

**DEVELOPMENT OF EMISSIONS INVENTORY OF  
AGRICULTURAL EQUIPMENT IN ALL TEXAS COUNTIES  
PART TWO**

**FINAL REPORT  
TASK 6**

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## **I. INTRODUCTION**

The Texas Commission on Environmental Quality (TCEQ) recognizes nonroad sources as potentially important contributors to Texas air quality concerns, and is considering emission reduction strategies for these sources. Preparing both temporally and spatially representative nonroad sector inventories will support TCEQ analyses to accurately characterize the emission reductions needed to achieve and maintain compliance with air quality standards. One of TCEQ's goals is to improve current criteria pollutant emission estimates from agricultural equipment such as tractors, combines, mowers, and sprayers. Under contract to the TCEQ, E.H. Pechan & Associates, Inc. (Pechan) and its subcontractor (Ewald & Wasserman Research Consultants, LLC) conducted a telephone survey of agricultural equipment owners in Texas. The collected data are being used to refine equipment populations, annual hours of use, and seasonal, weekly and diurnal activity profiles for these equipment types. These activity inputs will replace the default data in the Texas NONROAD model (TexN) for preparing 2008 base year, 2005, and 2011, 2014, 2018, and 2025 forecast year inventories.

For the first phase of this project, Pechan requested the necessary data from agricultural equipment owners in Texas through a telephone survey conducted during July/August of 2008. The second phase of the project (Part Two) involves statistical analysis of the survey data, development of updated model inputs, and the preparation of annual and ozone season day (OSD) agricultural equipment emission inventories for all Texas counties using the TexN model, updated to reflect the survey-based data. In April 2009, Pechan prepared a report to describe the analysis of the resulting data, and to provide recommendations for which model defaults should be replaced with data based on the survey results (Pechan, 2009). This report summarizes the work performed under this work order, including emission summaries of results obtained from the updated TexN model runs. Finally, suggestions for future work are discussed.

## **II. SURVEY OVERVIEW**

### **A. SURVEY IMPLEMENTATION**

Sampling design and stratification was developed based on an analysis of fuel use data by farming sector available from the U.S. Census of Agriculture. These data indicate that more than one-third of Texas expenditures on agricultural sector fuels/oils, and over one half of total agricultural tractor populations are in the North American Industrial Classification System (NAICS) code 112111 – Beef Cattle Ranching and Farming. The analysis also revealed that cotton, forage, wheat, sorghum, and corn account for a large proportion of total crop production-related diesel/gasoline consumption in Texas.

Based on this analysis, the sampling plan initially included six quota cells, based on NAICS-code defined farming operations, and included: 1) cotton farming; 2) hay farming; 3) wheat farming; 4) beef cattle ranching; 5) all other farming activities including cattle feed lots; and 6) all support activities for agricultural operations. During survey implementation, it was established that few respondents in the sixth quota group identified themselves as a farming support entity. As such, support activities for agricultural operations were eliminated from the final sample frame.

A questionnaire was developed in Part 1 to ask for information concerning the types of agricultural equipment operated, and the operating schedules of the equipment. In general, the survey requested the following information:

- 1) Farm production acreage (and head of cattle for beef farmers)
- 2) County location
- 3) Equipment type/fuel type
- 4) Equipment count
- 5) Volume of fuel used
- 6) Annual hours of use and percentage of use by season
- 7) Weekday versus weekend day use
- 8) Hourly (i.e., diurnal) use

Altogether, 2,309 farming operation surveys were completed with a total of 1,576 unique respondents. If a respondent engaged in multiple farming operations, as was the case in almost 50 percent of the completed interviews, the telephone survey system randomly selected up to two farming operations for the actual telephone survey. Table II-1 shows the distribution of completed surveys among the five quota groups, as well as the statistical representativeness of the respective quota data. The target number of completed surveys represents the number of surveys needed to achieve a pre-established precision level. The confidence interval at a confidence level of 95 percent ranges from 3.48 to 6.73 among the five quota groups. The smaller the confidence interval, the more precise the data. Note that the data collected for the hay farming and beef cattle farming respondents exceeded our targeted confidence interval of 5 percent.

The survey collected data from respondents conducting farming operations in 242 of the 255 total counties in Texas. Figure C-1 of Appendix C provides a map showing the number of responses by county (depicted as a range of responses). Reports providing more details of the survey design and implementation, including the telephone questionnaire, were prepared by Pechan for TCEQ in 2008 (Pechan, 2008a; Pechan 2008b).

**Table II-1. Completed Surveys and Associated Confidence Interval**

Quota Group	NAICS	Respondent Group	Number of Farms (Census 2000)	Target Number of Completed Surveys	Completed Surveys	Confidence interval at 95% confidence level
1	111920	Cotton farming	6,321	362	205	6.73
2	111940	Hay farming	31,173	379	622	3.89
3	111140	Wheat farming	9,031	369	320	5.38
4	112111	Beef cattle ranching & farming	127,974	383	788	3.48
5	111+112	All other farming	54,427	376	374	5.05
<b>Total</b>			<b>228,926</b>	<b>1,869</b>	<b>2,309</b>	<b>2.03</b>

## B. DATA PROCESSING AND QUALITY ASSURANCE

Prior to analyzing the data, Pechan performed the following processing and quality assurance steps (QA) on the survey database. We first converted the raw survey results to a format more conducive to analysis. For each respondent, equipment type was converted into a separate record, along with all associated variables for which information was collected. All other respondent information not specific to the equipment type was also carried forward (e.g., information such as contact name, NAICS, county of operation, and acres harvested). These manipulations were then cross-checked against the original database of responses for accuracy.

Additional manipulations prior to analysis included converting responses coded as “Refused” or “Don’t Know” into null values. For many questions, these responses were coded as numeric strings (e.g., 888888 and 999999). These values needed to be converted to null (and missing value) so as not to interfere with the calculation of the average values for the variables in question.

Once in this working format, Pechan began to examine the data provided for reasonableness (e.g., inaccuracies or outliers). Pechan contacted several survey respondents to request clarification or possible corrections of any questionable responses. In most cases, the values in question were not correct as recorded, and the correct values were reflected in the analysis.

## III. SURVEY RESULTS

The list of equipment types included in the study, along with a description, is provided in Table III-1. These equipment types are consistent with EPA’s NONROAD and TCEQ’s TexN models, which is important, since the survey-based data may replace equipment-specific defaults in TexN. NONROAD reports emission estimates for diesel and gasoline-fueled engines for all of these equipment types, and provides estimates for compressed natural gas (CNG) and liquefied petroleum gas (LPG) engines for select equipment. As reported by NONROAD, CNG and LPG fueled engines are typically used in a limited number of farming applications, including irrigation sets.

Questions concerning hourly and weekday/weekend day operations were asked in relation to the operation of all equipment used by the respondent, and not specific to a certain equipment type. Questions on annual and seasonal usage, and number of pieces of equipment, and fuel-type distributions were asked for each of 10 types of equipment owned (operated) by the respondent. For all temporal activity variables, responses were weighted by two factors. First, the values were weighted by the number of pieces of equipment for which respondents provided information (i.e., equipment counts per respondent as a fraction of total equipment for all respondents). This step generated a weighted average per equipment type per quota group. Second, the values were weighted by the fraction of the surveyed respondents quota-specific farming activity (e.g., acres of cotton harvested) to the State-level total activity data for their quota group. This second step produced a weighted average for each equipment type across all quota groups.

**Table III-1. Equipment Types Included in Survey**

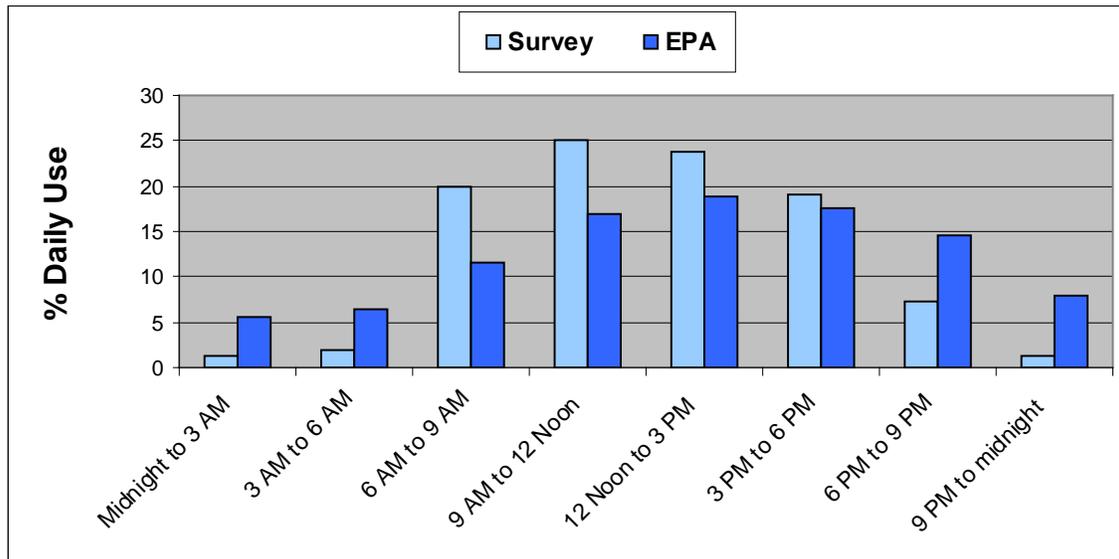
<b>Equipment Type</b>	<b>Description</b>
2- Wheel Tractors	Walk-behind 2-wheeled tractors for use in edible produce or other intensive farming
Agricultural Tractors	Large and small agricultural tractors (most prevalent farm equipment type)
Combines	Self-propelled combined harvesting and cleaning equipment
Balers	Equipment that bales from loose or windrowed hay or other forage mowed crop
Agricultural Mowers	Equipment for mowing not intended for later baling or harvesting
Sprayers	Small (backpack) and large (self-propelled) powered equipment designed specifically for spraying
Tillers > 6 HP	Primarily small tillers similar to those used in lawn and garden applications intended to be used in edible produce or other intensive farming
Swathers	Equipment designed to cut crops for later baling or harvesting including windrowers
Irrigation Sets	Agricultural pumps and pivot wheel irrigation equipment to distribute water to fields or livestock
Other Agricultural Equipment	Other various cultivation equipment types and include harvesters or other special cultivating equipment

Discussions of the preliminary results for hourly and weekly temporal profiles, as well as annual and seasonal use are presented in the following sections. For these variables, final survey results are compared to existing default data, either from EPA modeling protocols or NONROAD2008 model defaults. Note that TexN and NONROAD model default data are the same for the inputs evaluated for this project. In addition, procedures for, and resulting estimated equipment populations and fuel consumption from the survey data, are discussed.

#### A. WEEKLY AND HOURLY TEMPORAL PROFILES

The survey requested information on the operation of equipment during eight 3-hour time periods during a typical day. The percentage of farm operations occurring during each time period was weighted by the associated number of each equipment type owned by the respondent, to give more weight to those respondents operating more pieces of equipment. The typical diurnal profile developed from the survey results is shown in Figure III-1, and compared to EPA's diurnal profile for diesel agricultural equipment, as listed in EPA's Emission Modeling Clearinghouse (EPA, 2009). EPA's default profile reflects variations within each 3-hour period, but were aggregated for the same time periods as the survey. Note that for the 24-hour period, the survey data shows higher relative activity from 6AM to 6PM, and considerably less from 6PM to 6AM. EPA's default hourly profile shows comparatively higher levels of activity than the survey data starting at 6PM and through the night up to 6AM. The fraction of diurnal activity for each hour of the day as calculated based on the survey is provided in Table III-2. Although NONROAD and TexN models do not have the ability to calculate hourly emissions, TCEQ may use the survey-based diurnal profile for their own modeling efforts.

**Figure III-1. Comparison of Agricultural Equipment Diurnal Profiles**



**Table III-2. Agricultural Equipment Diurnal Distribution**

Time of Day	Average Diurnal Distribution	Time of Day	Average Diurnal Distribution
Midnight	0.00397	12:00 PM	0.07952
1:00 AM	0.00397	1:00 PM	0.07952
2:00 AM	0.00397	2:00 PM	0.07952
3:00 AM	0.00629	3:00 PM	0.06412
4:00 AM	0.00629	4:00 PM	0.06412
5:00 AM	0.00629	5:00 PM	0.06412
6:00 AM	0.06637	6:00 PM	0.02466
7:00 AM	0.06637	7:00 PM	0.02466
8:00 AM	0.06637	8:00 PM	0.02466
9:00 AM	0.08388	9:00 PM	0.00451
10:00 AM	0.08388	10:00 PM	0.00451
11:00 AM	0.08388	11:00 PM	0.00451

The survey also asked respondents to provide the percent of weekly use occurring on a weekday versus a weekend day. Based on these percentages, it was estimated that farming equipment was 1.4 times more likely to be operated on an average weekday than an average weekend day. Table III-3 shows the default NONROAD model weekly profile, which assumes that agricultural equipment is 2 times as likely to be operated during an average weekday than an average weekend day (EPA, 2004a). Weekly inputs for NONROAD are not based on survey data, but were developed based on EPA’s assessment of typical usage patterns as well as California Air Resources Board (ARB’s) use profiles in their OFFROAD model.

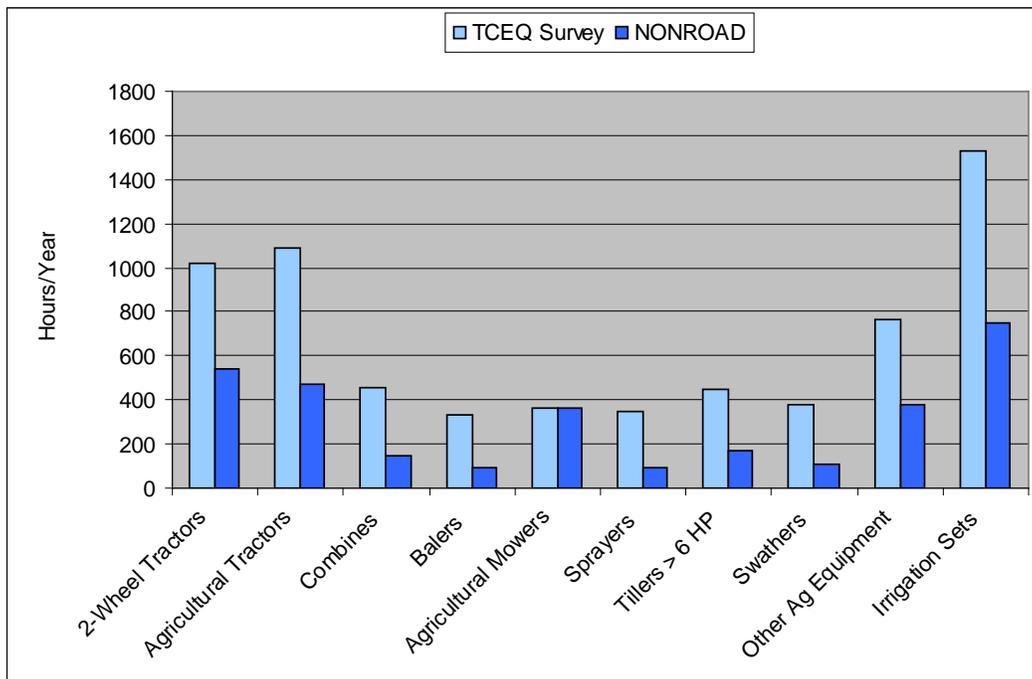
**Table III-3. Comparison of Agricultural Equipment Weekly Profiles**

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

**B. ANNUAL HOURS OF USE**

Survey respondents were asked to provide estimates of the hours of operation per week and the weeks of operation per year for each specific equipment type. We then estimated annual hours of use by multiplying hours of operation per week by weeks of operation per year. Figure III-2 shows a comparison of the annual use values derived from the survey and those included in NONROAD/TexN for diesel equipment types (EPA, 2004b). Table III-4 provides reported annual use values for both diesel and gasoline equipment. In addition, the count of equipment forming the basis of use values is listed in the last column of Table III-4. The average use values for diesel equipment were based on responses for at least 140 pieces of equipment (for diesel swathers) and up to over 4,000 pieces (for agricultural tractors).

**Figure III-2. Comparison of Annual Hours of Use Values for Diesel Equipment**



**Table III-4. Comparison of Annual Hours of Use Values**

Equipment Description	Activity, Hours per Year		# of Pieces Equipment
	NONROAD	Survey	
Gasoline 2-Wheel Tractors	286	373	27
Gasoline Agricultural Tractors	550	362	43
Gasoline Combines	125	78	11
Gasoline Balers	68	90	16
Gasoline Agricultural Mowers	175	174	125
Gasoline Sprayers	80	138	88
Gasoline Tillers > 6 HP	43	29	24
Gasoline Swathers	95	45	5
Gasoline Other Agricultural Equipment	124	403	30
Gasoline Irrigation Sets	716	2,935	340
Diesel 2-Wheel Tractors	544	1,017	404
Diesel Agricultural Tractors	475	1,086	4,221
Diesel Combines	150	457	379
Diesel Balers	95	332	393
Diesel Agricultural Mowers	363	361	572
Diesel Sprayers	90	350	512
Diesel Tillers > 6 HP	172	450	209
Diesel Swathers	110	382	146
Diesel Other Agricultural Equipment	381	762	196
Diesel Irrigation Sets	749	1,526	445

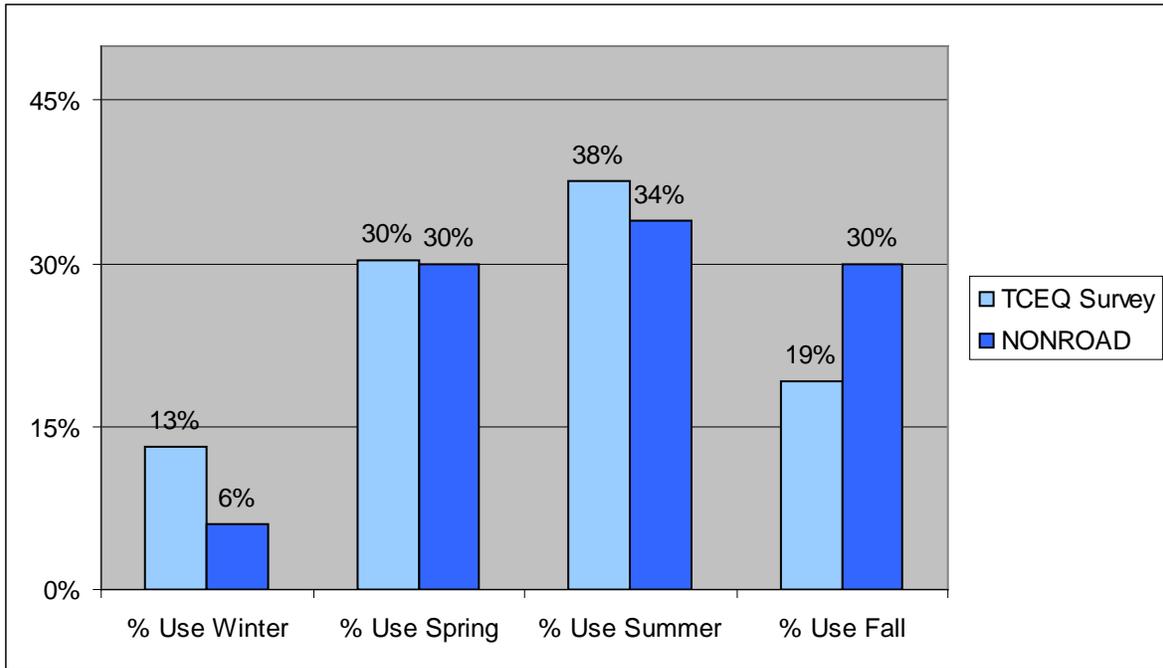
With the exception of diesel and gasoline agricultural mowers, and other select gasoline equipment types, preliminary hours per year estimates are much higher than NONROAD default values. This could be due to regional differences, in that equipment in Texas is operated more than the national average due to climatic and farming activity differences. A specific application such as irrigation sets are likely to operate much more than the national average in a dry climate like Texas. We recommend use of the annual hours of use values derived from the survey for all diesel and gasoline equipment types. Consistent with NONROAD and TexN, the same annual use profiles will be used for gasoline, LPG and CNG equipment. Additional discussion to support use of these revised annual activity estimates is provided in the “Conclusions” section.

### C. SEASONAL ACTIVITY

Based on responses to questions concerning operation during the four seasons of the year, we estimated the average seasonal percentages for each equipment type. Winter is comprised of the months December, January, and February, spring includes March, April and May, summer includes June, July and August, and fall consists of the months of September, October, and November. The NONROAD model includes a single seasonal allocation for all agricultural equipment, regardless of engine (i.e., fuel) or application (EPA, 2005). For comparison, the Texas survey data were evaluated across all equipment types. A comparison of the survey-based and NONROAD/TexN profiles is shown in Figure III-3. The survey data shows more activity than NONROAD during the winter and summer seasons, but significantly less activity during the fall. Because the seasonal data were collected by equipment type, and because the number of respondents and pieces of equipment by equipment type were deemed sufficient, we propose to add equipment-specific profiles in TexN to reflect these survey data. The profiles would be

equivalent for all fuel types within a particular equipment type. Table III-5 shows the recommended seasonal profiles along with the number of respondents and associated pieces of equipment that comprise the temporal profiles.

**Figure III-3. Comparison of Seasonal Use Profiles for All Agricultural Equipment Types**



**Table III-5. Average Seasonal Use Profiles by Equipment Type**

Equipment Label	Equipment Type	% Use in Winter	% Use in Spring	% Use in Summer	% Use in Fall	No. of Respondents	No. of Pieces Equipment
1	2-wheel tractors	19%	30%	31%	19%	228	1,043
2	agricultural tractors	17%	29%	32%	22%	1,916	5,303
3	combines	5%	19%	53%	23%	284	413
4	balers	5%	23%	59%	13%	319	430
5	agricultural mowers	7%	26%	49%	18%	465	736
6	sprayers	4%	45%	39%	12%	541	1,137
7	Tillers > 6HP	15%	32%	30%	23%	133	243
8	Swathers	1%	35%	48%	17%	131	155
9	Irrigation Sets	8%	33%	48%	12%	227	1,039
10	Other specified	15%	26%	26%	33%	120	257

## D. EQUIPMENT POPULATION

To scale the results to the entire state of Texas, equipment populations were estimated based on scaling factors derived from the survey results. Survey respondents were asked for estimates of crop-specific acres harvested and head of beef rangeland cattle to relate to their responses of nonroad use. Scaling factors were developed by quota group and equipment type, i.e., source classification code (SCC) using the following steps.

