



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

EPA Emission Inventory Conference

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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

Survey Design

Table 1. 2002 Census of Agriculture Data for Texas

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

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

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

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



Survey Design

Sample Frame and Quotas for Statistically Representative Sample

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

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

Survey Questionnaire

Agricultural Tractors



Balers



Combines



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



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

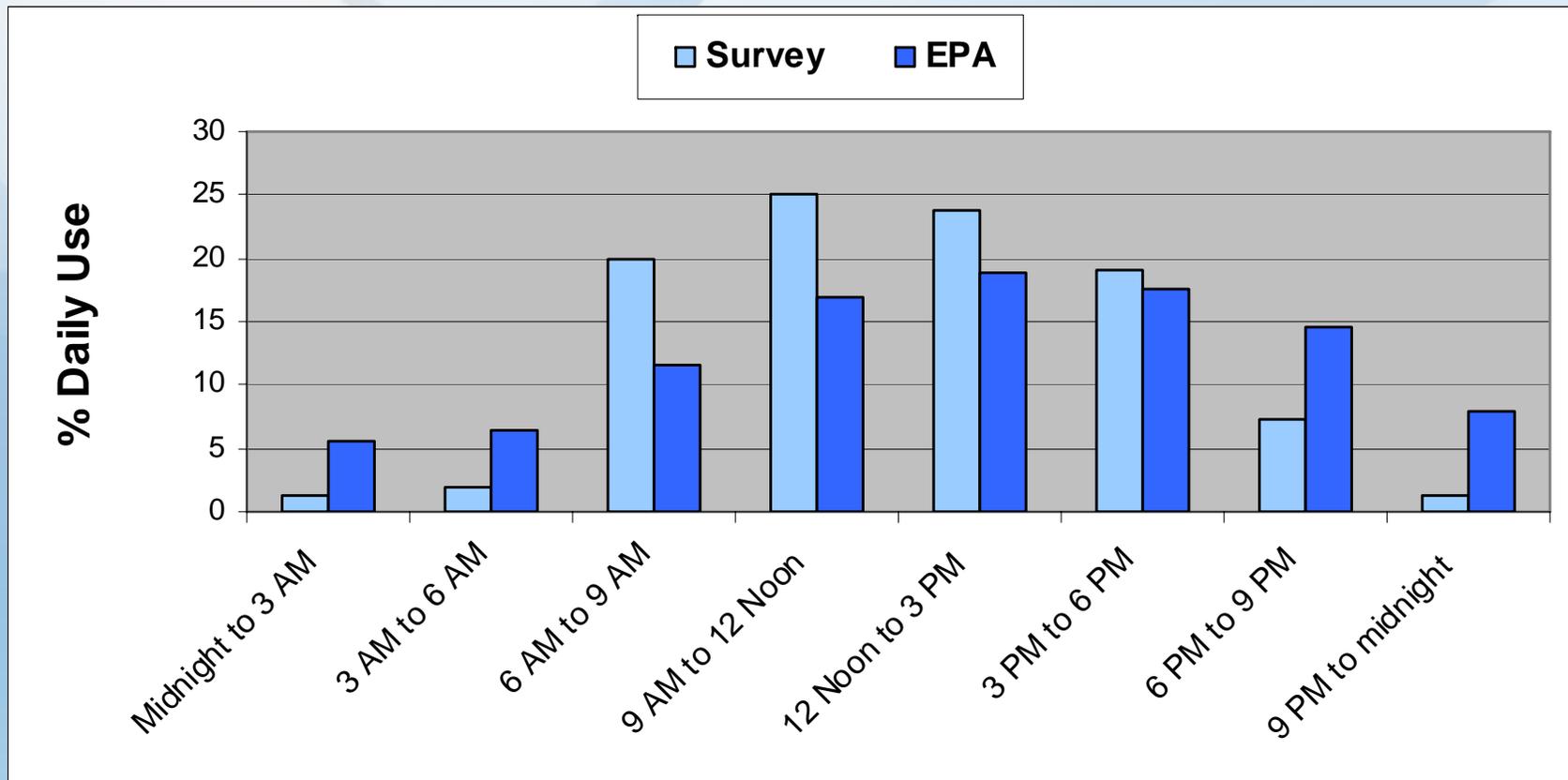
Respondent Group	# Completed Surveys	Respondent Group	# Completed Surveys
Beef	303	Cotton/Hay	14
Cotton	100	Cotton/Other	27
Hay	143	Cotton/Wheat	48
Other	208	Hay/Other	60
Wheat	90	Hay/Wheat	57
Subtotal - 1 Quota	844	Other/Wheat	41
Beef/Cotton	15	Subtotal - 2 Quotas (731 x 2)	1,462
Beef/Hay	348	Beef/Cotton/Other	1
Beef/Other	37	Subtotal - 3 Quotas	3
Beef/Wheat	84	Total Completed Surveys	2,309



