<td>Hay/Other</td>
<td>60</td>
</tr>
<tr>
<td>Wheat</td>
<td>90</td>
<td>Hay/Wheat</td>
<td>57</td>
</tr>
<tr>
<td><strong>Subtotal - 1 Quota</strong></td>
<td><strong>844</strong></td>
<td>Other/Wheat</td>
<td>41</td>
</tr>
<tr>
<td>Beef/Cotton</td>
<td>15</td>
<td><strong>Subtotal - 2 Quotas (731 x 2)</strong></td>
<td><strong>1,462</strong></td>
</tr>
<tr>
<td>Beef/Hay</td>
<td>348</td>
<td>Beef/Cotton/Other</td>
<td>1</td>
</tr>
<tr>
<td>Beef/Other</td>
<td>37</td>
<td><strong>Subtotal - 3 Quotas</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td>Beef/Wheat</td>
<td>84</td>
<td><strong>Total Completed Surveys</strong></td>
<td><strong>2,309</strong></td>
</tr>
</tbody>
</table>
Activity Data Analysis

- **Activity Information Weighted Using Following Steps:**
  1. Equipment counts per respondent as a fraction of total equipment for all respondents
  2. Fraction of sampled versus total State activity
     - Acres harvested for crops
     - Head of beef cattle excluding feedlot cattle

- **Averaging Method**
  - Diurnal and weekly data - all equipment types combined
  - Annual hours of use and seasonal profiles - by equipment type
Temporal Profiles – Diurnal

- Midnight to 3 AM
- 3 AM to 6 AM
- 6 AM to 9 AM
- 9 AM to 12 Noon
- 12 Noon to 3 PM
- 3 PM to 6 PM
- 6 PM to 9 PM
- 9 PM to midnight

% Daily Use

Survey

EPA
Temporal Profiles – Weekly

- Weekday/Weekend Day Profiles
  - NONROAD
    - Weekday activity 2 times higher than weekend activity
  - Survey
    - Weekday activity ~1.4 times higher than weekend activity

<table>
<thead>
<tr>
<th>Time Period</th>
<th>NONROAD</th>
<th>TCEQ Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Weekday</td>
<td>0.167</td>
<td>0.154</td>
</tr>
<tr>
<td>Average Weekend Day</td>
<td>0.083</td>
<td>0.113</td>
</tr>
<tr>
<td>Weekday Total (x5)</td>
<td>0.833</td>
<td>0.771</td>
</tr>
<tr>
<td>Weekend Total (x2)</td>
<td>0.167</td>
<td>0.226</td>
</tr>
<tr>
<td>Weekday/Weekend Ratio</td>
<td>2</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Temporal Profiles – Seasonal

• Seasonal Percentages
  • NONROAD seasonal profile applies to all farm equipment
  • Same for all States in Southwest Region

• Seasonal Use Data for >10,000 Total Pieces of Equipment in Texas
  • Collected data for specific equipment types
  • Developed a weighted seasonal profile across all equipment types
  • Potential for equipment-specific profiles
Temporal Profiles – Seasonal

- Comparison of NONROAD and Survey Profiles
Annual Hours of Use

- Annual use varies by equipment and fuel type
  - Diesel engines generally operated more hours per year than gasoline engines
  - Preliminary hours per year estimates much higher than NONROAD default values
- Determine if data are robust to replace defaults
  - Average use values based on responses for at least 200 pieces of equipment (for irrigation sets) up to over 4,000 pieces (for agricultural tractors)
Annual Hours of Use – Diesel Equipment

The chart illustrates the annual hours of use for various types of diesel equipment, categorized by TCEQ Survey and NONROAD data. Notable equipment types include:

- 2-Wheel Tractors
- Agricultural Tractors
- Combines
- Balers
- Agricultural Mowers
- Sprayers
- Tillers > 6 HP
- Swathers
- Other Ag Equipment
- Irrigation Sets

The data shows a range of usage hours per year, with some types of equipment showing significantly higher usage than others.

([Image of bar chart showing annual hours of use for different types of diesel equipment])

PECHAN

[Logo]
Estimation of Equipment Populations

- Review of Survey Responses
  - Determine which records should be kept/removed
  - Where respondents say no equipment was used, contact state agricultural experts to establish if this makes logical sense for the given crop type
  - In cases where it does make sense, we will include the acreage in our equipment population calculations
Estimation of Equipment Populations

- Equipment population scaling factors will be calculated by:
  1. Adding up number of pieces of equipment and the acres harvested for each equipment type within each quota group
  2. Dividing the number of pieces of equipment by the number of acres harvested/head of cattle.
Estimation of Equipment Populations

- County-level acres harvested for each Quota Group will be multiplied by scaling factor to estimate county, SCC-level equipment populations
- Use head of beef cattle for scaling data for Beef Quota
- Sum equipment populations for all Quota Groups to estimate total population
Estimation of Fuel Consumption

• Use procedure similar to equipment extrapolations
• From survey data, develop fuel use profiles relating gallons of fuel consumed by Quota Group to acres harvested or head of cattle
• Apply scaling factors to county-level surrogate data for State of Texas
• Determine if data are robust for all fuel types
  • CNG and LPG estimates would need to be based on few data points
Equipment Population and Fuel Estimates

- Default 2008 NONROAD/TexN statewide data
  - Agricultural tractor populations = ~101,000
  - Ag tractor annual fuel use = ~200 million gallons diesel and ~300,000 gallons gasoline
- NONROAD/TexN populations are top-down estimates based on national sales/attrition estimates allocated to counties using surrogate data
  - Survey-based estimates will be considered in this context
Next Steps

- Complete analysis of Equipment, Fuel and Temporal Profile survey data
- Perform a comparative analysis with TexN defaults and determine which data to replace in TexN
- Perform county-level modeling runs for base year 2008 and select forecast years using updated inputs
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- Peter Ogbeide
  - Texas Commission on Environmental Quality