- 1) Adding up the number of pieces of equipment and the acres harvested for each equipment type within each quota group.
- 2) Calculating the scaling factor by dividing the number of pieces of owned equipment by the number of acres harvested. A calculation for agricultural tractors used in cotton farming in Carson County follows as an example.

$$\text{Equation (1)} \quad SF = Eq_{SCC, Quota} \div Acres_{Quota}$$

where

$$\begin{aligned} SF_{SCC, QUOTA} &= \text{Scaling factor, for SCC/QUOTA combination} \\ Eq_{SCC, QUOTA} &= \text{Agricultural tractors for all surveyed cotton farmers;} \\ & \quad 571 \\ Acres_{QUOTA} &= \text{Acres harvested by surveyed cotton farmers; 178,719} \end{aligned}$$

Resulting in:

$$\text{Equation (2)} \quad SF_{SCC, QUOTA} = 571 \div 178,719 = 0.003195$$

- 3) County-level acres of cotton harvested for Texas (compiled from USDA) will then be multiplied by this scaling factor to yield an estimate of county, SCC-level populations:

$$\text{Equation (3)} \quad Eq_{SCC, CTY} = SF_{SCC, QUOTA} * Acres_{CTY}$$

where

$$\begin{aligned} Eq_{SCC, CTY} &= \text{County equipment count, by SCC} \\ SF_{SCC, QUOTA} &= \text{Scaling factor for agricultural tractors used in} \\ & \quad \text{cotton farming; 0.003195} \\ Acres_{CTY} &= \text{Total acres cotton harvested in county; 24,600} \end{aligned}$$

Resulting in:

$$\text{Equation (4)} \quad Eq_{SCC, CTY} = 0.003195 * 24,600 = 79 \text{ agricultural tractors}$$

To estimate total equipment in use, populations derived from scaling the surveyed equipment populations to counties for all five quota farming groups were added together. We also reviewed the survey responses to identify whether there were equipment count records that should be removed or corrected. In addition, where respondents indicated that no equipment of a specific type was used, we included the corresponding acreage in our equipment population calculations.

Table III-6 shows the distribution of respondents for each type of farming operation, including those performing multiple operations addressed by the survey. In using available equipment count data for all completed surveys, we were concerned about the possible double counting of equipment for those respondents that completed a survey for more than one farming operation. We confirmed that this was the case for some of the respondents that we contacted (e.g., if they indicated they used 3 agricultural tractors for their beef operations, and 3 tractors for their wheat operations, they actually only owned a total of 3 tractors, and used them for both operations). Our initial extrapolations using all records resulted in State-level equipment populations as shown in Table III-7. To test whether these values were overestimates, we performed the extrapolation using only data from those respondents that completed a survey for only 1 operation (i.e., quota group). Overall these counts were appreciably lower (though for some equipment they were higher), and the gasoline distribution resulted in higher gasoline populations for several equipment types. These values are also presented in Table III-7.

To avoid any double counting, but to use the maximum number of available records, we performed the extrapolation again, this time discounting equipment count records where there was an overlap in reported pieces of equipment for multiple farming operations. Where equipment counts for one operation were higher than the second operation, the higher value was used (and this was considered the maximum number of pieces of equipment for a respondent). Where equipment counts were equal for the two operations, records selected for inclusion in the analysis were split evenly among the two quota groups. Table III-8 presents these final equipment population estimates for Texas and compares them with the NONROAD2005 populations for the year 2007.<sup>1</sup> Appendix A presents the scaling factors used by quota group and by equipment type in estimating county-level equipment populations (see Table A-1). In addition, the fuel distribution applied to the extrapolated equipment populations based on the survey data are shown in Table A-2.

Overall, the equipment populations derived from the survey are 22 percent higher than NONROAD (251,601 versus 196,914). Diesel equipment populations are 73 percent higher than NONROAD. All diesel equipment types show an increase - with the exception of diesel combines. Diesel agricultural tractors show the largest increase from NONROAD estimates (35,000 additional tractors statewide). For gasoline engines, there is a marked decrease in total equipment, offsetting somewhat the increases in diesel equipment numbers. NONROAD estimates a large population of tillers (~50,000) and sprayers (~13,000). Estimates for these two applications from the survey are much lower (~727 tillers and ~2,800 sprayers). For LPG and CNG, the survey estimates between 4,000 and 5,000 pieces of equipment for each fuel type, which is much higher than NONROAD. The survey also estimated populations for many more equipment types than NONROAD (CNG and LPG populations are only reported for other agricultural equipment and irrigation sets). Possible explanations to validate these higher overall equipment numbers are discussed in the “Conclusions” section.

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<sup>1</sup> Note that NONROAD2008 was not released when this initial comparison of survey-based equipment populations and fuel consumption was first performed, but the 2007 population and fuel consumption values from NONROAD2008 are expected to be comparable to or equal to NONROAD2005. NONROAD2008 was used in emission comparisons presented in Chapter IV of this report.

**Table III-6. Number of Completed Surveys by Respondent Group**

Respondent Group	No. of Completed Surveys	Respondent Group	No. of 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
<b>Subtotal - 1 Quota</b>	<b>844</b>	Other/Wheat	41
Beef/Cotton	15	<b>Subtotal - 2 Quotas (731 x 2)</b>	<b>1,462</b>
Beef/Hay	348	Beef/Cotton/Other	1
Beef/Other	37	<b>Subtotal - 3 Quotas</b>	<b>3</b>
Beef/Wheat	84	<b>Total Completed Surveys</b>	<b>2,309</b>

**Table III-7. Results of Preliminary Equipment Population Extrapolations**

State-level Texas Equipment Populations Using Data for All Respondents						
Code	Equipment Type	Diesel Equipment Population	Gasoline Equipment Population	LPG Equipment Population	CNG Equipment Population	Total Equipment Population (All Fuel Types)
1	2-wheel tractors	26,369	2,024	832	22	29,247
2	Agricultural tractors	143,105	5,435	1,508	40	150,088
3	Combines	9,493	453	-	-	9,945
4	Balers	13,483	374	212	3	14,072
5	Agricultural mowers	18,778	3,937	151	9	22,875
6	Sprayers	25,819	5,710	344	106	31,979
7	Tillers > 6HP	6,281	897	-	-	7,178
8	Swathers	4,772	167	39	-	4,978
9	Irrigation Sets	14,857	2,838	2,058	6,657	26,410
10	Other specified	5,239	1,166	56	-	6,461
	<b>Total</b>	<b>268,196</b>	<b>23,001</b>	<b>5,201</b>	<b>6,835</b>	<b>303,234</b>

State-level Texas Equipment Populations Using Data for Respondents with only 1 Quota Group						
Code	Equipment Type	Diesel Equipment Population	Gasoline Equipment Population	LPG Equipment Population	CNG Equipment Population	Total Equipment Population (All Fuel Types)
1	2-wheel tractors	12,604	1,251	185	-	14,040
2	Agricultural tractors	133,967	7,050	2,428	-	143,446
3	Combines	6,786	187	-	-	6,973
4	Balers	10,134	425	475	10	11,045
5	Agricultural mowers	19,335	11,046	339	-	30,720
6	Sprayers	14,296	4,143	214	116	18,768
7	Tillers > 6HP	4,501	1,750	-	-	6,251
8	Swathers	2,504	281	180	-	2,964
9	Irrigation Sets	13,502	2,525	3,401	4,031	23,459
10	Other specified	6,021	2,683	-	-	8,704
	<b>Total</b>	<b>223,651</b>	<b>31,340</b>	<b>7,222</b>	<b>4,157</b>	<b>266,370</b>
	<b>Difference</b>	<b>(44,546)</b>	<b>8,338</b>	<b>2,021</b>	<b>(2,678)</b>	<b>(36,865)</b>

**Table III-8. Comparison of Final Survey-Based and NONROAD Equipment Populations for Texas, 2007**

Survey-Based Estimates						
Code	Equipment Type	Diesel Equipment Population	Gasoline Equipment Population	LPG Equipment Population	CNG Equipment Population	Total Equipment Population (All Fuel Types)
1	2-wheel tractors	10,776	800	304	22	11,902
2	Agricultural tractors	134,608	4,960	1,409	48	141,025
3	Combines	8,685	390	-	-	9,075
4	Balers	12,608	354	223	4	13,188
5	Agricultural mowers	17,256	3,912	142	8	21,317
6	Sprayers	14,889	2,826	201	41	17,957
7	Tillers > 6HP	5,118	727	-	-	5,845
8	Swathers	4,183	143	39	-	4,365
9	Irrigation Sets	11,448	2,396	1,655	5,105	20,605
10	Other specified	5,144	1,122	56	-	6,322
	<b>Total</b>	<b>224,714</b>	<b>17,630</b>	<b>4,029</b>	<b>5,228</b>	<b>251,601</b>

NONROAD Estimates						
Code	Equipment Type	Diesel Equipment Pop	Gasoline Equipment Pop	LPG Equipment Pop	CNG Equipment Pop	Total Equipment Population (All Fuel Types)
1	2-wheel tractors	30	329	-	-	359
2	Agricultural tractors	98,847	178	-	-	99,025
3	Combines	19,942	2	-	-	19,944
4	Balers	382	1,224	-	-	1,606
5	Agricultural mowers	21	558	-	-	579
6	Sprayers	3,151	13,046	-	-	16,197
7	Tillers > 6HP	3	49,030	-	-	49,033
8	Swathers	4,163	764	-	-	4,926
9	Irrigation Sets	1,877	1,537	1	20	3,434
10	Other specified	1,589	214	5	4	1,811
	<b>Total</b>	<b>130,004</b>	<b>66,881</b>	<b>5</b>	<b>23</b>	<b>196,914</b>

Difference						
Code	Equipment Type	Diesel Equipment Pop	Gasoline Equipment Pop	LPG Equipment Pop	CNG Equipment Pop	Total Equipment Population (All Fuel Types)
1	2-wheel tractors	10,746	471	304	22	11,543
2	Agricultural tractors	35,761	4,782	1,409	48	42,000
3	Combines	(11,257)	388	-	-	(10,869)
4	Balers	12,225	(870)	223	4	11,582
5	Agricultural mowers	17,235	3,354	142	8	20,738
6	Sprayers	11,738	(10,220)	201	41	1,760
7	Tillers > 6HP	5,115	(48,303)	-	-	(43,188)
8	Swathers	20	(621)	39	-	(561)
9	Irrigation Sets	9,572	859	1,655	5,085	17,171
10	Other specified	3,555	909	51	(4)	4,512
	<b>Total</b>	<b>94,710</b>	<b>(49,250)</b>	<b>4,024</b>	<b>5,205</b>	<b>54,688</b>

## E. FUEL CONSUMPTION

Procedures for estimating fuel consumption were similar to the equipment population extrapolation. From the respondent data for annual amount of fuel used, we developed fuel use profiles relating gallons of fuel consumed by quota group to acres harvested or head of cattle. We then applied the scaling factors to county-level surrogate data for the State of Texas.

A state-level summary of the fuel consumption by fuel type and equipment type is presented in Table III-9. Using the scaling factors developed from the respondents' estimates of fuel consumed and acres harvested, statewide fuel consumption for all equipment types was estimated to be lower than NONROAD for diesel, gasoline, and CNG fuel types. For LPG engines, the survey indicates higher overall LPG consumption than NONROAD. This is likely due to the much higher prevalence of LPG engines as indicated by the Texas survey than estimated by NONROAD.

Based on the survey results, agricultural tractors contribute the largest percentage of total fuel for diesel (64 percent) and gasoline (70 percent) equipment types. The NONROAD model estimates an even greater percentage of total agricultural diesel fuel consumed by agricultural tractors (87 percent). Gasoline percentages for tractors are comparable. Agricultural tractor diesel fuel consumed based on the survey is much less than estimated by NONROAD (42 percent decrease). The overwhelming contribution of agricultural tractors results in the overall decrease in total diesel consumption, since all other diesel applications, with the exception of diesel combines and other agricultural equipment, show a fuel increase relative to NONROAD. For gasoline engines, 2-wheel and agricultural tractors, combines, and mowers all show fuel increases relative to NONROAD, while all other applications show a fuel decrease. Though this detail is not shown, the hay and beef quota groups contribute the largest percentages to the fuel use totals for all fuel types, except for CNG, which was reported primarily for cotton and wheat operations.

Fuel consumption is not a direct input of NONROAD. Fuel consumption is estimated by NONROAD using average brake-specific fuel consumption factors for various horsepower/fuel engine combinations. In addition, most pollutant emission estimates, with the exception of SO<sub>2</sub>, CO<sub>2</sub>, and evaporative VOC components, are not estimated using fuel as the base activity. For all other pollutants, emission rates in lbs/hp-hr are applied to equipment populations by horsepower class, annual hours of use, and load factor. One would expect that if survey-based equipment populations and hours of use are higher than the NONROAD defaults, that the estimated fuel consumption from the survey would also be higher than NONROAD, and that lower equipment populations would be associated with lower fuel consumption. Most applications exhibit this pattern, but a few equipment types, including diesel agricultural tractors, gasoline and CNG irrigation sets, and diesel and gasoline other agricultural equipment, do not. Further discussions of the fuel consumption estimates as obtained per the survey and how they relate to NONROAD/TexN are included in Section V, "Conclusions and Recommendations."

Scaling factors calculated for the various fuel types by quota group are presented in Table B-1 through B-4 of Appendix B. These data also show that CNG and LPG statewide estimates in particular are based on very few data points, so the representativeness of the fuel consumption values obtained for these fuel types is especially uncertain.

**Table III-9. Comparison of Statewide Texas Fuel Consumption by Equipment and Fuel Type**

<b>Diesel, gallons per year</b>			
<b>Equipment Type</b>	<b>Diesel Consumption</b>	<b>NONROAD</b>	<b>Difference</b>
2-wheel tractors	8,068,104	4,425	8,063,679
Agricultural tractors	113,986,680	195,695,480	(81,708,800)
Combines	11,522,032	17,568,191	(6,046,159)
Balers	10,014,224	98,216	9,916,008
Agricultural mowers	10,189,296	19,609	10,169,687
Sprayers	8,813,812	1,491,824	7,321,988
Tillers > 6HP	2,552,253	2,240	2,550,013
Swathers	2,854,971	1,379,280	1,475,691
Irrigation Sets	5,823,283	2,809,917	3,013,366
Other specified	2,982,003	3,826,135	(844,132)
<b>Total Equipment</b>	<b>176,806,658</b>	<b>222,895,317</b>	<b>(46,088,660)</b>
<b>Gasoline, gallons per yr</b>			
<b>Equipment Type</b>	<b>Gasoline Consumption</b>	<b>NONROAD</b>	<b>Difference</b>
2-wheel tractors	106,692	76,868	29,824
Agricultural tractors	2,210,998	324,221	1,886,777
Combines	72,625	2,233	70,392
Balers	40,981	214,026	(173,045)
Agricultural mowers	259,557	65,975	193,582
Sprayers	103,684	766,127	(662,442)
Tillers > 6HP	74,776	1,586,873	(1,512,097)
Swathers	22,590	339,003	(316,413)
Irrigation Sets	105,223	559,921	(454,698)
Other specified	177,942	490,860	(312,918)
<b>Total Equipment</b>	<b>3,175,068</b>	<b>4,426,106</b>	<b>(1,251,038)</b>
<b>LPG, gallons per yr</b>			
<b>Equipment Type</b>	<b>LPG Fuel Consumption</b>	<b>NONROAD</b>	<b>Difference</b>
2-wheel tractors	128,144		128,144
Agricultural tractors	352,602		352,602
Combines	0		0
Balers	57,500		57,500
Agricultural mowers	49,044		49,044
Sprayers	54,956		54,956
Tillers > 6HP	865		865
Swathers	3,707		3,707
Irrigation Sets	3,965	3,430	535
Other specified	1,842	5,382	(3,540)
<b>Total Equipment</b>	<b>652,626</b>	<b>8,812</b>	<b>643,814</b>
<b>CNG, gallons per yr</b>			
<b>Equipment Type</b>	<b>CNG Fuel Consumption</b>	<b>NONROAD</b>	<b>Difference</b>
2-wheel tractors	0		0
Agricultural tractors	35		35
Combines	0		0
Balers	0		0
Agricultural mowers	0		0
Sprayers	28,849		28,849
Tillers > 6HP	0		0
Swathers	0		0
Irrigation Sets	144,046	69,224,032	(69,079,986)
Other specified	2,885	2,946,503	(2,943,618)
<b>Total Equipment</b>	<b>175,815</b>	<b>72,170,535</b>	<b>(71,994,720)</b>

## F. SURROGATE COUNTY DATA

The source of the county level data used for extrapolating survey-based equipment populations and fuel consumption to the entire State is described in more detail in the sections below for the various quota groups. The most complete dataset, closest to the year of interest for the survey (i.e., 2007) was used for developing the surrogate county data. For maps displaying the surrogate data for each of the quota groups by Texas county, see Figures C-2 through C-6 of Appendix C.

### 1. Wheat and Cotton

For wheat and cotton quota groups, county-level acres harvested were obtained from the USDA National Agricultural Statistics Service (NASS) county estimates publications (USDA 2009d; USDA, 2009f). For wheat, 2008 data were available, while 2007 data were obtained for cotton. Acres of cotton harvested were reported for both All Upland Cotton and Pima Cotton (for a select few counties) so these were summed to obtain total acres cotton harvested by county and district. There were instances in both data sets where county-level acres harvested were withheld. Acres harvested data were available by district under the heading "other counties." For the counties that were withheld, these "other counties" amounts were allocated using the distribution of the previous year's acres harvested for those counties.

There were also instances where all the counties in a district reported acres harvested along with a record for "other counties." The county coverage for each district was compared with 2007 Census of Agriculture tables (USDA, 2009b) to determine the additional counties where wheat and cotton activity were believed to be occurring. Counties that either provided actual acres harvested or withheld data in the 2007 Census were included. The "other counties" acres harvested was then assigned evenly to those counties obtained from the 2007 Census.

### 2. Hay and Other Crops

County-level acres harvested for the hay quota group was obtained from the 2007 Census of Agriculture (USDA, 2009c). Withheld county-level data were assumed to be zero. County-level acres harvested representing "Other Crops" were obtained from a NASS report on total acres harvested by crop (USDA, 2009e). The following crops were accounted for: corn, oats, peanuts, rice, sorghum, soybeans, sugarcane, and sunflower seeds. Hay, wheat, and cotton acres harvested were excluded.

### 3. Beef

For the beef quota group, the surrogate data used was the head of beef cattle on pastureland. To estimate these data, 2008 Texas county head of cattle was obtained from an NASS report (USDA, 2009g). These county values represent county-level head of all cattle and calves, which include beef cows as well as milk cows and cattle on feedlots. The county level data were summed to District totals. State-level head of milk heifers and District-level head of feedlot-fed cattle were also obtained from NASS reports (USDA, 2009h; USDA, 2009i). The State total

head of milk heifers was apportioned to Districts according to milk cow district distributions. The District-level head of beef cattle were then estimated by subtracting the milk cows, milk heifers, and the feedlot-fed cattle from the cattle all totals. The district totals were then allocated to the county-level using acres pastureland obtained from the 2007 Census of Agriculture (USDA, 2009a). The pastureland acreage was believed to be a better indicator by county of the beef rangeland cattle than the counts of all cattle, which as stated above included cattle on feedlots and dairy cows.

## IV. TEXN MODEL RUNS AND RESULTS

### A. MODIFIED INPUTS

Consistent with the Task 2 recommendations, and as agreed to by TCEQ, Pechan made the following modifications to TexN inputs for the agricultural equipment sector:

- Replaced the TexN default average weekday/weekend day profile for all agricultural equipment combined with the survey-based profile;
- Replaced the TexN default seasonal profile for all agricultural equipment combined with the survey-based equipment-specific seasonal profiles;
- Replaced the TexN default annual hours of use per year for diesel, gasoline, CNG and LPG equipment with the survey-based annual usage values; and
- Replaced the TexN default equipment populations for all fuel types and equipment with the survey-based county equipment populations.

It should be noted that the survey indicated several additional LPG and CNG applications that are not currently included in NONROAD/TexN. For both LPG and CNG engines, NONROAD/TexN only reports populations and emissions for Irrigation Sets and Other Agricultural Equipment. Currently, new SCCs cannot be accommodated in TexN. As such, equipment populations for all LPG and CNG applications other than Irrigation Sets were combined and reported under the SCC for Other Agricultural Equipment.

Finally, since NONROAD or TexN does not incorporate diurnal profile data, activity profiles by hour of the day developed from the survey data were not applied for this project. However, Pechan had recommended that the updated diurnal temporal profile representing an average for all agricultural operations be used in future modeling efforts by TCEQ.

### B. EMISSION SUMMARIES

Table IV-1 shows the 2008 Texas statewide ozone season day agricultural equipment emissions inventory, generated using the above mentioned modified inputs to TexN. The updated inputs result in a substantial increase in emissions relative to the previous version of TexN (which relied upon NONROAD2005 model inputs), increasing by a factor of 3 to 4, depending upon the pollutant. Much of this increase is attributable to the increased number of equipment pieces derived from the survey in the new study, as well as increased annual hours of use values for most equipment types. Emission decreases result for a few equipment type/pollutant combinations, since the number of gasoline-fueled equipment for these equipment types

(i.e., sprayers, swathers and tillers) were shown to substantially decrease relative to diesel-fueled equipment.

**Table IV-1. Comparison of Previous and Updated Statewide Agricultural Equipment Emissions, 2008 OSD (tons per day)**

<b>Previous Default TexN Data<sup>1</sup></b>					
<b>Equipment Type</b>	<b>CO</b>	<b>NOx</b>	<b>PM10</b>	<b>SO2</b>	<b>VOC</b>
2-Wheel Tractor	1.2792	0.0055	0.0004	0.0001	0.0182
Agricultural Mowers	0.9763	0.009	0.001	0.0001	0.0199
Agricultural Tractor	32.3041	49.9095	5.3645	0.9862	5.7811
Balers	0.9553	0.0649	0.0041	0.0006	0.0701
Combines	2.2781	5.1931	0.5927	0.0885	0.5167
Irrigation Sets	2.3065	0.7537	0.0617	0.0144	0.1503
Other Ag Equipment	4.0161	1.1283	0.1231	0.0195	0.2524
Sprayers	8.2422	0.4626	0.0547	0.0078	0.436
Swathers	1.735	0.4403	0.0546	0.0071	0.1378
Tillers > 6hp	19.5582	0.0816	0.0033	0.0007	0.6754
<b>Grand Total</b>	<b>73.6511</b>	<b>58.0485</b>	<b>6.2601</b>	<b>1.1251</b>	<b>8.0579</b>

<b>Updated TexN Input Data</b>					
<b>Equipment Type</b>	<b>CO</b>	<b>NOx</b>	<b>PM10</b>	<b>SO2</b>	<b>VOC</b>
2-Wheel Tractor	4.606056	0.881398	0.15405	0.025064	0.24052
Agricultural Mowers	19.6038	9.890082	1.628957	0.218724	1.863703
Agricultural Tractor	140.2537	188.4401	16.06049	5.223884	17.54706
Balers	7.804173	8.203312	1.429198	0.184214	1.567955
Combines	10.0875	16.03002	1.540345	0.32919	1.700135
Irrigation Sets	142.8615	29.94916	2.060856	0.573879	5.162823
Other Ag Equipment	20.48912	7.980208	0.51321	0.145702	1.271325
Sprayers	12.9526	14.01045	1.876771	0.285807	2.320048
Swathers	2.481198	2.866152	0.442342	0.063176	0.406108
Tillers > 6hp	2.867168	3.755158	0.393229	0.074638	0.416834
<b>Grand Total</b>	<b>364.0068</b>	<b>282.0061</b>	<b>26.09945</b>	<b>7.124279</b>	<b>32.49651</b>

<b>% Difference (Difference Divided by Default Value)</b>					
<b>Equipment Type</b>	<b>CO</b>	<b>NOx</b>	<b>PM10</b>	<b>SO2</b>	<b>VOC</b>
2-Wheel Tractor	260%	15925%	38412%	24964%	1222%
Agricultural Mowers	1908%	109790%	162796%	218624%	9265%
Agricultural Tractor	334%	278%	199%	430%	204%
Balers	717%	12540%	34758%	30602%	2137%
Combines	343%	209%	160%	272%	229%
Irrigation Sets	6094%	3874%	3240%	3885%	3335%
Other Ag Equipment	410%	607%	317%	647%	404%
Sprayers	57%	2929%	3331%	3564%	432%
Swathers	43%	551%	710%	790%	195%
Tillers > 6hp	-85%	4502%	11816%	10563%	-38%
	394%	386%	317%	533%	303%

<sup>1</sup>Source: "Deliverable 3 - Update of TexN with Agricultural Equipment Population Data and Temporal Allocation Profiles," Work order #582-7-84003-FY09-19, Prepared by ERG for TCEQ, July 15, 2009.