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



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

Time Period	NONROAD	TCEQ Survey
Average Weekday	0.167	0.154
Average Weekend Day	0.083	0.113
Weekday Total (x5)	0.833	0.771
Weekend Total (x2)	0.167	0.226
Weekday/Weekend Ratio	2	1.4

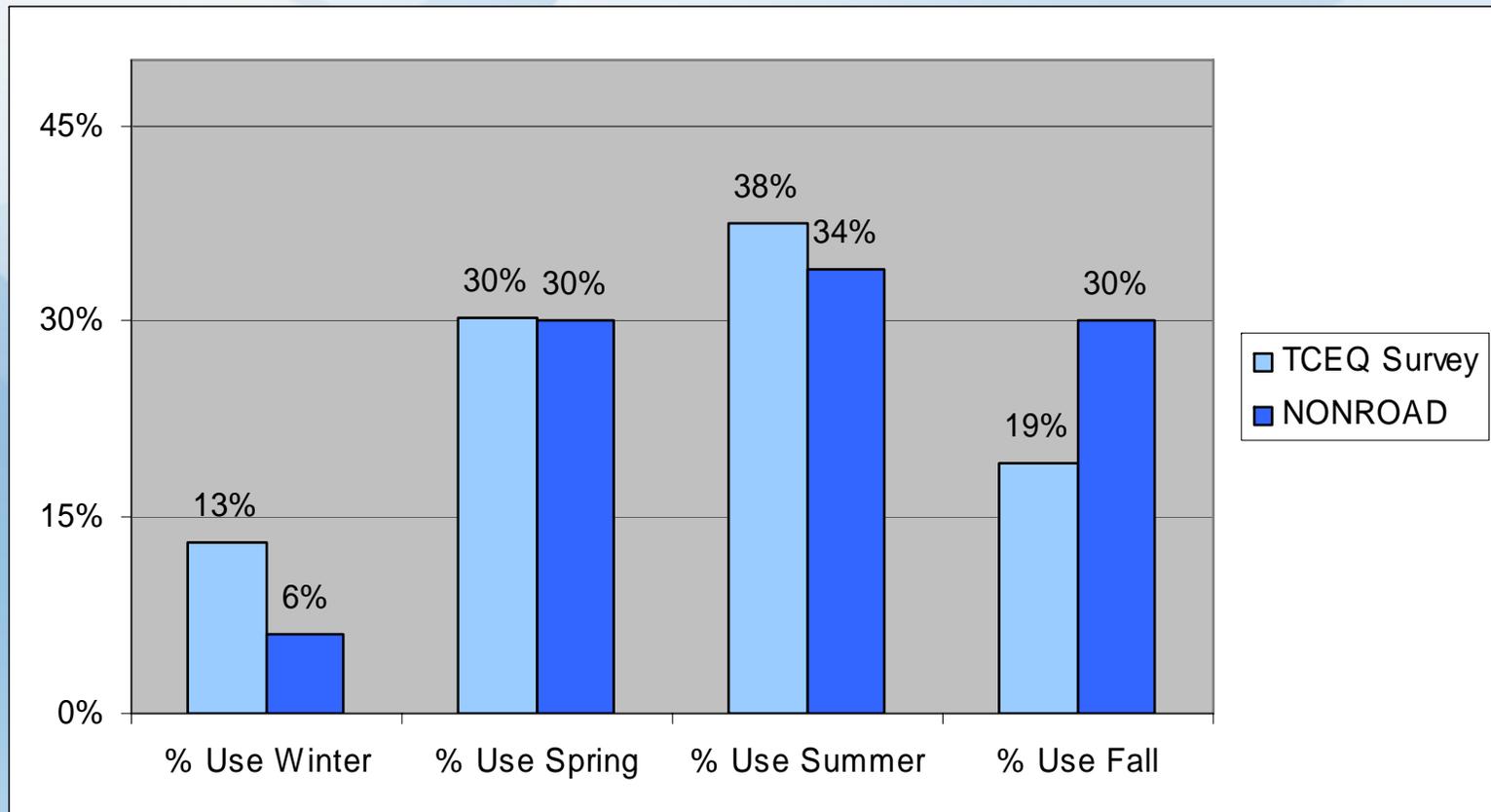


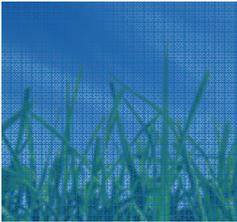
Temporal Profiles – Seasonal

- 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

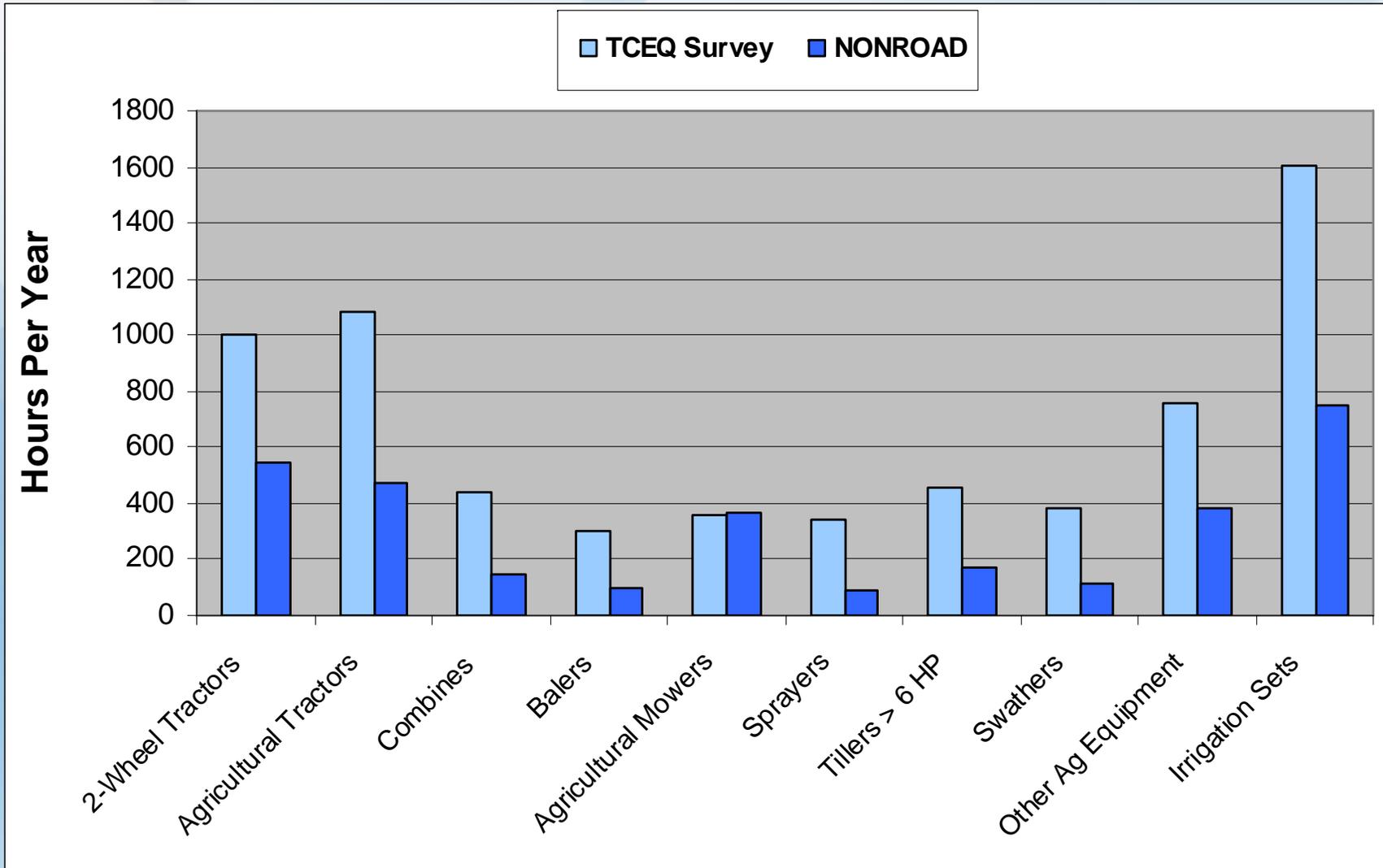




Annual Hours of Use

- 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





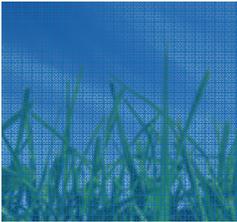
Estimation of Equipment Populations

- 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



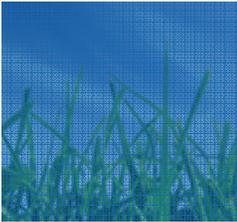
Estimation of Equipment Populations

- 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.



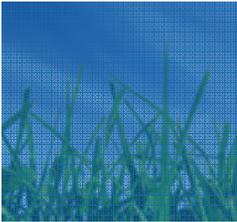
Estimation of Equipment Populations

- 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



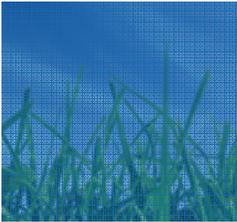
Estimation of Fuel Consumption

- 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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