2008 SCC-specific emission summaries are provided in Appendix D. Table D-1 shows a comparison of SCC-level OSD emissions, while Table D-2 shows a similar comparison for annual emissions. It should be noted that these comparisons are made using a different baseline, namely NONROAD2008 results for Texas. Pechan did not have access to the version of TexN prior to the model updates made reflecting the new agricultural activity inputs (i.e., the version of TexN used to generate previous results shown in Tables IV-2a and IV-2b, respectively). NONROAD2008 resulted in higher emissions statewide than the previous version of TexN.

**Table IV-2a. Comparison of OSD 2008 Updated TexN to Previous TexN and NONROAD2008 Emissions (tons per day)**

	VOC	NOx	CO	PM10-PRI	SO2
Previous Default TexN	8.06	58.05	73.65	6.26	1.13
Updated TexN	32.50	282.01	364.01	26.10	7.12
% Diff (Updated TexN - Previous TexN)/Previous TexN	303%	386%	394%	317%	533%
NONROAD08	14.10	120.27	114.45	11.45	2.42
Updated TexN	32.50	282.01	364.01	26.10	7.12
% Diff (Updated TexN - NR2008)/NR2008	131%	134%	218%	128%	195%

**Table IV-2b. Comparison of Annual 2008 Updated TexN to NONROAD2008 Emissions (tons per year)**

	VOC	NOx	CO	PM10-PRI	SO2
NONROAD08	3,328	27,949	26,595	2,661	562
Updated TexN	7,666	72,598	80,563	6,215	1,769
% Diff (Updated TexN - NR2008)/NR2008	130%	160%	203%	134%	215%

The updated monthly and weekly profiles would be reflected in the seasonal emissions for a given model run, as well as the typical ozone season weekday emissions. The survey showed less weekday activity relative to weekend day activity than prior defaults (see Table III-2), and slightly higher summer season activity than the default (38 percent versus 34 percent - see Figure III-3). Though not shown, Pechan performed seasonal model runs for 2008 to confirm that the updated monthly allocations by SCC were generating the expected results.

In addition to a base year 2008 inventory, Pechan developed annual and OSD emission estimates for 2005, 2011, 2014, 2018, and 2025. A summary of total annual agricultural equipment emissions for each year is shown in Table IV-3. A similar table of OSD emissions for each year is shown in Table IV-4. Emissions for all pollutants decrease over time, as new engines that must meet more stringent emission standards replace older engines. In addition, decreasing levels of sulfur in nonroad fuels result in lower SO<sub>2</sub> emissions and a leveling off in future years. For a breakout of annual and OSD emissions by SCC for each forecast year, see Tables D-3 and D-4 of Appendix D. Finally, a summary table of 2008 emissions by county, for all agricultural SCCs combined, is provided in Table D-5, so that county-level contributions to the State total can be determined.

**Table IV-3. Statewide Annual Agricultural Emissions for 2005, 2008, and Select Forecast Years (tons per year)**

Year	VOC	NOx	CO	PM10-PRI	SO2
2005	10,128	93,253	186,429	7,584	10,415
2008	7,666	72,598	80,563	6,215	1,769
2011	6,358	60,745	59,761	5,444	98
2014	5,116	47,374	48,005	4,086	94
2018	4,295	29,989	35,395	2,123	91
2025	4,130	18,408	29,422	902	95

**Table IV-4. Statewide OSD Agricultural Emissions for 2005, 2008, and Select Forecast Years (tons per day)**

Year	VOC	NOx	CO	PM10-PRI	SO2
2005	44	375	942	33	62
2008	32	282	364	26	7
2011	27	236	260	23	0.4
2014	22	185	214	17	0.4
2018	18	120	165	9	0.4
2025	17	74	141	4	0.4

## V. CONCLUSIONS AND RECOMMENDATIONS

The major findings of the agricultural equipment survey for Texas are as follows.

- The survey showed marked increases in both equipment populations and annual hours of use for most applications.
- The increases in population and activity produce significant increases in emissions for most applications.
- Equipment-specific seasonal use profiles were supported by the survey data to replace default seasonal profiles for all agricultural equipment types combined.
- Compared to NONROAD’s default weekly profile, the ratio of average weekday/weekend day use was lower according to the survey results (i.e., 1.4 times as likely per survey compared to 2 times as likely per NONROAD). In other words, weekday activity is 1.4 times weekend activity.

The survey collected data from respondents conducting farming operations in 242 of the 255 total counties in Texas. However, it is important to consider that the data collected from this survey is being used to represent average use profiles for all counties in the State. It is possible that farmers engaged in the same crop farming activity may utilize different practices and equipment (e.g., tilling versus no tilling) in different parts of the State, which would affect the equipment use profiles by region. In addition, custom application and custom farming may be an important part of some farming operations. This may include fertilizer application, pesticide

application, and growth regulator or harvest aid application (often done by aerial or ground applicators). The extent that these operations are done by equipment not owned by the farmer may vary widely with location, size of operation, and growth stage of the crop (Miller, 2009). It should be noted that Pechan initially included entities in the sample frame that would likely fall under custom application (i.e., NAICS 115: Support activities for agricultural operations). This quota group was dropped from the final sample frame upon completion of the survey because so few respondents identified themselves as performing these activities.

Because of the marked increases in both equipment populations and annual hours of use, a more detailed discussion of these variables, and possible explanations to support use of these data, is provided below. In addition, a discussion of the fuel consumption estimated from the survey is also presented. Finally, recommendations for follow-on work are described.

#### A. EQUIPMENT POPULATIONS AND ANNUAL ACTIVITY

The NONROAD model allocates national equipment populations to counties based on total harvested cropland by county as reported by the USDA in the 2002 Census of Agriculture. Table V-1 summarizes the Texas contribution to the national total for select agricultural goods, which include most of the farming sectors focused on in our survey. As the values show, NONROAD estimates that 6 percent of the total national equipment populations are in use in Texas. However, when one considers some of the specific crops, Texas has by far the highest acres planted/harvested and production of cotton of any state in 2007 (45 percent of national total). Texas also has the highest harvested acres and production of hay/forage of any state in 2007. Based on the 2005 USDA fuel use per planted acreage data that was used in prioritizing the sectors for the survey, cotton and forage-land also had the highest diesel fuel use per acre of any of the major crops. In addition, numbers of beef cattle managed are especially significant in Texas relative to other states. Therefore, the occurrence of these fuel-intensive agricultural operations in larger proportions in Texas could be contributing to the increased equipment populations and hours of use, compared to the NONROAD model assumptions.

**Table V-1. Contribution of Texas to National Total for Select Agricultural Goods**

<b>Crop/Commodity<sup>1</sup></b>	<b>Total for Texas</b>	<b>Total for US</b>	<b>Fraction Texas/US</b>
Acres Harvested Cropland <sup>2</sup>	18,136,653	295,406,519	6%
Acres Cotton Harvested	4,723,400	10,489,100	45%
Acres Hay (Forage) Harvested	5,264,122	61,455,483	9%
Acres Wheat Harvested	3,295,604	55,685,000	6%
Beef Pastureland	58,598,044	408,832,116	14%
Head of Beef Cattle	10,709,700	67,465,000	16%

<sup>1</sup>All values derived from 2007 or 2008 USDA reports; except for Harvested Cropland from 2002 Census of Agriculture.

<sup>2</sup>Harvested Cropland used for allocating national equipment populations to counties for NONROAD2005.

One climate-related variable that is different for Texas is irrigation. As such, equipment such as irrigation sets are likely to operate at a significantly higher rate than the national average in a dry climate like Texas. The 2007 Census of Agriculture shows that irrigated land is 18.3 percent of

total harvested cropland for the nation, while this value for Texas is 26.1 percent. Though values could not be found to substantiate this, the Texas-to-national average ratio for volume of irrigation water may be even much higher than that represented by the acreage data.

For comparison, Pechan also reviewed annual use values recently developed by ARB from a 2008 offroad survey (ARB, 2008). A comparison of annual use values developed from this survey with ARB’s data is provided in Table V-2. NONROAD model default values are also shown for comparison. Note that for many diesel equipment types the activity values from the TCEQ study and ARB’s study are comparable, and are both shown to be substantially higher than NONROAD. However, a few notable exceptions are diesel agricultural mowers and tractors, and swathers. ARB’s annual use estimates are closer in value or lower than NONROAD’s default values for these three applications. There are greater differences between the TCEQ and ARB studies estimates of gasoline equipment usage. In total, across all agricultural equipment types, though, both the TCEQ study and the ARB study show increased hours of use relative to NONROAD. In addition, though the values are not shown since State-specific population values for California and Texas are not expected to be comparable, the ARB study found that most agricultural equipment populations are the same or higher than NONROAD2008 default populations.

**Table V-2. Agricultural Equipment Activity Comparison, hrs/yr**

<b>Equipment Type</b>	<b>Fuel Type</b>	<b>TCEQ Survey</b>	<b>ARB 2008 Study</b>	<b>NONROAD2008</b>
Agricultural Mowers	Diesel	361	70	363
Agricultural Tractors	Diesel	1,086	301	475
Balers	Diesel	332	361	95
Combines	Diesel	457	463	150
Irrigation Sets	Diesel	1,526	1,400	749
Sprayers	Diesel	350	386	90
Swathers	Diesel	382	133	110
Other Agricultural Equipment	Diesel	762	469	381
Agricultural Mowers	Gasoline	174	540	175
Agricultural Tractors	Gasoline	362	54	550
Balers	Gasoline	90	300	68
Combines	Gasoline	78	93	125
Sprayers	Gasoline	138	170	80
Swathers	Gasoline	45	35	95
Tillers	Gasoline	29	83	43
Other Agricultural Equipment	Gasoline	403	179	124

## B. FUEL CONSUMPTION

The survey data resulted in overall lower diesel fuel consumption estimates than NONROAD. As explained in the fuel consumption section, this is due primarily to lower diesel fuel use as estimated by the survey for agricultural tractors. For this application, one would expect higher fuel estimates than NONROAD given the increased equipment populations and hours of use. There appears to be a disconnect in the model’s estimated fuel and the fuel estimated based on the survey extrapolation procedures. This could potentially result from differences in the actual

BSFC or load factor. For gasoline consumption, the survey also resulted in lower gasoline consumed than NONROAD, but this is in line with the decrease in gasoline equipment populations for most applications as estimated by the survey.

Pechan first compared survey-based fuel use per acre estimates used in extrapolating fuel consumption statewide with available reported fuel factors for reasonableness. Texas A&M's Department of Agricultural Economics provides estimates of production costs by district and crop operation that also provide estimates of total fuel use per acre and specific fuel use for select equipment types, including agricultural tractors (Texas A&M, 2009). These costs are compiled from available information for twelve Extension districts in Texas which represent a wide range of geographical regions throughout the State. Pechan compiled data for both agricultural tractors and other self-propelled equipment from the Texas A&M data to estimate diesel fuel consumption factors. Table V-3 presents a summary of these data for four of the crop types in our study. With the exception of cotton, the Texas A&M estimates are slightly lower than the survey-based factors for agricultural tractors. Diesel consumption factors for other self-propelled equipment are significantly different for cotton, hay, and other--but less so for wheat.

**Table V-3. Fuel Consumption Factor Comparison by Sector**

<b>Fuel Consumption Factors for Diesel Agricultural Tractors, gallons/acre</b>		
<b>Sector</b>	<b>Survey</b>	<b>Texas A&amp;M</b>
Cotton	3.03	5.13
Hay	4.76	3.75
Wheat	3.07	2.46
Other	3.57	2.81

<b>Fuel Consumption Factors for Diesel Self-Propelled Equipment, gallons/acre</b>		
<b>Sector</b>	<b>Survey</b>	<b>Texas A&amp;M</b>
Cotton	2.39	1.31
Hay	2.89	4.20
Wheat	2.01	1.40
Other	1.39	0.20

Pechan also compiled state-level diesel fuel consumption totals from two independent sources, the 2007 Census of Agriculture for Texas, and the 2007 Fuel Oil and Kerosene Sales, Texas Diesel Sales for Farms. These values are compared to default NONROAD2008 and the survey-based estimates in Table V-4. Note that the fuel consumption values from the published sources are both higher than NONROAD2008, which is also higher than the survey-based estimate.

As a final exercise, Pechan compared the percentages of diesel consumption by farm sector as calculated from the survey, and also calculated based on reported USDA Census of Agriculture data. This comparison is shown in Table V-5.

**Table V-4. Statewide Texas Diesel Consumption Values—Agricultural Sector**

<b>Source</b>	<b>Diesel Consumption, gallons</b>
TCEQ Survey	176,806,658
NONROAD	222,895,317
2007 Census of Agriculture	265,481,579
2007 Fuel Oil and Kerosene Sales	242,322,000

**Table V-5. Percentages of Diesel Fuel Consumed by Farm Sector in Texas**

<b>Source</b>	<b>Cotton</b>	<b>Hay</b>	<b>Beef</b>	<b>Wheat</b>	<b>Other Crops</b>	<b>All Other</b>
Survey	18%	29%	24%	12%	17%	
2007 Census of Agriculture	13%	11% <sup>1</sup>	30%			46%
2002 Census of Agriculture	15%	11% <sup>1</sup>	32%			41%

<sup>1</sup>Reflects "Sugarcane farming, hay farming, and all other crop farming" (NAICS codes 11193, 11194, 11199)

Note that we had to apply an average national 61 percent of total fuel expenditures are diesel fuel for each of the specific farm NAICS codes listed in the Census of Agriculture—so there is some uncertainty associated with the Census-based estimates (USDA, 2008). The data seem to suggest that we are understating diesel consumption from all other farm activities (and possibly from wheat) since all non-cotton/hay/beef sector diesel consumption is estimated to account for 46 percent of total farm diesel consumption based on the 2007 Census, while the survey shows only 29 percent.

Further evidence that the survey may be understating diesel consumption from all other farm activities is provided in Table V-6. The Census 2007 data indicates that Oilseed and Grain Farming (NAICS code 1111) is 46 percent of all non-cotton/hay/beef consumption (i.e., 56 million gallons divided by 121 million gallons). Looking at the USDA-based 2005 year diesel consumption estimates by crop type, we can develop an estimate of the percentage of “Oilseed and Grain Farming” sector consumption from Wheat farms (we estimate Oilseed and Grain Farming by summing the Wheat, Sorghum, Corn, Rice, Oats, and Soybeans estimates—note that there are other crops that should be included in the Oilseed and Grain farm sector, such as beans/peas). When we do this, Wheat farms are estimated to account for 35 percent of Oilseed and Grain Farming diesel consumption (in reality, the percentage would be somewhat lower since we know Table V-6 does not include all crops considered Oilseed and Grain). Given that the 2007 Census indicates that the Oilseed and Grain Farming sector accounts for 46 percent of all non-cotton/hay/beef consumption of diesel in Texas, one could estimate that Wheat farms should account for no more than 16 percent of all non-cotton/hay/beef consumption of diesel in Texas ( $0.35 * 0.46 = 0.16$ )—this is far less than the 41 percent estimated by our survey. Therefore, one can conclude that we are likely understating diesel consumption from the “All Other” category (i.e., all crops/livestock sectors not specifically covered by our survey).

**Table V-6. Diesel Consumption Estimates for Texas, USDA 2005**

<b>Crop Type</b>	<b>Diesel (Gallons)</b>
Cotton, all	115,911,120
Forage-land used for all hay & haylage, grass silage, & greenchop	66,443,398
Wheat for grain, all	28,050,000
Sorghum for grain	21,320,000
Corn for grain	18,245,000
Rice	8,423,400
Peanuts for nuts	8,321,000
Oats for grain	3,519,000
Soybeans for beans	1,066,000
Subtotal	271,298,918

Fuel consumption estimates from various sources yield varying estimates that are not consistent when compared with the survey-based fuel data. As we have noted earlier, fuel consumption is not an input to TexN. Because an increase in equipment populations and activity would seemingly contribute to an increase in fuel consumption and corresponding emissions (unless the fuel efficiency has increased drastically, which has not been found to be the case), the fuel consumption values from the survey must be treated as preliminary, and in need of further confirmation.

### C. RECOMMENDATIONS

The following are recommendations for potential areas of improvement to agricultural equipment emissions modeling and inventories in the future:

1. For this project, the population of farms was stratified to obtain statistically-valid samples for various types of farming operations statewide. As such, the data collected and applied represent average use profiles for all counties in Texas. Further stratifying the sample into other defined populations that are expected to have different use patterns (e.g., tillage versus no-till operations, or based on region of the State) and completing the survey or portions of the survey again may be worthwhile to establish that these variations are sufficiently represented.
2. Related to the fuel contribution comparisons performed in the previous section, specific crop farming operations that were combined into the “Other Crop Farming Quota Group” may warrant individual attention, and should be a priority in further survey efforts.
3. An increase in equipment populations and activity would be expected to contribute to an increase in fuel consumption. Since the fuel consumption obtained from the survey does not follow this pattern, especially for agricultural tractors, one may want to consider a targeted survey of farmers to obtain their tractor hours of use and fuel consumption. One limitation of the survey is that the respondents may not be accurately remembering or reporting their fuel use (or hours of use) for a whole year, or for long time periods throughout the year. The farmers could be selected to be on a panel where we send them a mailing each month or two to report these data. Fuel consumption will be an

increasingly important parameter to estimate as greenhouse gas inventories are developed and refined, since these inventories typically rely on accurate fuel usage estimates as the activity.

4. To refine monthly allocations of activity/emissions within seasons, TCEQ may want to consider an analysis of monthly and weekly diesel fuel consumed by major crop type in Texas. These data are available from USDA crop progress data, which report the percentage of total annual planted acreage that is planted by week, and the percentage of total harvested acreage that is harvested in each week by major crop type.

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**APPENDIX A. EQUIPMENT POPULATION SCALING FACTORS AND  
FUEL DISTRIBUTIONS**

**Table A-1. Survey-Based Equipment Population Scaling Factors by Quota Group and Equipment Type**

Quota Group Name	Equipment Code	Equipment Type	Respondent Count	Number of Pieces used in 2007	Number of acres harvested in 2007	Scaling Factor
COTTON	1	2-wheel tractors	26	68	255,851	0.000266
COTTON	2	Agricultural tractors	150	571	178,719	0.003195
COTTON	3	Combines	24	31	249,851	0.000124
COTTON	4	Balers	5	10	256,401	0.000039
COTTON	5	Agricultural mowers	12	14	253,601	0.000055
COTTON	6	Sprayers	79	91	243,730	0.000373
COTTON	7	Tillers > 6HP	18	44	252,945	0.000174
COTTON	8	Swathers	3	3	254,401	0.000012
COTTON	9	Irrigation Sets	46	228	253,731	0.000899
COTTON	10	Other specified	32	66	256,401	0.000257
HAY	1	2-wheel tractors	42	96	119,688	0.000802
HAY	2	Agricultural tractors	354	980	95,541	0.010257
HAY	3	Combines	21	28	140,486	0.000199
HAY	4	Balers	109	159	129,864	0.001224
HAY	5	Agricultural mowers	129	189	132,604	0.001425
HAY	6	Sprayers	97	109	136,741	0.000797
HAY	7	Tillers > 6HP	37	60	141,221	0.000425
HAY	8	Swathers	54	63	121,546	0.000518
HAY	9	Irrigation Sets	49	101	119,691	0.000844
HAY	10	Other specified	11	15	141,297	0.000106
WHEAT	1	2-wheel tractors	33	82	184,266	0.000445
WHEAT	2	Agricultural tractors	191	570	139,336	0.004091
WHEAT	3	Combines	118	158	177,036	0.000892
WHEAT	4	Balers	18	24	180,687	0.000133
WHEAT	5	Agricultural mowers	26	36	180,271	0.000200
WHEAT	6	Sprayers	63	72	170,926	0.000421
WHEAT	7	Tillers > 6HP	20	39	184,203	0.000212
WHEAT	8	Swathers	13	15	179,281	0.000084
WHEAT	9	Irrigation Sets	34	224	180,022	0.001244
WHEAT	10	Other specified	5	11	186,921	0.000059
OTHER	1	2-wheel tractors	14	41	170,586	0.000240
OTHER	2	Agricultural tractors	260	765	143,644	0.005326
OTHER	3	Combines	58	74	163,597	0.000452
OTHER	4	Balers	10	12	168,897	0.000071
OTHER	5	Agricultural mowers	61	85	166,563	0.000510
OTHER	6	Sprayers	61	87	156,215	0.000557
OTHER	7	Tillers > 6HP	19	24	169,343	0.000142
OTHER	8	Swathers	4	4	169,770	0.000024
OTHER	9	Irrigation Sets	48	209	164,211	0.001273
OTHER	10	Other specified	27	48	170,815	0.000281
Quota Group Name	Equipment Code	Equipment Type	Respondent Count	Number of Pieces used in 2007	Head of Beef Rangeland Cattle in 2007	Scaling Factor
BEEF	1	2-wheel tractors	59	128	358,429	0.000357
BEEF	2	Agricultural tractors	441	1,044	335,226	0.003114
BEEF	3	Combines	28	80	362,013	0.000221
BEEF	4	Balers	92	115	212,850	0.000540
BEEF	5	Agricultural mowers	155	207	211,336	0.000979
BEEF	6	Sprayers	138	158	211,950	0.000745
BEEF	7	Tillers > 6HP	33	47	354,308	0.000133
BEEF	8	Swathers	36	41	367,762	0.000111
BEEF	9	Irrigation Sets	30	60	353,393	0.000170
BEEF	10	Other specified	38	105	371,216	0.000283

**Table A-2. Fuel Distribution by Equipment Type from Survey**

Quota Group Name	Equipment Label	Equipment Type	% Diesel	% Gasoline	% LPG	% CNG
COTTON	1	2-wheel tractors	91	2	5	2
COTTON	2	agricultural tractors	98	1	1	0
COTTON	3	combines	100			
COTTON	4	balers	80	10	10	
COTTON	5	agricultural mowers	100			
COTTON	6	sprayers	93	5	2	
COTTON	7	Tillers > 6HP	98	3		
COTTON	8	Swathers	100			
COTTON	9	Irrigation Sets	73	4	0	23
COTTON	10	Other specified	94	2	5	
HAY	1	2-wheel tractors	91	8	1	
HAY	2	agricultural tractors	95	4	1	
HAY	3	combines	82	18		
HAY	4	balers	97	2	1	
HAY	5	agricultural mowers	96	4	0	
HAY	6	sprayers	86	13	1	
HAY	7	Tillers > 6HP	88	12		
HAY	8	Swathers	96	3	1	
HAY	9	Irrigation Sets	89	3	1	7
HAY	10	Other specified	74	26		
WHEAT	1	2-wheel tractors	94	1	5	
WHEAT	2	agricultural tractors	98	1	1	
WHEAT	3	combines	96	4		
WHEAT	4	balers	100			
WHEAT	5	agricultural mowers	87	10	3	
WHEAT	6	sprayers	93	7		
WHEAT	7	Tillers > 6HP	100			
WHEAT	8	Swathers	100			
WHEAT	9	Irrigation Sets	18	39		43
WHEAT	10	Other specified	100			
BEEF	1	2-wheel tractors	90	7	3	
BEEF	2	agricultural tractors	94	5	1	
BEEF	3	combines	97	3		
BEEF	4	balers	95	3	2	0
BEEF	5	agricultural mowers	71	28	1	
BEEF	6	sprayers	77	22	1	1
BEEF	7	Tillers > 6HP	80	20		
BEEF	8	Swathers	95	5		
BEEF	9	Irrigation Sets	72	4	1	24
BEEF	10	Other specified	76	24		
OTHER	1	2-wheel tractors	88	12		
OTHER	2	agricultural tractors	96	4	1	
OTHER	3	combines	100			
OTHER	4	balers	80	20		
OTHER	5	agricultural mowers	74	25	1	0
OTHER	6	sprayers	85	13	2	
OTHER	7	Tillers > 6HP	77	23		
OTHER	8	Swathers	100			
OTHER	9	Irrigation Sets	40	7	26	27
OTHER	10	Other specified	82	18		

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## APPENDIX B. FUEL CONSUMPTION SCALING FACTORS

**Table B-1. Diesel Fuel Scaling Factors by Quota Group and Equipment Type**

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of Diesel Consumed	Number of Acres Harvested in 2007	Scaling Factor (Diesel)
COTTON	1	2-Wheel Tractors	17	50	66,950	251,984	0.26569
COTTON	2	Agricultural Tractors	132	508	776,720	180,933	4.29286
COTTON	3	Combines	22	31	202,750	251,621	0.80578
COTTON	4	Balers	3	8	12,100	256,401	0.04719
COTTON	5	Agricultural Mowers	10	13	14,250	252,186	0.05651
COTTON	6	Sprayers	67	80	116,570	236,589	0.49271
COTTON	7	Tillers > 6HP	11	22	14,180	254,636	0.05569
COTTON	8	Swathers	4	4	1,750	256,401	0.00683
COTTON	9	Irrigation Sets	16	82	92,251	232,339	0.39705
COTTON	10	Other Specified	26	58	92,090	248,401	0.37073
HAY	1	2-Wheel Tractors	41	112	77,805	140,641	0.55322
HAY	2	Agricultural Tractors	374	1026	676,048	98,826	6.84079
HAY	3	Combines	16	21	25,400	136,220	0.18646
HAY	4	Balers	101	139	100,225	133,023	0.75344
HAY	5	Agricultural Mowers	107	153	85,015	134,571	0.63175
HAY	6	Sprayers	72	88	33,338	138,562	0.24060
HAY	7	Tillers > 6HP	23	40	23,465	138,946	0.16888
HAY	8	Swathers	39	48	29,760	125,627	0.23689
HAY	9	Irrigation Sets	18	34	18,802	135,525	0.13873
HAY	10	Other Specified	9	12	16,900	141,996	0.11902
WHEAT	1	2-Wheel Tractors	35	88	56,694	183,516	0.30893
WHEAT	2	Agricultural Tractors	187	523	574,287	138,772	4.13835
WHEAT	3	Combines	98	117	129,048	163,258	0.79045
WHEAT	4	Balers	19	26	17,215	181,631	0.09478
WHEAT	5	Agricultural Mowers	18	26	16,875	181,857	0.09279
WHEAT	6	Sprayers	50	58	81,382	170,646	0.47691
WHEAT	7	Tillers > 6HP	21	47	34,540	181,756	0.19003
WHEAT	8	Swathers	14	16	14,850	182,531	0.08136
WHEAT	9	Irrigation Sets	6	72	15,801	185,461	0.08520
WHEAT	10	Other Specified	3	7	10,100	186,471	0.05416
OTHER	1	2-Wheel Tractors	9	24	13,758	168,155	0.08182
OTHER	2	Agricultural Tractors	195	607	610,111	126,742	4.81380
OTHER	3	Combines	46	58	90,605	148,264	0.61111
OTHER	4	Balers	8	9	7,647	168,714	0.04533
OTHER	5	Agricultural Mowers	32	45	17,366	164,539	0.10554
OTHER	6	Sprayers	39	49	33,952	149,253	0.22748
OTHER	7	Tillers > 6HP	8	15	12,526	165,906	0.07550
OTHER	8	Swathers	4	4	3,170	169,770	0.01867
OTHER	9	Irrigation Sets	12	40	47,600	133,386	0.35686
OTHER	10	Other specified	12	18	10,330	165,755	0.06232

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of Diesel Consumed	Head of Cattle Farm Managed in 2007	Scaling Factor
BEEF	1	2-Wheel Tractors	50	623	82,740	354,851	0.23317
BEEF	2	Agricultural Tractors	438	1066	624,919	313,177	1.99542
BEEF	3	Combines	23	76	42,270	362,468	0.11662
BEEF	4	Balers	84	107	100,867	203,856	0.49480
BEEF	5	Agricultural Mowers	135	187	108,243	200,095	0.54096
BEEF	6	Sprayers	92	105	85,176	354,111	0.24053
BEEF	7	Tillers > 6HP	15	30	14,080	360,694	0.03904
BEEF	8	Swathers	34	42	24,028	211,002	0.11388
BEEF	9	Irrigation Sets	14	34	24,721	211,018	0.11715
BEEF	10	Other Specified	19	64	4,555	369,257	0.01234

**Table B-2. Gasoline Scaling Factors by Quota Group and Equipment Type**

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of Gasoline Consumed	Number of Acres Harvested in 2007	Scaling Factor
COTTON	1	2-Wheel Tractors	1	1	10	256,401	0.00004
COTTON	2	Agricultural Tractors	6	35	7,365	253,901	0.02901
COTTON	3	Combines	0	0	0	256,401	0.00000
COTTON	4	Balers	0	0	0	256,401	0.00000
COTTON	5	Agricultural Mowers	0	0	0	256,401	0.00000
COTTON	6	Sprayers	5	8	695	252,904	0.00275
COTTON	7	Tillers > 6HP	1	1	7	255,801	0.00003
COTTON	8	Swathers	0	0	0	256,401	0.00000
COTTON	9	Irrigation Sets	2	14	3,300	255,820	0.01290
COTTON	10	Other Specified	1	1	120	256,401	0.00047
HAY	1	2-Wheel Tractors	8	20	1,150	141,801	0.00811
HAY	2	Agricultural Tractors	33	112	32,885	140,671	0.23377
HAY	3	Combines	6	10	850	141,996	0.00599
HAY	4	Balers	2	4	320	141,745	0.00226
HAY	5	Agricultural Mowers	8	10	2,610	141,926	0.01839
HAY	6	Sprayers	12	16	1,017	141,161	0.00720
HAY	7	Tillers > 6HP	5	7	174	141,911	0.00123
HAY	8	Swathers	2	4	600	141,996	0.00423
HAY	9	Irrigation Sets	0	0	0	139,936	0.00000
HAY	10	Other Specified	2	4	230	141,996	0.00162
WHEAT	1	2-Wheel Tractors	3	9	650	186,221	0.00349
WHEAT	2	Agricultural Tractors	10	27	4,637	183,886	0.02522
WHEAT	3	Combines	3	5	1,500	185,246	0.00810
WHEAT	4	Balers	0	0	0	186,921	0.00000
WHEAT	5	Agricultural Mowers	1	1	700	186,301	0.00376
WHEAT	6	Sprayers	4	5	485	185,571	0.00261
WHEAT	7	Tillers > 6HP	1	0	5	186,921	0.00003
WHEAT	8	Swathers	0	0	0	186,921	0.00000
WHEAT	9	Irrigation Sets	2	5	1,000	184,181	0.00543
WHEAT	10	Other Specified	0	0	0	186,921	0.00000
OTHER	1	2-Wheel Tractors	4	5	430	170,807	0.00252
OTHER	2	Agricultural Tractors	19	56	8,265	170,728	0.04841
OTHER	3	Combines	0	0	0	170,817	0.00000
OTHER	4	Balers	1	1	1	170,817	0.00001
OTHER	5	Agricultural Mowers	14	20	2,423	170,693	0.01420
OTHER	6	Sprayers	9	12	557	170,542	0.00327
OTHER	7	Tillers > 6HP	3	3	32	170,784	0.00019
OTHER	8	Swathers	0	0	0	170,817	0.00000
OTHER	9	Irrigation Sets	2	4	120	170,361	0.00070
OTHER	10	Other specified	4	7	1,020	170,801	0.00597

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of Gasoline Consumed	Head of Cattle Farm Managed in 2007	Scaling Factor
BEEF	1	2-Wheel Tractors	10	19	1,399	370,438	0.00378
BEEF	2	Agricultural Tractors	60	206	18,305	368,438	0.04968
BEEF	3	Combines	1	1	500	371,138	0.00135
BEEF	4	Balers	2	4	600	221,053	0.00271
BEEF	5	Agricultural Mowers	9	13	2,825	362,518	0.00779
BEEF	6	Sprayers	30	35	993	369,643	0.00269
BEEF	7	Tillers > 6HP	10	13	2,330	371,218	0.00628
BEEF	8	Swathers	1	1	12	371,238	0.00003
BEEF	9	Irrigation Sets	5	7	800	371,228	0.00216
BEEF	10	Other Specified	9	24	4,795	369,298	0.01298

**Table B-3. LPG Scaling Factors by Quota Group and Equipment Type\***

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of LPG Consumed	Number of Acres Harvested in 2007	Scaling Factor
COTTON	1	2-Wheel Tractors	1	2	100	256,401	0.00039
COTTON	2	Agricultural Tractors	7	23	3,745	253,901	0.01475
COTTON	4	Balers	1	5	2,000	256,401	0.00780
COTTON	6	Sprayers	1	2	100	256,051	0.00039
COTTON	10	Other Specified	1	6	100	256,401	0.00039
HAY	1	2-Wheel Tractors	1	6	600	141,846	0.00423
HAY	2	Agricultural Tractors	11	34	3,435	141,470	0.02428
HAY	4	Balers	1	1	300	141,983	0.00211
HAY	5	Agricultural Mowers	1	2	75	141,981	0.00053
HAY	6	Sprayers	1	1	30	141,296	0.00021
HAY	8	Swathers	1	2	100	141,996	0.00070
HAY	9	Irrigation Sets	1	4	100	139,996	0.00071
WHEAT	1	2-Wheel Tractors	4	13	1,150	186,221	0.00618
WHEAT	2	Agricultural Tractors	9	21	2,122	186,921	0.01135
WHEAT	5	Agricultural Mowers	1	1	500	186,921	0.00267
OTHER	2	Agricultural Tractors	4	11	660	169,611	0.00389
OTHER	5	Agricultural Mowers	1	1	50	170,817	0.00029
OTHER	6	Sprayers	2	2	300	170,612	0.00176
OTHER	9	Irrigation Sets	1	1	2	164,417	0.00001
Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of Gasoline Consumed	Head of Cattle Farm Managed in 2007	Scaling Factor
BEEF	1	2-Wheel Tractors	5	10	2,900	371,138	0.00781
BEEF	2	Agricultural Tractors	15	51	3,432	369,923	0.00928
BEEF	4	Balers	2	4	330	370,718	0.00089
BEEF	5	Agricultural Mowers	3	5	1,250	371,163	0.00337
BEEF	6	Sprayers	4	4	1,515	371,238	0.00408
BEEF	7	Tillers > 6HP	1	2	30	371,238	0.00008
BEEF	9	Irrigation Sets	1	1	5	362,688	0.00001
BEEF	10	Other Specified			0	371,238	0.00000

\*All Other Quota Group/Equipment Types not listed did not report LPG use.

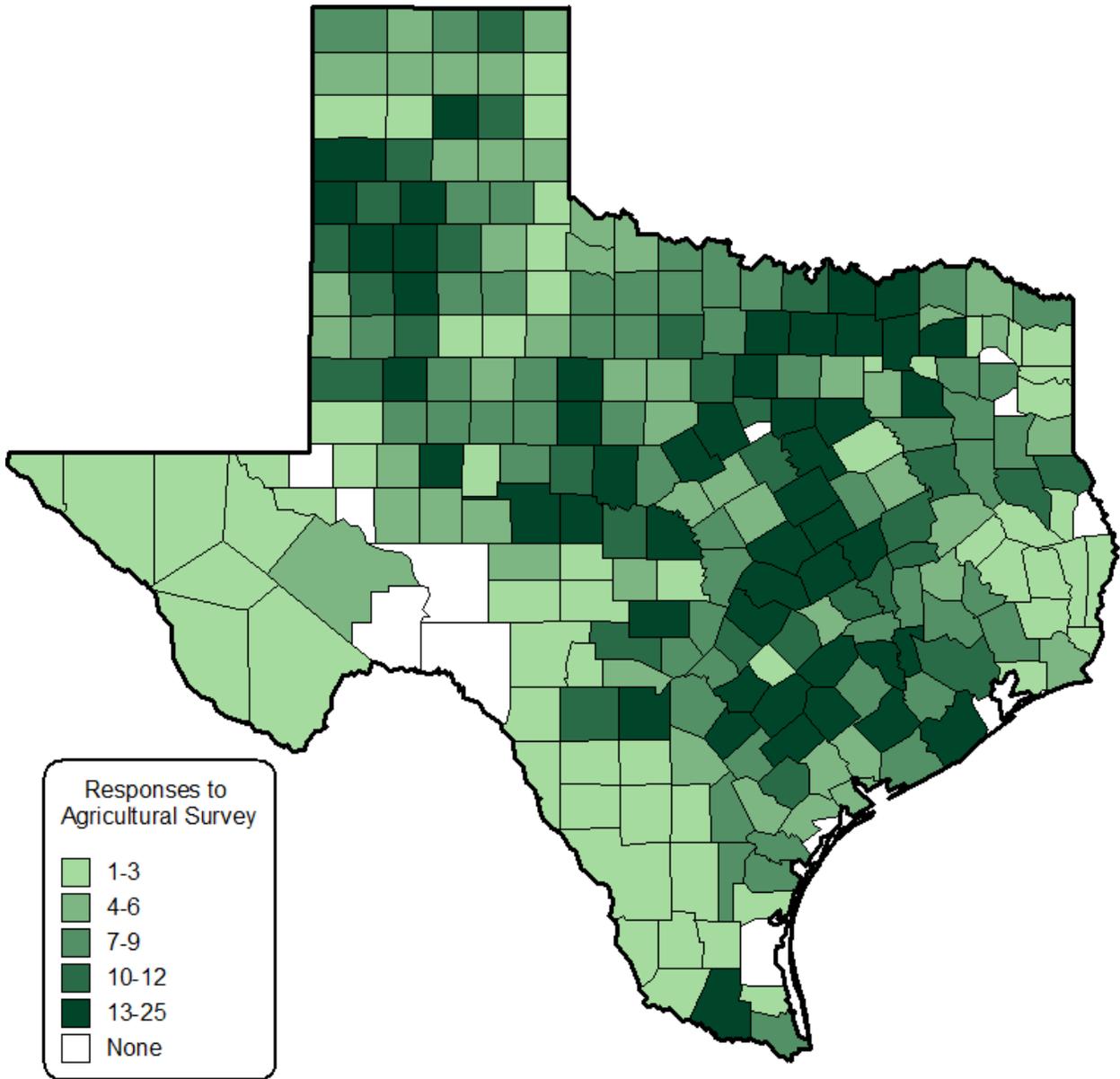
**Table B-4. CNG Scaling Factors by Quota Group and Equipment Type\***

Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of CNG Consumed	Number of Acres Harvested in 2007	Scaling Factor
COTTON	9	Irrigation Sets	3	18	3,100	245,911	0.0126062
WHEAT	2	Agricultural Tractors	1	2	2	186,921	1.07E-05
WHEAT	9	Irrigation Sets	2	12	4,400	171601	0.0256409
Quota Group Name	Equipment Label	Equipment Type	Number of Respondents	Number of Equipment Pieces	Gallons of CNG Consumed	Head of Cattle Farm Managed in 2007	Scaling Factor
BEEF	6	Sprayers	1	1	1,000	371,238	0.0026937
BEEF	10	Other specified	1	3	100	371,238	0.0002694

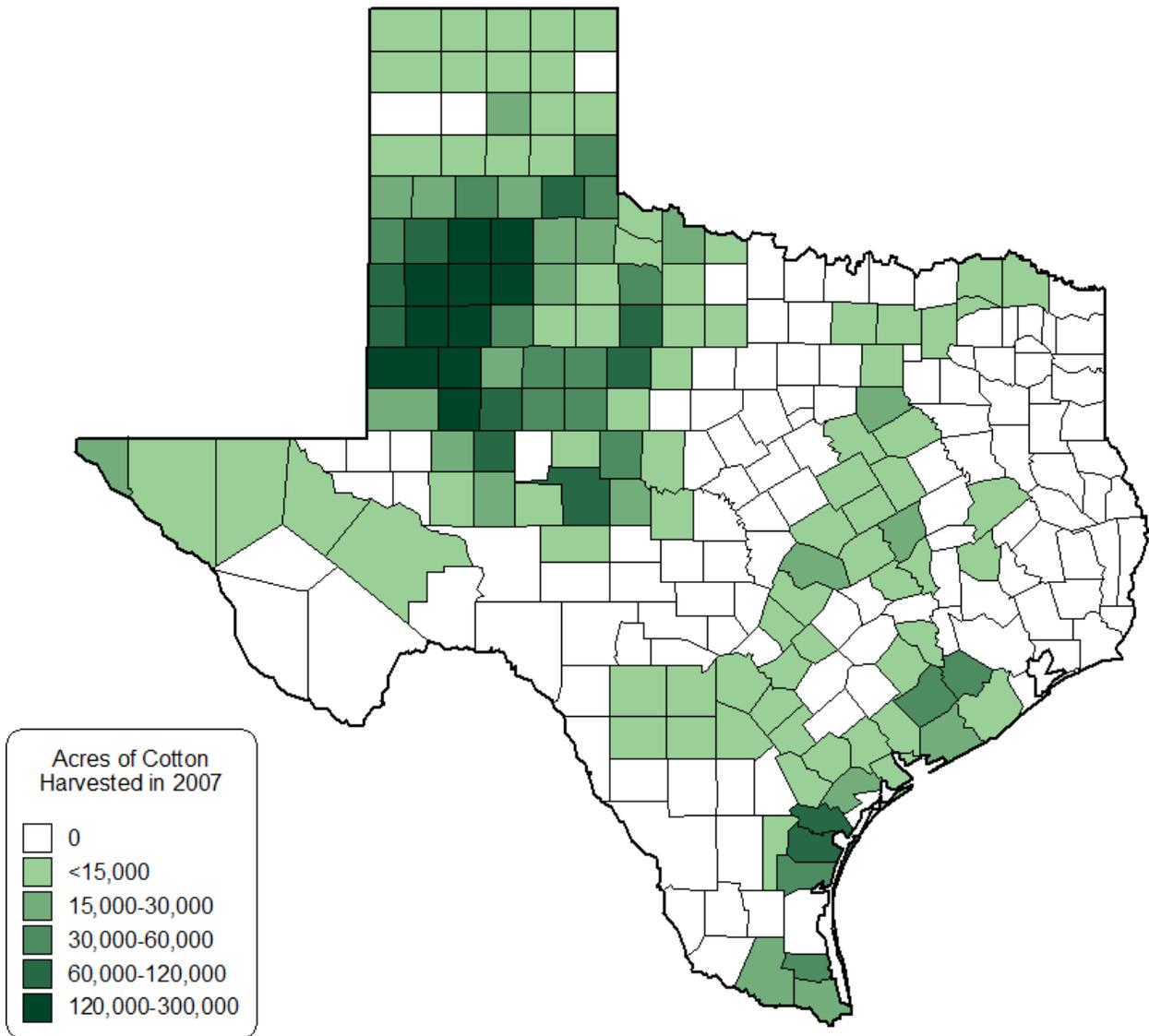
\*All Other Quota Group/Equipment Types not listed did not report CNG use.

**APPENDIX C. COUNTY-LEVEL DATA MAPS**

**Figure C-1. Number of Respondents by County for 2008 Texas Agricultural Equipment Survey**



**Figure C-2. Acres of Cotton Harvested by County, 2007**



**Figure C-3. Acres of Hay Harvested by County, 2007**

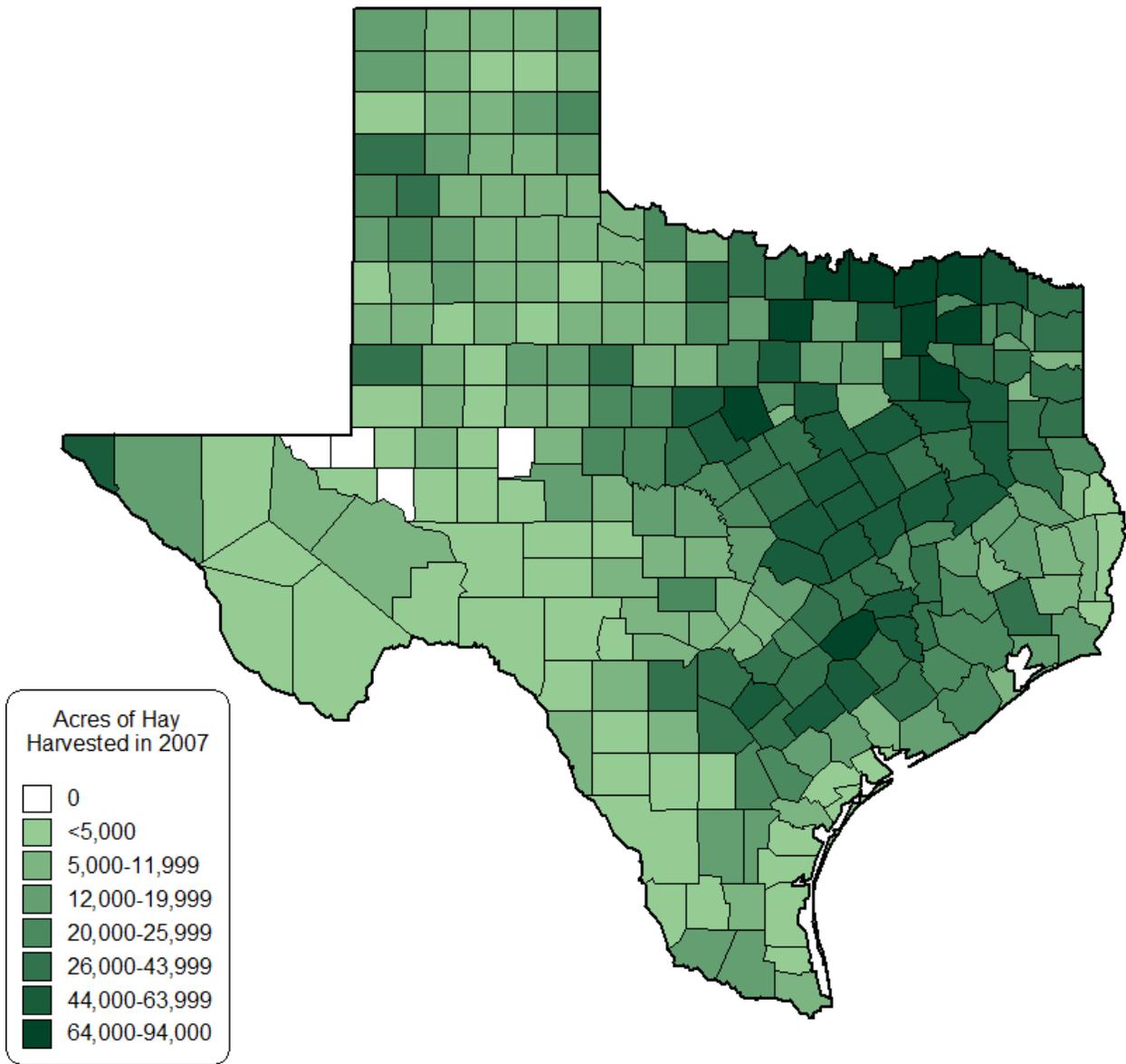


Figure C-4. Acres of Wheat Harvested by County, 2007

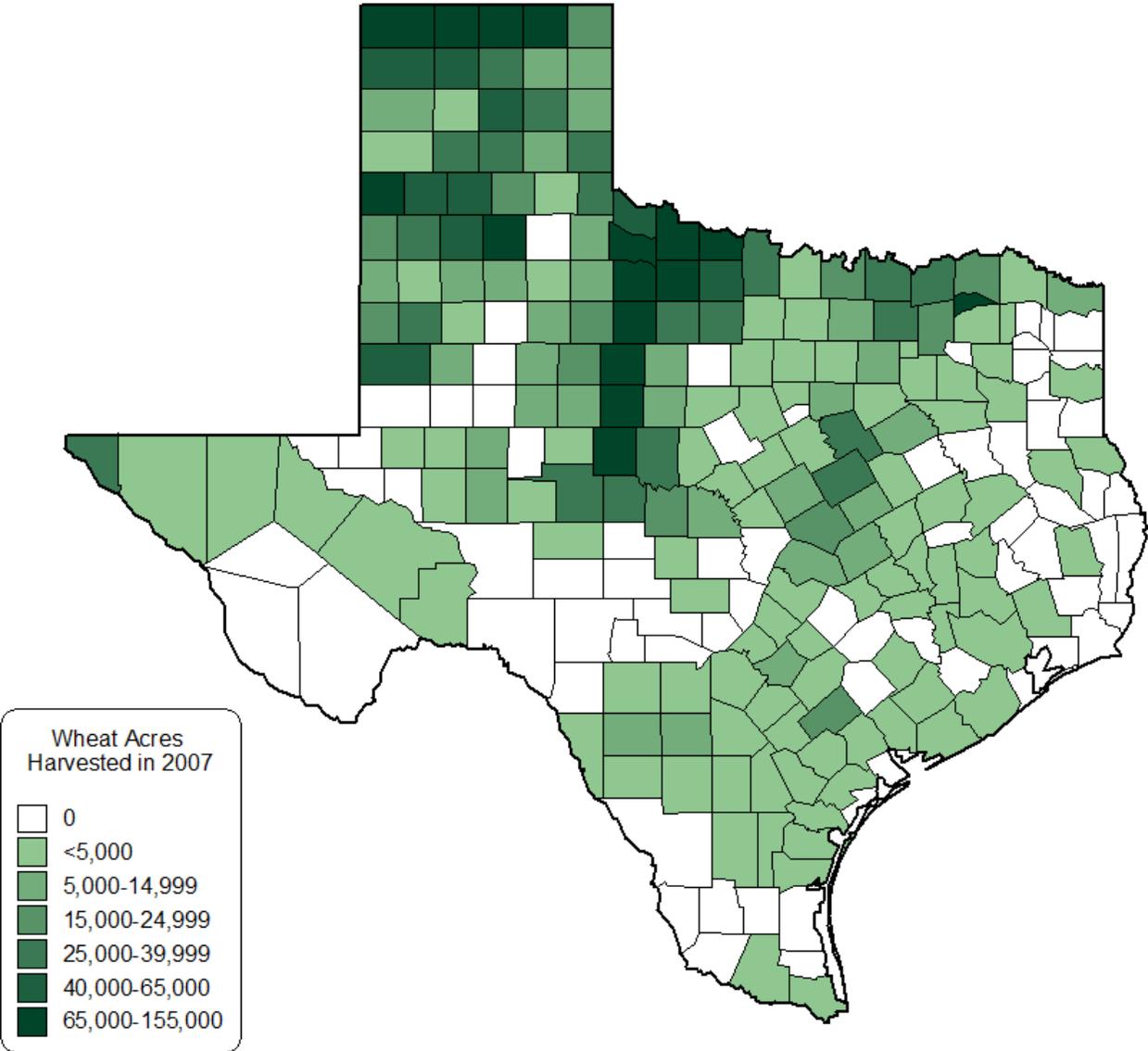


Figure C-5. Acres of Other Crops Harvested by County, 2007

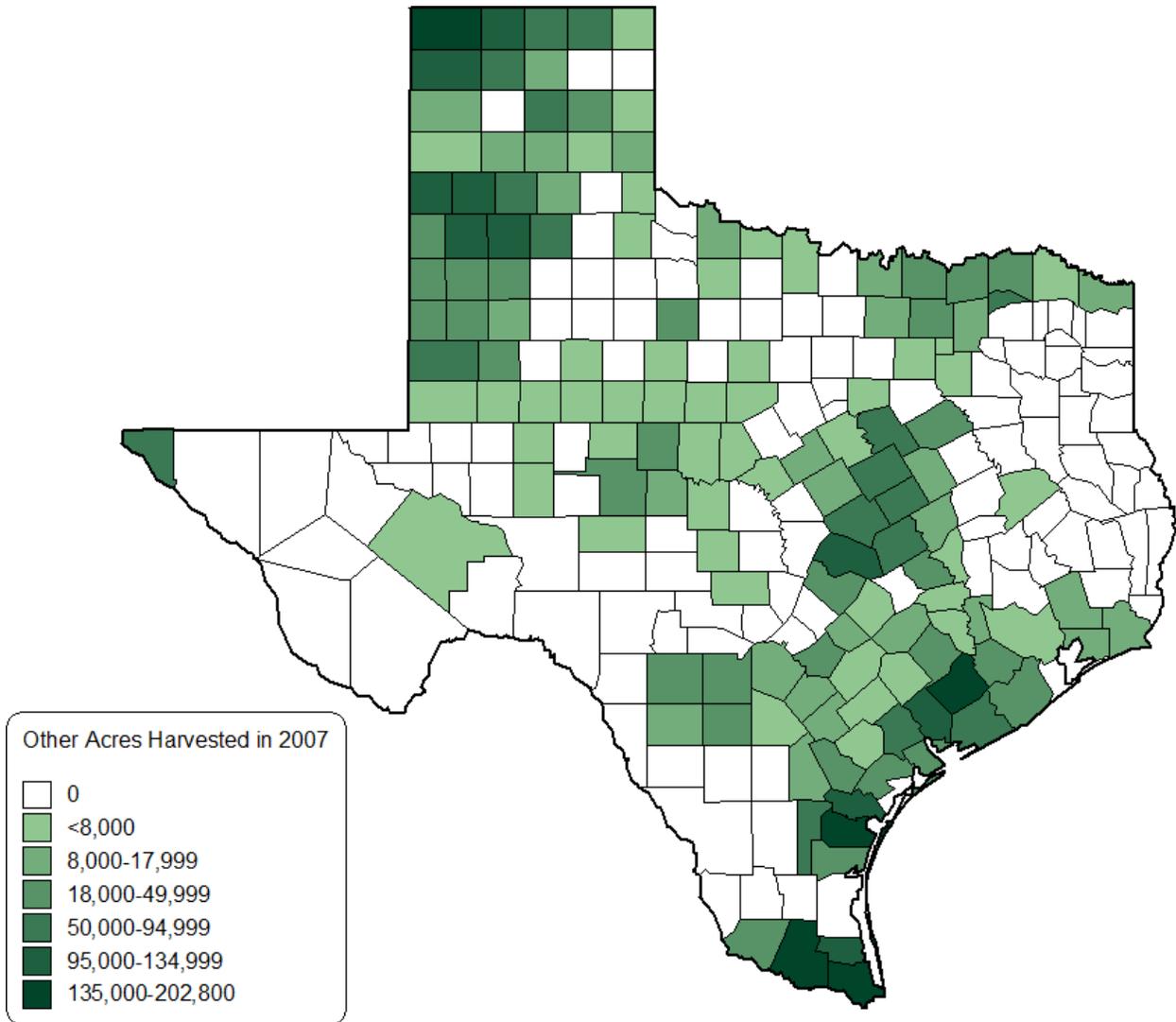
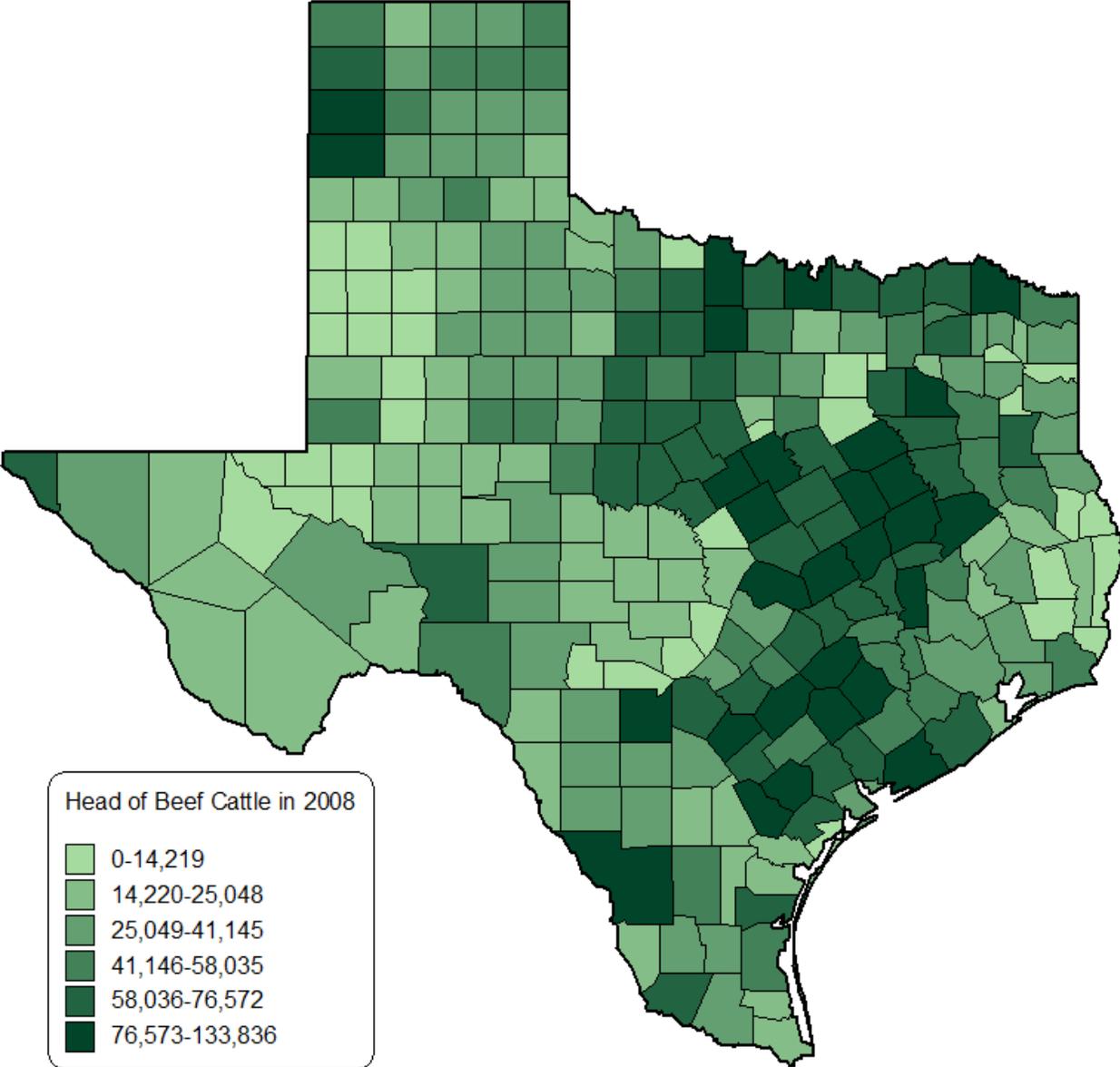
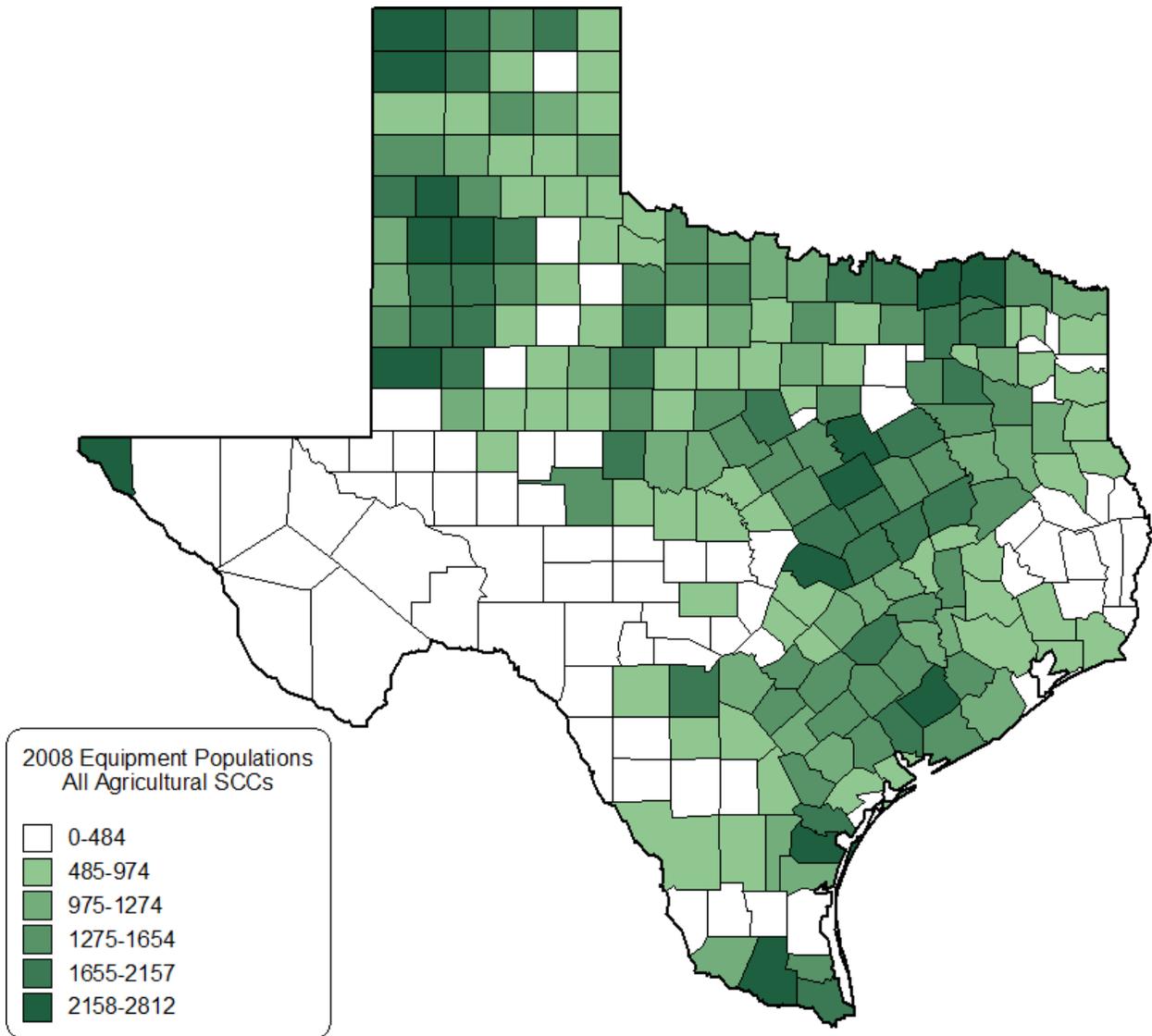


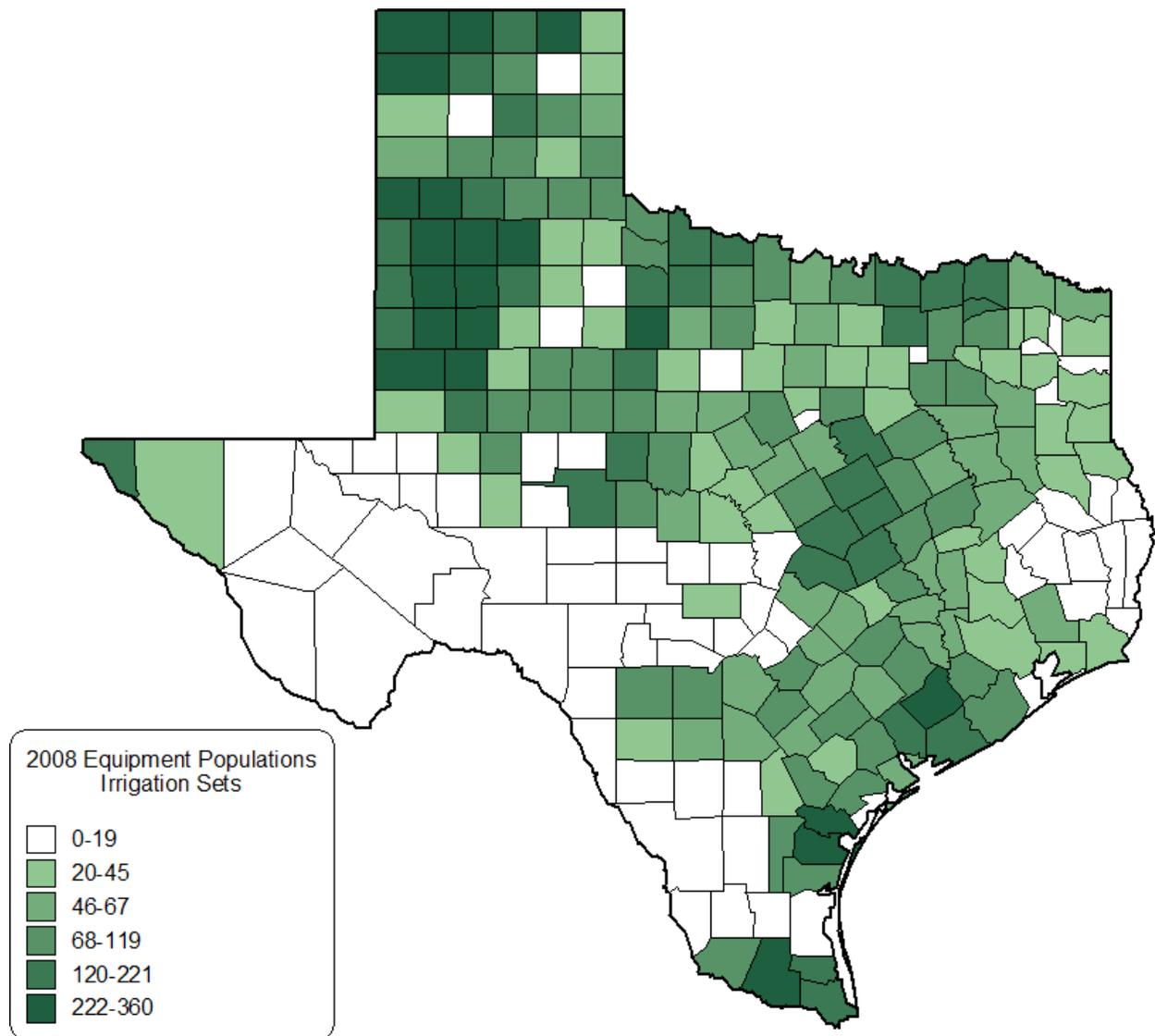
Figure C-6. Head of Beef Cattle by County, 2008



**Figure C-7. 2008 Equipment Populations by County,  
for All Agricultural Equipment Types**



**Figure C-8. 2008 Equipment Populations by County, for Irrigation Sets**



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## APPENDIX D. DETAILED EMISSIONS SUMMARIES

**Table D-1. Comparison of Annual 2008 Updated TexN to  
NONROAD2008 Emissions by SCC**

### 2008 NONROAD08 Run

SCC	EQUIP	Engine Type	VOC	NOx	CO	SO2	PM10-PRI
2260005035	Sprayers	2 Stroke	17.48	0.60	62.93	0.06	2.30
2265005010	2-Wheel Tractors	4 Stroke	7.03	2.54	230.70	0.15	0.09
2265005015	Agricultural Tractors	4 Stroke	18.84	22.25	501.38	0.65	0.30
2265005020	Combines	4 Stroke	0.24	0.24	3.48	0.00	0.00
2265005025	Balers	4 Stroke	26.66	22.70	333.76	0.43	0.17
2265005030	Agricultural Mowers	4 Stroke	7.33	2.28	218.85	0.13	0.07
2265005035	Sprayers	4 Stroke	129.02	39.00	2,305.71	1.43	1.00
2265005040	Tillers > 6 HP	4 Stroke	263.86	45.52	6,501.95	3.12	1.39
2265005045	Swathers	4 Stroke	35.89	35.96	528.66	0.68	0.27
2265005055	Other Agricultural Equipment	4 Stroke	47.72	43.11	1,005.18	0.98	0.44
2265005060	Irrigation Sets	4 Stroke	28.91	36.63	629.97	1.11	0.56
2267005055	Other Agricultural Equipment	LPG	0.15	0.56	2.47	0.00	0.00
2267005060	Irrigation Sets	LPG	0.06	0.23	1.38	0.00	0.00
2268005055	Other Agricultural Equipment	CNG	0.01	0.43	1.90	0.00	0.00
2268005060	Irrigation Sets	CNG	0.12	6.80	30.55	0.01	0.04
2270005010	2-Wheel Tractors	Diesel	0.08	0.46	0.57	0.01	0.07
2270005015	Agricultural Tractors	Diesel	2,392.92	23,980.96	12,688.60	485.44	2,281.93
2270005020	Combines	Diesel	215.67	2,498.51	947.97	43.58	249.99
2270005025	Balers	Diesel	1.97	11.77	8.18	0.24	1.55
2270005030	Agricultural Mowers	Diesel	0.33	2.37	1.91	0.05	0.34
2270005035	Sprayers	Diesel	26.94	189.05	99.33	3.69	19.97
2270005040	Tillers > 6 HP	Diesel	0.03	0.29	0.17	0.01	0.02
2270005045	Swathers	Diesel	20.45	180.89	105.75	3.42	22.78
2270005055	Other Agricultural Equipment	Diesel	54.00	504.99	260.82	9.49	51.64
2270005060	Irrigation Sets	Diesel	32.81	320.61	123.28	6.97	25.97
			17.48	0.60	62.93	0.06	2.30

### 2008 TexN Run

SCC	EQUIP	Engine Type	VOC	NOx	CO	SO2	PM10-PRI
2260005035	Sprayers	2 Stroke	5.96	0.16	28.14	0.00	0.88
2265005010	2-Wheel Tractors	4 Stroke	24.12	6.70	858.56	0.05	0.28
2265005015	Agricultural Tractors	4 Stroke	471.56	410.89	12,184.18	1.14	5.38
2265005020	Combines	4 Stroke	43.46	21.78	453.24	0.05	0.20
2265005025	Balers	4 Stroke	11.15	6.42	145.68	0.02	0.07
2265005030	Agricultural Mowers	4 Stroke	54.68	12.64	1,809.91	0.09	0.50
2265005035	Sprayers	4 Stroke	43.35	10.68	902.99	0.05	0.40
2265005040	Tillers > 6 HP	4 Stroke	2.78	0.38	71.52	0.00	0.01
2265005045	Swathers	4 Stroke	5.95	2.49	50.86	0.01	0.02
2265005055	Other Agricultural Equipment	4 Stroke	77.37	56.24	2,077.55	0.20	1.06
2265005060	Irrigation Sets	4 Stroke	480.10	346.04	9,783.75	4.54	26.63
2267005055	Other Agricultural Equipment	LPG	165.46	582.88	3,393.45	1.05	5.17
2267005060	Irrigation Sets	LPG	101.45	466.93	3,800.85	3.89	21.97
2268005055	Other Agricultural Equipment	CNG	0.87	50.48	233.70	0.05	0.27
2268005060	Irrigation Sets	CNG	16.27	1,077.92	10,439.07	6.63	39.60
2270005010	2-Wheel Tractors	Diesel	41.78	250.62	367.14	6.80	41.73
2270005015	Agricultural Tractors	Diesel	4,220.57	52,904.51	24,792.60	1,394.06	4,277.33
2270005020	Combines	Diesel	244.48	2,673.41	1,170.48	53.39	249.16
2270005025	Balers	Diesel	221.93	1,241.38	995.96	27.12	209.57
2270005030	Agricultural Mowers	Diesel	277.94	1,811.03	1,598.64	38.58	286.48
2270005035	Sprayers	Diesel	462.95	3,225.38	1,889.19	62.89	410.94
2270005040	Tillers > 6 HP	Diesel	115.88	1,133.72	742.69	21.28	112.00
2270005045	Swathers	Diesel	69.64	541.25	398.40	11.50	80.29
2270005055	Other Agricultural Equipment	Diesel	171.92	2,045.37	907.29	46.27	161.02
2270005060	Irrigation Sets	Diesel	334.73	3,718.96	1,467.13	88.94	284.20
			<b>7,666</b>	<b>72,598</b>	<b>80,563</b>	<b>1,769</b>	<b>6,215</b>

**Table D-1. Comparison of Annual 2008 Updated TexN to  
NONROAD2008 Emissions by SCC (Cont'd)**

<b>Percent Difference (Difference Divided by Default Value)</b>							
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>SO2</b>	<b>PM10-PRI</b>
2260005035	Sprayers	2 Stroke	-66%	-74%	-55%	-96%	-62%
2265005010	2-Wheel Tractors	4 Stroke	243%	164%	272%	-70%	223%
2265005015	Agricultural Tractors	4 Stroke	2403%	1746%	2330%	77%	1712%
2265005020	Combines	4 Stroke	18253%	9094%	12917%	1007%	11090%
2265005025	Balers	4 Stroke	-58%	-72%	-56%	-96%	-62%
2265005030	Agricultural Mowers	4 Stroke	646%	455%	727%	-34%	597%
2265005035	Sprayers	4 Stroke	-66%	-73%	-61%	-97%	-61%
2265005040	Tillers > 6 HP	4 Stroke	-99%	-99%	-99%	-100%	-99%
2265005045	Swathers	4 Stroke	-83%	-93%	-90%	-99%	-92%
2265005055	Other Agricultural Equipment	4 Stroke	62%	30%	107%	-79%	142%
2265005060	Irrigation Sets	4 Stroke	1561%	845%	1453%	309%	4688%
2267005055	Other Agricultural Equipment	LPG	107263%	103810%	137361%	151230%	165860%
2267005060	Irrigation Sets	LPG	157968%	207237%	274832%	893291%	1010623%
2268005055	Other Agricultural Equipment	CNG	11703%	11720%	12228%	12364%	12373%
2268005060	Irrigation Sets	CNG	13662%	15752%	34073%	108435%	112749%
2270005010	2-Wheel Tractors	Diesel	55023%	54442%	63921%	61909%	61752%
2270005015	Agricultural Tractors	Diesel	76%	121%	95%	187%	87%
2270005020	Combines	Diesel	13%	7%	23%	23%	0%
2270005025	Balers	Diesel	11181%	10443%	12082%	11053%	13383%
2270005030	Agricultural Mowers	Diesel	83883%	76464%	83698%	79315%	83861%
2270005035	Sprayers	Diesel	1619%	1606%	1802%	1602%	1958%
2270005040	Tillers > 6 HP	Diesel	410770%	392109%	432848%	382935%	470112%
2270005045	Swathers	Diesel	241%	199%	277%	236%	253%
2270005055	Other Agricultural Equipment	Diesel	218%	305%	248%	388%	212%
2270005060	Irrigation Sets	Diesel	920%	1060%	1090%	1176%	994%
			130%	160%	203%	215%	134%

**Table D-2. Comparison of OSD 2008 Updated TexN to  
NONROAD2008 Emissions by SCC**

**2008 NONROAD08 Run**

SCC	EQUIP	Engine Type	VOC	NOx	CO	SO2	PM10-PRI
2260005035	Sprayers	2 Stroke	0.07	0.00	0.27	0.00	0.01
2265005010	2-Wheel Tractors	4 Stroke	0.03	0.01	0.99	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	0.08	0.10	2.16	0.00	0.00
2265005020	Combines	4 Stroke	0.00	0.00	0.01	0.00	0.00
2265005025	Balers	4 Stroke	0.10	0.10	1.44	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.03	0.01	0.94	0.00	0.00
2265005035	Sprayers	4 Stroke	0.49	0.17	9.92	0.01	0.00
2265005040	Tillers > 6 HP	4 Stroke	1.04	0.20	27.98	0.01	0.01
2265005045	Swathers	4 Stroke	0.13	0.15	2.27	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.19	0.19	4.33	0.00	0.00
2265005060	Irrigation Sets	4 Stroke	0.12	0.16	2.71	0.00	0.00
2267005055	Other Agricultural Equipment	LPG	0.00	0.00	0.01	0.00	0.00
2267005060	Irrigation Sets	LPG	0.00	0.00	0.01	0.00	0.00
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.01	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.03	0.13	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	0.00	0.00	0.00	0.00	0.00
2270005015	Agricultural Tractors	Diesel	10.30	103.20	54.60	2.09	9.82
2270005020	Combines	Diesel	0.93	10.75	4.08	0.19	1.08
2270005025	Balers	Diesel	0.01	0.05	0.04	0.00	0.01
2270005030	Agricultural Mowers	Diesel	0.00	0.01	0.01	0.00	0.00
2270005035	Sprayers	Diesel	0.12	0.81	0.43	0.02	0.09
2270005040	Tillers > 6 HP	Diesel	0.00	0.00	0.00	0.00	0.00
2270005045	Swathers	Diesel	0.09	0.78	0.46	0.01	0.10
2270005055	Other Agricultural Equipment	Diesel	0.23	2.17	1.12	0.04	0.22
2270005060	Irrigation Sets	Diesel	0.14	1.38	0.53	0.03	0.11
			<b>14</b>	<b>120</b>	<b>114</b>	<b>2</b>	<b>11</b>

**2008 TexN Run**

SCC	EQUIP	Engine Type	VOC	NOx	CO	SO2	PM10-PRI
2260005035	Sprayers	2 Stroke	0.03	0.00	0.13	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.09	0.02	3.26	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	1.72	1.35	47.28	0.00	0.02
2265005020	Combines	4 Stroke	0.19	0.12	2.86	0.00	0.00
2265005025	Balers	4 Stroke	0.05	0.04	1.01	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.29	0.07	10.53	0.00	0.00
2265005035	Sprayers	4 Stroke	0.19	0.04	4.22	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.26	0.00	0.00
2265005045	Swathers	4 Stroke	0.02	0.01	0.29	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.24	0.15	6.60	0.00	0.00
2265005060	Irrigation Sets	4 Stroke	2.66	1.74	55.80	0.03	0.15
2267005055	Other Agricultural Equipment	LPG	0.51	1.79	10.39	0.00	0.02
2267005060	Irrigation Sets	LPG	0.56	2.58	21.00	0.02	0.12
2268005055	Other Agricultural Equipment	CNG	0.00	0.15	0.72	0.00	0.00
2268005060	Irrigation Sets	CNG	0.09	5.98	57.95	0.04	0.22
2270005010	2-Wheel Tractors	Diesel	0.15	0.86	1.35	0.02	0.15
2270005015	Agricultural Tractors	Diesel	15.83	187.09	92.98	5.22	16.04
2270005020	Combines	Diesel	1.51	15.91	7.23	0.33	1.54
2270005025	Balers	Diesel	1.51	8.16	6.79	0.18	1.43
2270005030	Agricultural Mowers	Diesel	1.58	9.82	9.07	0.22	1.63
2270005035	Sprayers	Diesel	2.11	13.97	8.60	0.29	1.87
2270005040	Tillers > 6 HP	Diesel	0.41	3.75	2.61	0.07	0.39
2270005045	Swathers	Diesel	0.38	2.85	2.19	0.06	0.44
2270005055	Other Agricultural Equipment	Diesel	0.53	5.89	2.78	0.14	0.49
2270005060	Irrigation Sets	Diesel	1.85	19.64	8.11	0.49	1.57
			<b>32</b>	<b>282</b>	<b>364</b>	<b>7</b>	<b>26</b>

**Table D-2. Comparison of OSD 2008 Updated TexN to  
NONROAD2008 Emissions by SCC (Cont'd)**

**Percent Difference (Difference Divided by Default Value)**

<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>SO2</b>	<b>PM10-PRI</b>
2260005035	Sprayers	2 Stroke	-62%	-72%	-53%	-96%	-60%
2265005010	2-Wheel Tractors	4 Stroke	206%	96%	228%	-74%	175%
2265005015	Agricultural Tractors	4 Stroke	2080%	1310%	2091%	60%	1478%
2265005020	Combines	4 Stroke	21436%	11979%	18967%	1527%	15919%
2265005025	Balers	4 Stroke	-43%	-58%	-29%	-94%	-39%
2265005030	Agricultural Mowers	4 Stroke	897%	570%	1018%	-10%	819%
2265005035	Sprayers	4 Stroke	-62%	-74%	-57%	-96%	-58%
2265005040	Tillers > 6 HP	4 Stroke	-99%	-99%	-99%	-100%	-99%
2265005045	Swathers	4 Stroke	-83%	-92%	-87%	-99%	-89%
2265005055	Other Agricultural Equipment	4 Stroke	26%	-19%	53%	-85%	72%
2265005060	Irrigation Sets	4 Stroke	2098%	1005%	1958%	439%	6092%
2267005055	Other Agricultural Equipment	LPG	76323%	73865%	97747%	107620%	118034%
2267005060	Irrigation Sets	LPG	202878%	266144%	352944%	1147118%	1297785%
2268005055	Other Agricultural Equipment	CNG	8305%	8317%	8678%	8775%	8782%
2268005060	Irrigation Sets	CNG	17652%	20348%	43981%	139904%	145468%
2270005010	2-Wheel Tractors	Diesel	46870%	43392%	54452%	52660%	52602%
2270005015	Agricultural Tractors	Diesel	54%	81%	70%	150%	63%
2270005020	Combines	Diesel	63%	48%	77%	75%	43%
2270005025	Balers	Diesel	17773%	16009%	19200%	17497%	21261%
2270005030	Agricultural Mowers	Diesel	110683%	96421%	110438%	104283%	110650%
2270005035	Sprayers	Diesel	1718%	1617%	1912%	1696%	2077%
2270005040	Tillers > 6 HP	Diesel	335104%	301696%	353116%	312013%	383511%
2270005045	Swathers	Diesel	336%	267%	382%	329%	351%
2270005055	Other Agricultural Equipment	Diesel	127%	171%	148%	247%	122%
2270005060	Irrigation Sets	Diesel	1211%	1324%	1429%	1533%	1306%
			131%	134%	218%	195%	128%

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy**

<b>2005</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	9.00	0.14	31.07	107.87	0.01	0.86	0.79	0.01
2265005010	2-Wheel Tractors	4 Stroke	24.28	6.94	885.26	2,292.43	0.11	0.28	0.26	0.04
2265005015	Agricultural Tractors	4 Stroke	537.89	511.40	14,071.30	58,780.36	2.85	5.24	4.82	18.03
2265005020	Combines	4 Stroke	38.97	24.42	480.36	2,484.32	0.14	0.19	0.18	0.90
2265005025	Balers	4 Stroke	10.69	7.51	158.81	777.70	0.04	0.06	0.06	0.30
2265005030	Agricultural Mowers	4 Stroke	58.53	14.04	2,048.84	4,396.40	0.23	0.52	0.48	0.06
2265005035	Sprayers	4 Stroke	47.82	12.63	1,051.57	2,480.74	0.14	0.36	0.33	0.31
2265005040	Tillers > 6 HP	4 Stroke	2.73	0.36	70.68	149.10	0.01	0.01	0.01	0.00
2265005045	Swathers	4 Stroke	5.21	2.80	53.90	287.00	0.02	0.02	0.02	0.11
2265005055	Other Agricultural Equipment	4 Stroke	99.67	82.96	2,633.19	10,673.16	0.46	1.02	0.94	3.41
2265005060	Irrigation Sets	4 Stroke	1,185.63	1,043.77	30,486.13	224,723.48	15.07	24.64	22.67	137.59
2267005055	Other Agricultural Equipment	LPG	250.62	899.94	4,311.99	57,985.56	1.13	5.17	5.17	44.94
2267005060	Irrigation Sets	LPG	509.53	1,681.24	16,960.60	205,189.43	3.99	21.97	21.97	246.03
2268005055	Other Agricultural Equipment	CNG	1.49	88.35	387.99	3,705.26	0.08	0.45	0.45	90.87
2268005060	Irrigation Sets	CNG	143.76	7,995.20	75,971.99	722,504.70	15.94	97.64	97.64	4,371.57
2270005010	2-Wheel Tractors	Diesel	52.44	301.10	381.47	32,277.44	38.61	46.53	45.13	1.48
2270005015	Agricultural Tractors	Diesel	4,961.53	62,235.36	26,745.11	6,679,563.06	7,957.70	5,177.01	5,021.70	552.51
2270005020	Combines	Diesel	272.55	3,034.15	1,292.25	255,935.70	349.48	311.93	302.57	47.19
2270005025	Balers	Diesel	254.28	1,311.63	1,017.92	123,219.95	185.58	247.89	240.45	28.66
2270005030	Agricultural Mowers	Diesel	308.44	1,978.21	1,615.52	176,750.30	248.65	330.89	320.96	33.77
2270005035	Sprayers	Diesel	554.02	3,482.96	2,054.04	299,572.65	467.20	519.92	504.32	70.52
2270005040	Tillers > 6 HP	Diesel	131.16	1,237.72	823.18	103,160.41	123.82	134.55	130.51	19.49
2270005045	Swathers	Diesel	74.02	598.22	384.16	52,522.26	78.99	97.83	94.89	10.81
2270005055	Other Agricultural Equipment	Diesel	208.04	2,396.66	1,052.35	230,202.93	243.43	199.85	193.85	25.87
2270005060	Irrigation Sets	Diesel	385.43	4,305.63	1,459.50	452,950.90	681.75	359.11	348.33	37.77
			<b>10,128</b>	<b>93,253</b>	<b>186,429</b>	<b>9,702,693</b>	<b>10,415</b>	<b>7,584</b>	<b>7,359</b>	<b>5,742</b>

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy (Cont'd)**

<b>2008</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	5.96	0.16	28.14	114.81	0.00	0.88	0.81	0.02
2265005010	2-Wheel Tractors	4 Stroke	24.12	6.70	858.56	2,370.82	0.05	0.28	0.26	0.04
2265005015	Agricultural Tractors	4 Stroke	471.56	410.89	12,184.18	59,069.63	1.14	5.38	4.95	45.18
2265005020	Combines	4 Stroke	43.46	21.78	453.24	2,535.86	0.05	0.20	0.19	2.26
2265005025	Balers	4 Stroke	11.15	6.42	145.68	788.55	0.02	0.07	0.06	0.76
2265005030	Agricultural Mowers	4 Stroke	54.68	12.64	1,809.91	4,419.19	0.09	0.50	0.46	0.07
2265005035	Sprayers	4 Stroke	43.35	10.68	902.99	2,522.53	0.05	0.40	0.36	0.73
2265005040	Tillers > 6 HP	4 Stroke	2.78	0.38	71.52	152.14	0.00	0.01	0.01	0.00
2265005045	Swathers	4 Stroke	5.95	2.49	50.86	292.96	0.01	0.02	0.02	0.27
2265005055	Other Agricultural Equipment	4 Stroke	77.37	56.24	2,077.55	10,566.66	0.20	1.06	0.98	8.53
2265005060	Irrigation Sets	4 Stroke	480.10	346.04	9,783.75	230,483.41	4.54	26.63	24.50	235.40
2267005055	Other Agricultural Equipment	LPG	165.46	582.88	3,393.45	54,012.07	1.05	5.17	5.17	109.06
2267005060	Irrigation Sets	LPG	101.45	466.93	3,800.85	200,020.70	3.89	21.97	21.97	403.10
2268005055	Other Agricultural Equipment	CNG	0.87	50.48	233.70	2,153.50	0.05	0.27	0.27	50.96
2268005060	Irrigation Sets	CNG	16.27	1,077.92	10,439.07	299,639.89	6.63	39.60	39.60	731.36
2270005010	2-Wheel Tractors	Diesel	41.78	250.62	367.14	34,498.10	6.80	41.73	40.48	1.63
2270005015	Agricultural Tractors	Diesel	4,220.57	52,904.51	24,792.60	7,133,663.55	1,394.06	4,277.33	4,149.01	581.78
2270005020	Combines	Diesel	244.48	2,673.41	1,170.48	273,350.88	53.39	249.16	241.69	49.96
2270005025	Balers	Diesel	221.93	1,241.38	995.96	131,685.00	27.12	209.57	203.28	30.44
2270005030	Agricultural Mowers	Diesel	277.94	1,811.03	1,598.64	188,834.44	38.58	286.48	277.89	35.83
2270005035	Sprayers	Diesel	462.95	3,225.38	1,889.19	320,177.15	62.89	410.94	398.61	74.95
2270005040	Tillers > 6 HP	Diesel	115.88	1,133.72	742.69	110,195.99	21.28	112.00	108.64	20.83
2270005045	Swathers	Diesel	69.64	541.25	398.40	56,095.67	11.50	80.29	77.88	11.46
2270005055	Other Agricultural Equipment	Diesel	171.92	2,045.37	907.29	245,891.96	46.27	161.02	156.19	27.30
2270005060	Irrigation Sets	Diesel	334.73	3,718.96	1,467.13	483,755.34	88.94	284.20	275.67	39.45
			<b>7,666</b>	<b>72,598</b>	<b>80,563</b>	<b>9,847,291</b>	<b>1,769</b>	<b>6,215</b>	<b>6,029</b>	<b>2,461</b>

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy (Cont'd)**

<b>2011</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	5.85	0.16	29.41	119.98	0.00	0.92	0.84	0.02
2265005010	2-Wheel Tractors	4 Stroke	21.19	5.61	862.66	2,478.37	0.05	0.29	0.27	0.04
2265005015	Agricultural Tractors	4 Stroke	373.81	324.90	10,355.16	59,702.90	1.22	5.62	5.17	73.96
2265005020	Combines	4 Stroke	34.13	19.97	409.54	2,586.71	0.05	0.21	0.19	3.73
2265005025	Balers	4 Stroke	8.59	5.59	125.77	799.35	0.02	0.07	0.06	1.26
2265005030	Agricultural Mowers	4 Stroke	47.44	11.71	1,678.19	4,538.07	0.09	0.50	0.46	0.07
2265005035	Sprayers	4 Stroke	31.91	9.17	725.85	2,598.85	0.05	0.45	0.41	1.19
2265005040	Tillers > 6 HP	4 Stroke	2.57	0.40	70.55	155.14	0.00	0.01	0.01	0.00
2265005045	Swathers	4 Stroke	4.57	2.28	45.83	298.83	0.01	0.02	0.02	0.44
2265005055	Other Agricultural Equipment	4 Stroke	49.87	31.62	1,541.06	10,566.09	0.21	1.11	1.02	13.84
2265005060	Irrigation Sets	4 Stroke	428.21	294.23	7,944.24	241,032.84	4.68	27.83	25.61	246.01
2267005055	Other Agricultural Equipment	LPG	77.38	280.39	2,081.99	50,636.39	0.98	5.17	5.17	170.92
2267005060	Irrigation Sets	LPG	54.82	346.03	1,837.18	200,161.07	3.89	21.97	21.97	403.10
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	37.54	248.51	309.16	36,703.98	0.34	28.21	27.36	1.83
2270005015	Agricultural Tractors	Diesel	3,585.74	44,597.64	23,091.13	7,588,483.06	68.42	3,791.32	3,677.58	606.99
2270005020	Combines	Diesel	212.31	2,340.83	1,014.98	290,818.45	2.64	211.36	205.02	52.59
2270005025	Balers	Diesel	185.17	1,176.57	956.29	140,182.55	1.29	180.09	174.69	32.38
2270005030	Agricultural Mowers	Diesel	243.92	1,686.42	1,591.13	200,956.95	1.85	266.36	258.37	38.09
2270005035	Sprayers	Diesel	377.82	2,986.32	1,699.90	340,811.19	3.10	335.90	325.82	79.14
2270005040	Tillers > 6 HP	Diesel	100.10	1,041.26	644.22	117,249.28	1.06	93.52	90.72	21.91
2270005045	Swathers	Diesel	62.61	501.68	400.85	59,685.23	0.55	73.59	71.39	12.17
2270005055	Other Agricultural Equipment	Diesel	144.64	1,744.85	816.11	261,590.72	2.36	142.25	137.98	28.53
2270005060	Irrigation Sets	Diesel	268.25	3,089.22	1,530.19	514,677.63	4.70	257.70	249.97	41.69
			<b>6,358</b>	<b>60,745</b>	<b>59,761</b>	<b>10,126,834</b>	<b>98</b>	<b>5,444</b>	<b>5,280</b>	<b>1,830</b>

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy (Cont'd)**

<b>2014</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	6.06	0.17	30.67	125.11	0.00	0.96	0.88	0.02
2265005010	2-Wheel Tractors	4 Stroke	16.90	3.82	856.27	2,588.38	0.05	0.30	0.28	0.04
2265005015	Agricultural Tractors	4 Stroke	274.85	228.34	8,481.99	60,472.02	1.17	5.86	5.39	104.04
2265005020	Combines	4 Stroke	30.71	17.67	366.13	2,635.87	0.05	0.22	0.20	5.30
2265005025	Balers	4 Stroke	7.25	4.62	105.46	809.94	0.02	0.07	0.07	1.79
2265005030	Agricultural Mowers	4 Stroke	39.63	9.03	1,627.55	4,708.15	0.09	0.51	0.47	0.08
2265005035	Sprayers	4 Stroke	21.84	6.81	664.14	2,697.26	0.05	0.40	0.37	1.88
2265005040	Tillers > 6 HP	4 Stroke	2.40	0.39	69.11	158.03	0.00	0.01	0.01	0.00
2265005045	Swathers	4 Stroke	4.12	2.02	40.87	304.50	0.01	0.02	0.02	0.62
2265005055	Other Agricultural Equipment	4 Stroke	33.31	18.66	1,262.30	10,890.31	0.21	1.14	1.05	18.30
2265005060	Irrigation Sets	4 Stroke	327.26	300.36	7,953.15	251,654.96	4.96	28.01	25.77	257.45
2267005055	Other Agricultural Equipment	LPG	32.55	143.49	941.15	49,664.07	0.96	5.17	5.17	217.43
2267005060	Irrigation Sets	LPG	54.82	346.03	1,837.18	200,161.07	3.89	21.97	21.97	403.10
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	38.64	264.07	298.34	38,904.88	0.36	23.73	23.02	1.98
2270005015	Agricultural Tractors	Diesel	2,898.58	33,821.86	16,389.96	8,045,548.96	65.23	2,738.87	2,656.70	604.35
2270005020	Combines	Diesel	179.44	1,959.55	787.68	308,368.22	2.65	166.86	161.86	53.83
2270005025	Balers	Diesel	158.67	1,098.87	855.35	148,688.50	1.32	155.22	150.56	33.90
2270005030	Agricultural Mowers	Diesel	209.74	1,511.35	1,404.15	213,135.35	1.87	230.16	223.26	39.26
2270005035	Sprayers	Diesel	317.26	2,670.87	1,428.02	361,466.40	3.15	277.89	269.55	81.81
2270005040	Tillers > 6 HP	Diesel	85.93	935.19	535.38	124,330.12	1.08	76.46	74.16	22.63
2270005045	Swathers	Diesel	54.04	446.67	352.44	63,295.86	0.56	62.33	60.46	12.58
2270005055	Other Agricultural Equipment	Diesel	119.68	1,374.50	628.51	277,354.45	2.32	108.87	105.60	28.67
2270005060	Irrigation Sets	Diesel	201.87	2,210.04	1,088.89	545,740.18	4.43	181.21	175.77	41.16
			<b>5,116</b>	<b>47,374</b>	<b>48,005</b>	<b>10,713,703</b>	<b>94</b>	<b>4,086</b>	<b>3,963</b>	<b>1,930</b>

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy (Cont'd)**

<b>2018</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	6.39	0.18	32.34	131.96	0.00	1.01	0.93	0.03
2265005010	2-Wheel Tractors	4 Stroke	17.15	3.69	896.00	2,730.52	0.05	0.32	0.30	0.05
2265005015	Agricultural Tractors	4 Stroke	184.40	133.79	6,539.77	62,031.09	1.20	6.18	5.69	144.01
2265005020	Combines	4 Stroke	25.56	14.56	305.18	2,700.83	0.05	0.23	0.21	7.54
2265005025	Balers	4 Stroke	5.33	3.35	76.99	824.69	0.02	0.08	0.07	2.55
2265005030	Agricultural Mowers	4 Stroke	34.18	6.97	1,638.76	4,959.74	0.10	0.53	0.49	0.10
2265005035	Sprayers	4 Stroke	17.92	4.80	639.30	2,816.32	0.06	0.41	0.38	2.69
2265005040	Tillers > 6 HP	4 Stroke	2.14	0.38	66.59	161.95	0.00	0.01	0.01	0.00
2265005045	Swathers	4 Stroke	3.43	1.66	33.96	311.99	0.01	0.03	0.02	0.89
2265005055	Other Agricultural Equipment	4 Stroke	29.40	14.41	1,204.96	11,427.84	0.22	1.21	1.11	23.36
2265005060	Irrigation Sets	4 Stroke	344.31	316.46	8,380.42	265,422.65	5.23	29.54	27.18	271.55
2267005055	Other Agricultural Equipment	LPG	14.80	89.44	519.12	49,244.09	0.96	5.17	5.17	264.57
2267005060	Irrigation Sets	LPG	54.82	346.03	1,837.18	200,161.07	3.89	21.97	21.97	403.10
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	41.49	284.14	318.44	41,828.22	0.38	25.53	24.76	2.13
2270005015	Agricultural Tractors	Diesel	2,443.99	19,866.68	7,809.74	8,652,029.25	61.31	1,152.86	1,118.27	666.52
2270005020	Combines	Diesel	151.40	1,440.95	596.99	331,660.38	2.66	120.79	117.17	58.08
2270005025	Balers	Diesel	127.34	970.01	700.81	159,988.59	1.34	123.01	119.32	36.56
2270005030	Agricultural Mowers	Diesel	165.56	1,215.71	1,146.76	229,327.20	1.90	180.00	174.60	42.36
2270005035	Sprayers	Diesel	251.13	2,142.70	1,073.71	388,892.13	3.20	211.33	204.99	88.24
2270005040	Tillers > 6 HP	Diesel	71.63	762.58	417.42	133,733.15	1.10	59.10	57.32	24.47
2270005045	Swathers	Diesel	42.78	358.27	283.16	68,097.03	0.56	47.17	45.76	13.56
2270005055	Other Agricultural Equipment	Diesel	97.77	877.48	404.97	298,284.54	2.25	69.21	67.14	31.25
2270005060	Irrigation Sets	Diesel	161.70	1,134.73	472.04	586,906.90	4.11	67.03	65.02	45.36
			<b>4,295</b>	<b>29,989</b>	<b>35,395</b>	<b>11,493,672</b>	<b>91</b>	<b>2,123</b>	<b>2,058</b>	<b>2,129</b>

**Table D-3. Statewide Annual Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpy (Cont'd)**

<b>2025</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	6.97	0.20	35.28	143.93	0.00	1.10	1.01	0.03
2265005010	2-Wheel Tractors	4 Stroke	18.71	4.03	977.34	2,978.36	0.06	0.35	0.32	0.05
2265005015	Agricultural Tractors	4 Stroke	147.27	89.44	5,779.58	66,883.00	1.29	6.74	6.20	203.33
2265005020	Combines	4 Stroke	16.42	9.16	193.74	2,816.61	0.06	0.25	0.23	11.86
2265005025	Balers	4 Stroke	2.53	1.68	36.18	864.55	0.02	0.08	0.08	3.94
2265005030	Agricultural Mowers	4 Stroke	34.75	6.74	1,764.35	5,410.19	0.11	0.58	0.54	0.11
2265005035	Sprayers	4 Stroke	17.41	4.01	666.91	3,058.03	0.06	0.45	0.41	3.86
2265005040	Tillers > 6 HP	4 Stroke	1.75	0.33	62.04	169.92	0.00	0.02	0.01	0.00
2265005045	Swathers	4 Stroke	2.20	1.04	21.48	325.34	0.01	0.03	0.03	1.40
2265005055	Other Agricultural Equipment	4 Stroke	31.50	15.13	1,298.13	12,464.03	0.24	1.32	1.21	26.19
2265005060	Irrigation Sets	4 Stroke	375.57	345.19	9,141.31	289,514.05	5.70	32.23	29.65	296.23
2267005055	Other Agricultural Equipment	LPG	12.36	82.86	426.94	49,236.15	0.96	5.17	5.17	272.14
2267005060	Irrigation Sets	LPG	54.82	346.03	1,837.18	200,161.07	3.89	21.97	21.97	403.10
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	46.56	318.86	357.39	46,939.38	0.43	28.70	27.84	2.39
2270005015	Agricultural Tractors	Diesel	2,520.66	11,882.72	3,770.17	9,709,896.44	64.42	343.22	332.92	800.31
2270005020	Combines	Diesel	117.85	722.05	314.18	372,340.16	2.67	59.47	57.68	65.78
2270005025	Balers	Diesel	86.62	767.41	469.41	179,704.90	1.37	73.31	71.11	41.20
2270005030	Agricultural Mowers	Diesel	111.79	746.50	766.88	257,568.47	1.94	104.69	101.55	47.80
2270005035	Sprayers	Diesel	181.13	1,347.14	670.45	436,709.82	3.28	121.41	117.76	99.50
2270005040	Tillers > 6 HP	Diesel	57.32	491.90	262.82	150,142.52	1.14	36.37	35.28	27.71
2270005045	Swathers	Diesel	30.28	227.13	186.90	76,470.47	0.57	26.33	25.54	15.29
2270005055	Other Agricultural Equipment	Diesel	89.59	381.18	162.18	334,791.63	2.26	19.93	19.34	36.44
2270005060	Irrigation Sets	Diesel	166.15	616.78	221.23	658,667.75	4.35	18.26	17.71	54.53
			<b>4,130</b>	<b>18,408</b>	<b>29,422</b>	<b>12,857,257</b>	<b>95</b>	<b>902</b>	<b>874</b>	<b>2,413</b>

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd**

<b>2005</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	0.04	0.00	0.14	0.49	0.00	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.09	0.02	3.34	8.40	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	1.95	1.69	54.18	220.24	0.01	0.02	0.02	0.04
2265005020	Combines	4 Stroke	0.18	0.14	3.01	15.30	0.00	0.00	0.00	0.00
2265005025	Balers	4 Stroke	0.06	0.05	1.10	5.31	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.31	0.07	11.86	24.96	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.21	0.05	4.89	11.28	0.00	0.00	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.25	0.52	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.02	0.01	0.30	1.58	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.30	0.22	8.29	32.69	0.00	0.00	0.00	0.01
2265005060	Irrigation Sets	4 Stroke	6.46	5.24	173.43	1,250.65	0.10	0.14	0.13	0.30
2267005055	Other Agricultural Equipment	LPG	0.77	2.76	13.21	177.62	0.00	0.02	0.02	0.11
2267005060	Irrigation Sets	LPG	2.82	9.29	93.72	1,133.84	0.02	0.12	0.12	0.54
2268005055	Other Agricultural Equipment	CNG	0.00	0.27	1.19	11.35	0.00	0.00	0.00	0.28
2268005060	Irrigation Sets	CNG	0.80	44.38	421.71	4,010.54	0.09	0.54	0.54	20.62
2270005010	2-Wheel Tractors	Diesel	0.19	1.03	1.40	118.35	0.22	0.18	0.17	0.00
2270005015	Agricultural Tractors	Diesel	18.61	220.36	100.30	25,049.96	45.92	20.71	20.09	1.11
2270005020	Combines	Diesel	1.68	18.09	7.98	1,581.02	2.90	1.99	1.93	0.03
2270005025	Balers	Diesel	1.73	8.63	6.94	840.08	1.52	1.71	1.66	0.01
2270005030	Agricultural Mowers	Diesel	1.75	10.74	9.17	1,003.31	1.83	1.91	1.85	0.03
2270005035	Sprayers	Diesel	2.52	15.10	9.35	1,363.99	2.50	2.40	2.33	0.07
2270005040	Tillers > 6 HP	Diesel	0.46	4.11	2.89	362.17	0.66	0.49	0.48	0.04
2270005045	Swathers	Diesel	0.41	3.16	2.12	289.29	0.52	0.55	0.53	0.01
2270005055	Other Agricultural Equipment	Diesel	0.64	6.92	3.22	705.24	1.31	0.66	0.64	0.06
2270005060	Irrigation Sets	Diesel	2.13	22.78	8.07	2,504.78	4.62	2.05	1.99	0.04
			<b>44</b>	<b>375</b>	<b>942</b>	<b>40,723</b>	<b>62</b>	<b>33</b>	<b>33</b>	<b>23</b>

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd (Cont'd)**

<b>2008</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	0.03	0.00	0.13	0.52	0.00	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.09	0.02	3.26	8.68	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	1.72	1.35	47.28	221.33	0.00	0.02	0.02	0.10
2265005020	Combines	4 Stroke	0.19	0.12	2.86	15.62	0.00	0.00	0.00	0.00
2265005025	Balers	4 Stroke	0.05	0.04	1.01	5.38	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.29	0.07	10.53	25.09	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.19	0.04	4.22	11.47	0.00	0.00	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.26	0.53	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.02	0.01	0.29	1.61	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.24	0.15	6.60	32.36	0.00	0.00	0.00	0.02
2265005060	Irrigation Sets	4 Stroke	2.66	1.74	55.80	1,282.71	0.03	0.15	0.14	0.42
2267005055	Other Agricultural Equipment	LPG	0.51	1.79	10.39	165.45	0.00	0.02	0.02	0.27
2267005060	Irrigation Sets	LPG	0.56	2.58	21.00	1,105.28	0.02	0.12	0.12	0.72
2268005055	Other Agricultural Equipment	CNG	0.00	0.15	0.72	6.60	0.00	0.00	0.00	0.16
2268005060	Irrigation Sets	CNG	0.09	5.98	57.95	1,663.27	0.04	0.22	0.22	1.33
2270005010	2-Wheel Tractors	Diesel	0.15	0.86	1.35	126.49	0.02	0.15	0.15	0.00
2270005015	Agricultural Tractors	Diesel	15.83	187.09	92.98	26,752.94	5.22	16.04	15.56	1.17
2270005020	Combines	Diesel	1.51	15.91	7.23	1,688.60	0.33	1.54	1.49	0.04
2270005025	Balers	Diesel	1.51	8.16	6.79	897.80	0.18	1.43	1.39	0.02
2270005030	Agricultural Mowers	Diesel	1.58	9.82	9.07	1,071.90	0.22	1.63	1.58	0.03
2270005035	Sprayers	Diesel	2.11	13.97	8.60	1,457.81	0.29	1.87	1.81	0.08
2270005040	Tillers > 6 HP	Diesel	0.41	3.75	2.61	386.87	0.07	0.39	0.38	0.04
2270005045	Swathers	Diesel	0.38	2.85	2.19	308.97	0.06	0.44	0.43	0.01
2270005055	Other Agricultural Equipment	Diesel	0.53	5.89	2.78	753.30	0.14	0.49	0.48	0.06
2270005060	Irrigation Sets	Diesel	1.85	19.64	8.11	2,675.13	0.49	1.57	1.52	0.05
			<b>32</b>	<b>282</b>	<b>364</b>	<b>40,666</b>	<b>7</b>	<b>26</b>	<b>25</b>	<b>5</b>

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd (Cont'd)**

<b>2011</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	0.03	0.00	0.13	0.55	0.00	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.08	0.02	3.26	9.08	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	1.36	1.07	40.01	223.70	0.00	0.02	0.02	0.16
2265005020	Combines	4 Stroke	0.16	0.11	2.57	15.93	0.00	0.00	0.00	0.00
2265005025	Balers	4 Stroke	0.04	0.04	0.87	5.45	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.25	0.06	9.73	25.76	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.14	0.04	3.38	11.82	0.00	0.00	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.26	0.54	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.02	0.01	0.26	1.64	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.15	0.08	4.87	32.36	0.00	0.00	0.00	0.03
2265005060	Irrigation Sets	4 Stroke	2.38	1.48	45.22	1,341.42	0.03	0.15	0.14	0.44
2267005055	Other Agricultural Equipment	LPG	0.24	0.86	6.38	155.11	0.00	0.02	0.02	0.43
2267005060	Irrigation Sets	LPG	0.30	1.91	10.15	1,106.05	0.02	0.12	0.12	0.72
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	0.14	0.85	1.13	134.58	0.00	0.10	0.10	0.00
2270005015	Agricultural Tractors	Diesel	13.45	157.93	86.60	28,458.62	0.26	14.22	13.79	1.22
2270005020	Combines	Diesel	1.31	13.95	6.27	1,796.50	0.02	1.31	1.27	0.04
2270005025	Balers	Diesel	1.26	7.74	6.52	955.73	0.01	1.23	1.19	0.02
2270005030	Agricultural Mowers	Diesel	1.38	9.16	9.03	1,140.72	0.01	1.51	1.47	0.03
2270005035	Sprayers	Diesel	1.72	12.94	7.74	1,551.76	0.01	1.53	1.48	0.08
2270005040	Tillers > 6 HP	Diesel	0.35	3.45	2.26	411.63	0.00	0.33	0.32	0.04
2270005045	Swathers	Diesel	0.34	2.65	2.21	328.74	0.00	0.41	0.39	0.01
2270005055	Other Agricultural Equipment	Diesel	0.44	5.04	2.50	801.40	0.01	0.44	0.42	0.07
2270005060	Irrigation Sets	Diesel	1.48	16.35	8.46	2,846.13	0.03	1.43	1.38	0.05
			<b>27</b>	<b>236</b>	<b>260</b>	<b>41,355</b>	<b>0</b>	<b>23</b>	<b>22</b>	<b>3</b>

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd (Cont'd)**

<b>2014</b>										
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>
2260005035	Sprayers	2 Stroke	0.03	0.00	0.14	0.57	0.00	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.06	0.01	3.24	9.48	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	1.00	0.75	32.77	226.58	0.00	0.02	0.02	0.22
2265005020	Combines	4 Stroke	0.14	0.10	2.30	16.24	0.00	0.00	0.00	0.00
2265005025	Balers	4 Stroke	0.04	0.03	0.73	5.53	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.21	0.05	9.44	26.73	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.09	0.03	3.09	12.26	0.00	0.00	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.25	0.55	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.02	0.01	0.23	1.68	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.10	0.05	3.99	33.35	0.00	0.00	0.00	0.05
2265005060	Irrigation Sets	4 Stroke	1.83	1.51	45.27	1,400.53	0.03	0.16	0.14	0.46
2267005055	Other Agricultural Equipment	LPG	0.10	0.44	2.88	152.13	0.00	0.02	0.02	0.54
2267005060	Irrigation Sets	LPG	0.30	1.91	10.15	1,106.05	0.02	0.12	0.12	0.72
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	0.14	0.91	1.09	142.65	0.00	0.09	0.08	0.00
2270005015	Agricultural Tractors	Diesel	10.87	119.76	61.47	30,172.73	0.24	10.27	9.96	1.21
2270005020	Combines	Diesel	1.11	11.68	4.87	1,904.91	0.02	1.03	1.00	0.04
2270005025	Balers	Diesel	1.08	7.23	5.83	1,013.72	0.01	1.06	1.03	0.02
2270005030	Agricultural Mowers	Diesel	1.19	8.21	7.97	1,209.85	0.01	1.31	1.27	0.03
2270005035	Sprayers	Diesel	1.44	11.58	6.50	1,645.80	0.01	1.27	1.23	0.09
2270005040	Tillers > 6 HP	Diesel	0.30	3.10	1.88	436.49	0.00	0.27	0.26	0.04
2270005045	Swathers	Diesel	0.30	2.36	1.94	348.63	0.00	0.34	0.33	0.01
2270005055	Other Agricultural Equipment	Diesel	0.37	3.97	1.93	849.69	0.01	0.33	0.32	0.07
2270005060	Irrigation Sets	Diesel	1.12	11.70	6.02	3,017.90	0.02	1.00	0.97	0.05
			<b>22</b>	<b>185</b>	<b>214</b>	<b>43,734</b>	<b>0</b>	<b>17</b>	<b>17</b>	<b>4</b>

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd (Cont'd)**

<b>2018</b>											
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>	
2260005035	Sprayers	2 Stroke	0.03	0.00	0.15	0.60	0.00	0.00	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.06	0.01	3.39	10.00	0.00	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	0.67	0.44	25.27	232.42	0.00	0.02	0.02	0.02	0.30
2265005020	Combines	4 Stroke	0.12	0.08	1.92	16.64	0.00	0.00	0.00	0.00	0.01
2265005025	Balers	4 Stroke	0.03	0.02	0.53	5.63	0.00	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.18	0.04	9.50	28.15	0.00	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.08	0.02	2.98	12.81	0.00	0.00	0.00	0.00	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.24	0.57	0.00	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.01	0.01	0.19	1.72	0.00	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.09	0.04	3.81	35.00	0.00	0.00	0.00	0.00	0.06
2265005060	Irrigation Sets	4 Stroke	1.93	1.59	47.70	1,477.15	0.03	0.16	0.15	0.48	0.48
2267005055	Other Agricultural Equipment	LPG	0.05	0.27	1.59	150.84	0.00	0.02	0.02	0.64	0.64
2267005060	Irrigation Sets	LPG	0.30	1.91	10.15	1,106.05	0.02	0.12	0.12	0.72	0.72
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	0.15	0.98	1.17	153.37	0.00	0.09	0.09	0.00	0.00
2270005015	Agricultural Tractors	Diesel	9.17	70.31	29.29	32,447.17	0.23	4.32	4.19	1.34	1.34
2270005020	Combines	Diesel	0.94	8.59	3.69	2,048.80	0.02	0.75	0.72	0.04	0.04
2270005025	Balers	Diesel	0.87	6.38	4.78	1,090.76	0.01	0.84	0.81	0.02	0.02
2270005030	Agricultural Mowers	Diesel	0.94	6.60	6.51	1,301.76	0.01	1.02	0.99	0.03	0.03
2270005035	Sprayers	Diesel	1.14	9.29	4.89	1,770.67	0.01	0.96	0.93	0.09	0.09
2270005040	Tillers > 6 HP	Diesel	0.25	2.53	1.47	469.50	0.00	0.21	0.20	0.05	0.05
2270005045	Swathers	Diesel	0.24	1.89	1.56	375.07	0.00	0.26	0.25	0.01	0.01
2270005055	Other Agricultural Equipment	Diesel	0.30	2.54	1.24	913.81	0.01	0.21	0.21	0.07	0.07
2270005060	Irrigation Sets	Diesel	0.89	6.01	2.61	3,245.55	0.02	0.37	0.36	0.05	0.05
			<b>18</b>	<b>120</b>	<b>165</b>	<b>46,894</b>	<b>0</b>	<b>9</b>	<b>9</b>	<b>4</b>	

**Table D-4. Statewide OSD Agricultural Emissions by Equipment Type for 2005, 2008, 2011, 2014, 2018, and 2025, tpd (Cont'd)**

<b>2025</b>											
<b>SCC</b>	<b>EQUIP</b>	<b>Engine Type</b>	<b>VOC</b>	<b>NOx</b>	<b>CO</b>	<b>CO2</b>	<b>SO2</b>	<b>PM10-PRI</b>	<b>PM25-PRI</b>	<b>NH3</b>	
2260005035	Sprayers	2 Stroke	0.03	0.00	0.16	0.65	0.00	0.01	0.00	0.00	0.00
2265005010	2-Wheel Tractors	4 Stroke	0.07	0.01	3.70	10.91	0.00	0.00	0.00	0.00	0.00
2265005015	Agricultural Tractors	4 Stroke	0.54	0.29	22.33	250.60	0.01	0.03	0.02	0.40	0.01
2265005020	Combines	4 Stroke	0.08	0.05	1.22	17.35	0.00	0.00	0.00	0.00	0.00
2265005025	Balers	4 Stroke	0.01	0.01	0.25	5.90	0.00	0.00	0.00	0.00	0.00
2265005030	Agricultural Mowers	4 Stroke	0.18	0.04	10.23	30.71	0.00	0.00	0.00	0.00	0.00
2265005035	Sprayers	4 Stroke	0.07	0.02	3.11	13.90	0.00	0.00	0.00	0.01	0.00
2265005040	Tillers > 6 HP	4 Stroke	0.01	0.00	0.22	0.60	0.00	0.00	0.00	0.00	0.00
2265005045	Swathers	4 Stroke	0.01	0.01	0.12	1.79	0.00	0.00	0.00	0.00	0.00
2265005055	Other Agricultural Equipment	4 Stroke	0.09	0.04	4.10	38.17	0.00	0.00	0.00	0.06	0.00
2265005060	Irrigation Sets	4 Stroke	2.10	1.73	52.04	1,611.23	0.03	0.18	0.16	0.53	0.00
2267005055	Other Agricultural Equipment	LPG	0.04	0.25	1.31	150.82	0.00	0.02	0.02	0.66	0.00
2267005060	Irrigation Sets	LPG	0.30	1.91	10.15	1,106.05	0.02	0.12	0.12	0.72	0.00
2268005055	Other Agricultural Equipment	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2268005060	Irrigation Sets	CNG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2270005010	2-Wheel Tractors	Diesel	0.17	1.10	1.31	172.11	0.00	0.11	0.10	0.01	0.00
2270005015	Agricultural Tractors	Diesel	9.45	42.01	14.14	36,414.43	0.24	1.29	1.25	1.63	0.00
2270005020	Combines	Diesel	0.73	4.31	1.94	2,300.09	0.02	0.37	0.36	0.05	0.00
2270005025	Balers	Diesel	0.59	5.05	3.20	1,225.18	0.01	0.50	0.48	0.02	0.00
2270005030	Agricultural Mowers	Diesel	0.63	4.05	4.35	1,462.07	0.01	0.59	0.58	0.04	0.00
2270005035	Sprayers	Diesel	0.82	5.84	3.05	1,988.39	0.01	0.55	0.54	0.11	0.00
2270005040	Tillers > 6 HP	Diesel	0.20	1.63	0.92	527.11	0.00	0.13	0.12	0.05	0.00
2270005045	Swathers	Diesel	0.17	1.20	1.03	421.20	0.00	0.15	0.14	0.01	0.00
2270005055	Other Agricultural Equipment	Diesel	0.27	1.10	0.50	1,025.65	0.01	0.06	0.06	0.09	0.00
2270005060	Irrigation Sets	Diesel	0.92	3.26	1.22	3,642.38	0.02	0.10	0.10	0.07	0.00
			<b>17</b>	<b>74</b>	<b>141</b>	<b>52,417</b>	<b>0</b>	<b>4</b>	<b>4</b>	<b>4</b>	

**Table D-5. 2008 Annual Emissions by Texas County,  
All Agricultural Equipment SCCs**

FIPS	COUNTY	VOC	NOx	CO	CO2	SO2	PM10-PRI	PM25-PRI	NH3
48001	Anderson County	33.43	313.34	296.44	41,534.58	4.91	27.87	27.03	6.05
48003	Andrews County	13.25	130.49	127.31	16,650.05	2.62	11.03	10.70	3.33
48005	Angelina County	11.55	108.33	102.44	14,361.07	2.88	9.73	9.44	2.09
48007	Aransas County	0.44	4.04	3.66	565.30	0.11	0.37	0.36	0.08
48009	Archer County	42.92	387.20	477.32	52,049.81	11.81	33.08	32.08	13.28
48011	Armstrong County	28.48	262.63	337.75	35,569.08	7.39	21.84	21.18	10.97
48013	Atascosa County	26.90	256.27	246.06	34,310.41	7.88	22.67	21.99	5.97
48015	Austin County	35.85	333.32	324.74	45,304.14	9.93	30.27	29.36	7.40
48017	Bailey County	37.87	379.02	431.37	51,353.43	4.12	30.28	29.37	16.04
48019	Bandera County	4.68	43.76	41.76	5,755.28	1.34	3.93	3.81	0.84
48021	Bastrop County	32.70	305.25	292.38	40,277.72	7.90	27.24	26.42	6.15
48023	Baylor County	45.56	386.88	591.34	54,490.32	11.59	32.47	31.48	19.13
48025	Bee County	42.22	382.12	433.97	53,363.48	10.03	34.40	33.38	12.96
48027	Bell County	63.59	597.71	704.69	82,908.72	16.88	51.20	49.67	24.03
48029	Bexar County	36.54	341.14	348.10	45,665.95	10.42	30.31	29.40	8.70
48031	Blanco County	7.21	67.81	63.36	8,938.91	1.76	6.05	5.87	1.29
48033	Borden County	10.56	108.17	100.67	13,891.34	3.11	9.06	8.79	2.91
48035	Bosque County	39.76	370.59	366.92	48,383.30	10.56	33.00	32.01	7.78
48037	Bowie County	34.23	327.35	332.02	43,410.06	9.41	28.35	27.50	8.61
48039	Brazoria County	35.17	325.66	355.60	44,563.66	10.49	29.03	28.16	9.72
48041	Brazos County	25.52	235.21	241.11	32,018.59	6.72	21.31	20.68	5.94
48043	Brewster County	5.16	48.67	47.33	6,127.85	1.30	4.26	4.13	0.94
48045	Briscoe County	28.11	269.42	315.48	35,910.92	5.32	22.18	21.52	10.22
48047	Brooks County	7.67	66.04	71.02	9,179.04	1.47	6.29	6.11	1.43
48049	Brown County	29.84	279.72	274.84	36,681.94	5.81	24.64	23.90	5.93
48051	Burleson County	34.78	322.06	339.08	44,416.79	9.21	28.96	28.09	9.27
48053	Burnet County	10.22	96.69	88.99	12,763.09	2.52	8.61	8.35	1.81
48055	Caldwell County	26.39	246.89	250.60	33,061.82	6.37	21.82	21.16	6.38
48057	Calhoun County	19.46	179.12	224.40	25,916.37	5.23	15.72	15.25	8.58
48059	Callahan County	27.48	255.98	273.85	33,447.12	7.43	22.22	21.55	6.59
48061	Cameron County	53.22	481.09	668.41	74,189.12	10.58	42.26	41.01	29.21
48063	Camp County	9.36	91.44	81.22	11,868.17	2.65	7.99	7.75	1.66
48065	Carson County	44.70	419.72	566.28	58,341.84	11.76	34.10	33.08	21.37
48067	Cass County	18.59	180.29	162.95	23,363.89	5.22	15.79	15.31	3.32
48069	Castro County	81.45	790.57	986.43	109,059.75	8.57	63.12	61.24	37.85
48071	Chambers County	17.90	165.26	170.91	22,465.64	5.39	14.95	14.50	4.09
48073	Cherokee County	32.95	310.96	289.25	41,282.22	4.88	27.60	26.77	5.90
48075	Childress County	22.16	208.73	254.17	28,430.30	4.18	17.22	16.70	8.36
48077	Clay County	37.19	341.97	385.45	44,903.99	10.47	29.53	28.64	9.72
48079	Cochran County	33.58	353.64	365.66	47,579.25	3.87	28.03	27.19	14.43
48081	Coke County	7.65	71.91	76.86	9,364.44	1.16	6.10	5.91	1.95
48083	Coleman County	34.11	314.57	365.14	42,033.24	6.36	26.76	25.96	10.10
48085	Collin County	48.24	450.65	520.30	61,529.16	11.87	38.41	37.25	16.06
48087	Collingsworth County	33.33	320.66	372.44	43,506.44	6.44	26.43	25.64	12.49
48089	Colorado County	44.06	403.68	446.19	56,012.55	11.87	36.30	35.22	12.95
48091	Comal County	11.27	103.13	103.82	13,532.99	3.14	9.31	9.03	2.13
48093	Comanche County	40.90	392.32	357.12	51,319.59	8.21	34.45	33.42	7.26
48095	Concho County	25.85	238.95	306.12	32,783.34	3.84	19.59	19.00	10.21
48097	Cooke County	56.48	544.29	537.40	70,775.69	16.87	46.85	45.44	12.94
48099	Coryell County	41.97	390.27	414.28	51,993.58	11.08	34.36	33.33	10.61
48101	Cottle County	16.65	157.35	177.73	20,916.00	3.16	13.20	12.80	5.18
48103	Crane County	0.82	7.56	7.81	943.40	0.15	0.66	0.64	0.16
48105	Crockett County	11.72	107.89	111.38	13,510.25	1.72	9.41	9.13	2.22
48107	Crosby County	41.55	444.70	421.08	58,697.90	4.87	35.36	34.30	15.22
48109	Culberson County	5.46	54.39	50.20	6,667.88	1.41	4.54	4.41	1.06
48111	Dallam County	86.64	814.13	1,103.68	113,609.90	22.81	66.18	64.21	42.55
48113	Dallas County	14.36	137.06	143.43	18,376.73	3.63	11.76	11.41	4.02
48115	Dawson County	57.61	625.22	592.94	83,071.06	6.86	49.37	47.90	23.01
48117	Deaf Smith County	39.06	382.57	360.22	48,346.94	10.97	32.81	31.83	8.05
48119	Delta County	66.56	600.21	830.94	84,992.62	16.81	50.43	48.91	29.75

**Table D-5. 2008 Annual Emissions by Texas County,  
All Agricultural Equipment SCCs (Cont'd)**

FIPS	COUNTY	VOC	NOx	CO	CO2	SO2	PM10-PRI	PM25-PRI	NH3
48121	Denton County	18.31	171.93	189.45	23,192.94	4.54	14.75	14.30	5.42
48123	De Witt County	43.65	390.48	423.48	54,123.78	11.63	35.54	34.47	10.23
48125	Dickens County	14.65	146.30	139.10	18,815.25	2.94	12.27	11.90	3.66
48127	Dimmit County	7.66	65.03	73.11	8,928.48	1.95	6.24	6.05	1.49
48129	Donley County	16.15	155.74	170.47	20,370.45	3.08	12.97	12.58	4.99
48131	Duval County	15.19	132.71	139.48	18,335.35	4.03	12.60	12.22	2.84
48133	Eastland County	36.76	358.76	324.76	46,105.81	7.36	30.90	29.97	6.74
48135	Ector County	1.38	12.76	13.74	1,632.94	0.26	1.10	1.07	0.31
48137	Edwards County	8.09	75.22	75.88	9,444.92	1.21	6.54	6.34	1.52
48139	Ellis County	6.70	69.65	62.97	9,253.03	1.86	5.82	5.65	1.99
48141	El Paso County	71.31	725.63	744.31	93,258.10	18.81	58.68	56.93	23.16
48143	Erath County	50.68	497.57	442.74	63,995.51	13.62	43.06	41.76	9.17
48145	Falls County	63.77	601.46	700.76	83,220.40	17.00	51.57	50.03	23.84
48147	Fannin County	67.22	649.01	657.71	85,242.59	18.38	55.36	53.70	17.20
48149	Fayette County	52.38	483.50	476.75	65,557.04	14.37	44.05	42.72	10.65
48151	Fisher County	30.18	296.63	307.27	39,341.75	8.63	25.00	24.25	9.13
48153	Floyd County	67.10	655.15	808.14	90,297.32	7.14	52.24	50.68	30.84
48155	Foard County	28.41	237.03	381.99	33,869.76	4.66	19.59	18.99	12.67
48157	Fort Bend County	38.83	369.82	408.87	51,491.02	11.90	32.32	31.35	13.23
48159	Franklin County	15.75	152.13	139.33	19,733.23	4.39	13.32	12.92	2.88
48161	Freestone County	35.85	337.17	322.47	43,914.41	9.37	29.99	29.09	6.56
48163	Frio County	22.64	207.84	260.16	29,313.15	6.25	17.92	17.39	9.15
48165	Gaines County	87.79	906.64	946.26	121,688.59	9.93	72.38	70.22	34.84
48167	Galveston County	5.83	53.72	52.72	7,119.67	1.74	4.89	4.74	1.01
48169	Garza County	14.70	152.14	138.61	19,585.87	1.66	12.48	12.11	4.06
48171	Gillespie County	18.49	173.52	171.56	23,278.81	4.50	15.32	14.86	4.09
48173	Glasscock County	23.22	239.84	246.17	31,882.93	3.87	19.32	18.75	8.82
48175	Goliad County	28.75	255.89	272.52	34,766.01	6.75	23.53	22.83	6.22
48177	Gonzales County	44.90	414.47	413.41	54,630.21	11.99	37.20	36.08	8.89
48179	Gray County	33.08	310.93	385.85	41,990.88	8.77	25.76	24.99	12.73
48181	Grayson County	60.06	575.58	610.24	76,264.83	16.25	48.91	47.44	17.00
48183	Gregg County	4.75	45.91	41.79	5,945.74	0.70	3.97	3.85	0.85
48185	Grimes County	38.92	355.46	350.74	47,791.13	10.20	32.59	31.61	7.15
48187	Guadalupe County	42.55	395.40	438.27	54,143.24	12.02	34.68	33.64	12.98
48189	Hale County	85.39	858.67	997.14	117,742.05	9.38	68.28	66.24	39.23
48191	Hall County	22.72	240.23	221.74	31,158.07	4.80	19.47	18.89	7.23
48193	Hamilton County	38.33	359.58	359.20	47,311.14	10.25	31.84	30.89	8.29
48195	Hansford County	52.35	473.98	691.73	66,726.30	13.20	38.57	37.41	25.82
48197	Hardeman County	24.96	216.57	314.30	30,310.08	4.30	17.97	17.42	10.08
48199	Hardin County	5.36	48.75	48.20	6,607.11	1.62	4.52	4.38	0.98
48201	Harris County	20.12	186.94	186.67	25,105.44	6.08	16.85	16.35	4.08
48203	Harrison County	19.84	191.09	176.09	24,760.82	5.52	16.76	16.25	3.62
48205	Hartley County	75.89	726.06	930.95	100,083.68	20.41	59.28	57.51	35.47
48207	Haskell County	63.75	571.32	819.56	80,894.28	16.26	47.21	45.79	29.18
48209	Hays County	14.00	127.70	130.20	16,814.35	3.28	11.46	11.11	2.78
48211	Hemphill County	17.49	164.85	173.90	21,018.80	4.69	14.17	13.74	4.06
48213	Henderson County	37.82	365.83	333.24	47,413.81	5.60	31.65	30.69	6.83
48215	Hidalgo County	74.10	664.29	922.45	102,113.22	14.61	58.69	56.96	39.37
48217	Hill County	76.83	721.67	846.35	99,947.73	20.40	61.86	60.01	28.39
48219	Hockley County	54.25	588.92	555.92	78,246.38	6.46	46.55	45.16	21.53
48221	Hood County	16.59	161.04	145.51	20,890.40	4.45	14.08	13.65	2.98
48223	Hopkins County	58.51	570.64	509.10	74,078.17	16.52	49.86	48.36	10.43
48225	Houston County	40.65	380.19	365.79	50,522.24	10.11	34.11	33.09	7.77
48227	Howard County	24.81	266.30	245.11	34,945.14	7.70	21.68	21.04	8.76
48229	Hudspeth County	13.52	139.17	121.02	17,145.01	3.63	11.49	11.15	2.71
48231	Hunt County	55.05	533.39	525.42	69,663.50	15.14	45.61	44.24	13.02
48233	Hutchinson County	25.82	236.87	310.11	32,080.66	6.64	19.72	19.13	10.20
48235	Irion County	5.85	54.55	56.73	6,935.83	0.87	4.70	4.56	1.26
48237	Jack County	23.26	220.48	212.95	28,093.38	5.96	19.32	18.74	4.35
48239	Jackson County	53.77	490.89	634.97	71,727.25	14.32	42.99	41.71	24.86
48241	Jasper County	8.25	76.99	73.70	10,195.66	2.50	6.96	6.75	1.50
48243	Jeff Davis County	3.46	32.36	32.28	4,047.74	0.86	2.84	2.75	0.64
48245	Jefferson County	21.39	194.09	211.62	26,924.61	6.39	17.75	17.22	5.73
48247	Jim Hogg County	6.58	55.17	63.12	7,614.12	1.22	5.31	5.15	1.26
48249	Jim Wells County	32.13	291.81	372.60	43,667.24	7.82	26.00	25.23	14.65

**Table D-5. 2008 Annual Emissions by Texas County,  
All Agricultural Equipment SCCs (Cont'd)**

FIPS	COUNTY	VOC	NOx	CO	CO2	SO2	PM10-PRI	PM25-PRI	NH3
48251	Johnson County	42.30	407.15	391.32	53,456.51	11.21	35.39	34.33	9.11
48253	Jones County	60.47	552.74	724.36	76,596.62	15.87	46.12	44.72	23.86
48255	Karnes County	35.92	326.84	339.62	44,901.47	8.66	29.73	28.84	8.44
48257	Kaufman County	46.41	446.55	425.63	58,376.07	11.89	38.88	37.72	9.69
48259	Kendall County	6.94	65.66	60.74	8,661.38	2.02	5.87	5.70	1.23
48261	Kenedy County	9.57	80.27	91.78	11,082.97	1.77	7.72	7.49	1.84
48263	Kent County	9.93	92.57	101.52	11,925.29	2.64	7.98	7.73	2.51
48265	Kerr County	7.34	67.75	66.11	8,890.53	2.07	6.11	5.93	1.33
48267	Kimble County	6.75	64.32	61.40	8,126.26	1.04	5.54	5.37	1.24
48269	King County	9.77	90.44	101.79	11,705.23	1.79	7.72	7.48	2.59
48271	Kinney County	4.80	43.00	45.24	5,597.57	1.23	3.91	3.79	0.91
48273	Kleberg County	33.38	300.61	374.42	44,078.41	8.03	27.10	26.29	13.59
48275	Knox County	48.74	417.89	643.66	59,279.96	8.24	34.37	33.32	21.75
48277	Lamar County	74.62	716.99	730.64	95,559.63	20.58	61.85	59.99	19.75
48279	Lamb County	81.01	811.58	952.23	111,725.18	8.87	64.62	62.70	37.88
48281	Lampasas County	14.24	137.47	124.32	18,077.09	2.89	12.02	11.66	2.60
48283	La Salle County	7.86	67.63	73.75	9,316.23	2.04	6.45	6.26	1.50
48285	Lavaca County	46.40	421.68	418.21	57,224.78	12.59	38.77	37.60	8.92
48287	Lee County	28.76	269.22	254.35	35,499.43	6.98	24.02	23.30	5.21
48289	Leon County	53.20	502.99	475.52	65,619.38	14.01	44.64	43.30	9.71
48291	Liberty County	27.92	261.63	265.62	35,555.58	8.51	23.38	22.68	6.50
48293	Limestone County	47.03	443.18	444.61	58,604.45	12.65	39.07	37.90	10.71
48295	Lipscomb County	22.26	209.34	235.17	27,306.77	5.94	17.75	17.22	6.35
48297	Live Oak County	18.37	165.44	177.55	23,568.85	4.50	15.28	14.82	4.85
48299	Llano County	7.04	65.14	63.24	8,553.98	1.68	5.84	5.67	1.28
48301	Loving County	0.00	0.05	0.01	5.79	0.00	0.00	0.00	0.00
48303	Lubbock County	58.44	624.63	604.80	83,135.01	6.85	49.57	48.09	22.81
48305	Lynn County	55.06	607.59	546.97	80,135.40	6.67	47.94	46.51	21.00
48307	Mc Culloch County	20.86	192.80	233.20	26,014.47	3.86	16.08	15.60	7.02
48309	Mc Lennan County	72.37	678.85	778.36	93,376.07	19.23	58.47	56.72	24.85
48311	Mc Mullen County	6.11	52.85	56.99	7,294.82	1.69	5.04	4.89	1.17
48313	Madison County	24.03	218.57	217.43	29,345.52	6.26	20.07	19.47	4.41
48315	Marion County	4.15	40.38	36.17	5,237.94	1.17	3.53	3.43	0.74
48317	Martin County	29.85	326.11	290.61	42,757.82	6.63	26.18	25.39	10.59
48319	Mason County	8.47	78.84	75.82	10,392.32	2.04	7.05	6.84	1.57
48321	Matagorda County	47.97	438.31	529.93	62,713.53	12.86	38.88	37.73	18.70
48323	Maverick County	7.82	68.36	71.80	9,451.88	2.08	6.49	6.29	1.47
48325	Medina County	54.68	506.36	561.15	68,743.00	15.32	44.66	43.33	16.40
48327	Menard County	4.70	44.33	43.28	5,587.11	0.71	3.83	3.72	0.87
48329	Midland County	13.77	138.21	133.77	17,924.11	2.80	11.50	11.16	3.78
48331	Milam County	62.94	579.34	641.21	80,861.33	16.51	51.81	50.26	19.05
48333	Mills County	22.53	211.00	206.93	27,607.85	4.38	18.62	18.06	4.43
48335	Mitchell County	25.59	251.06	261.01	33,190.74	7.29	21.23	20.59	7.82
48337	Montague County	33.27	323.55	296.81	41,419.45	10.07	28.05	27.21	6.19
48339	Montgomery County	16.82	157.02	149.85	20,897.37	5.12	14.22	13.79	2.91
48341	Moore County	57.20	539.52	731.00	75,340.14	15.11	43.76	42.45	28.50
48343	Morris County	10.18	98.42	89.56	12,745.73	2.85	8.63	8.37	1.83
48345	Motley County	13.30	133.63	123.21	17,056.17	2.68	11.24	10.91	3.14
48347	Nacogdoches County	23.63	220.97	210.93	29,310.36	5.88	19.85	19.25	4.34
48349	Navarro County	58.47	550.11	577.84	73,639.75	14.68	48.05	46.61	15.47
48351	Newton County	3.20	29.87	28.48	3,956.31	0.97	2.70	2.62	0.58
48353	Nolan County	23.31	227.99	243.15	30,254.03	6.60	19.23	18.66	7.55
48355	Nueces County	81.56	754.02	1,000.63	114,474.96	20.08	65.89	63.94	43.43
48357	Ochiltree County	72.99	647.15	993.05	92,031.75	17.96	52.52	50.93	36.95
48359	Oldham County	24.07	225.85	251.05	29,082.08	6.38	19.33	18.75	6.63
48361	Orange County	4.10	37.21	36.99	5,041.12	1.24	3.45	3.35	0.75
48363	Palo Pinto County	23.53	224.28	213.88	28,618.31	6.08	19.61	19.02	4.38
48365	Panola County	20.35	191.46	179.58	25,401.59	5.67	17.22	16.71	3.67
48367	Parker County	35.50	344.80	311.00	44,732.82	9.53	30.13	29.23	6.37
48369	Parmer County	70.86	671.32	893.03	93,530.10	7.26	53.52	51.92	34.26
48371	Pecos County	11.93	115.49	110.50	14,730.10	2.34	9.88	9.58	2.52
48373	Polk County	10.92	101.86	97.46	13,488.67	2.71	9.16	8.89	1.99
48375	Potter County	15.59	148.60	148.54	18,737.19	4.23	12.83	12.45	3.22
48377	Presidio County	4.41	41.57	40.58	5,229.56	1.11	3.64	3.53	0.80
48379	Rains County	14.67	142.95	127.61	18,544.48	4.14	12.50	12.12	2.61
48381	Randall County	31.76	297.05	358.26	39,732.93	8.41	24.83	24.08	10.92
48383	Reagan County	12.94	127.91	136.80	16,868.27	2.05	10.52	10.20	4.37

**Table D-5. 2008 Annual Emissions by Texas County,  
All Agricultural Equipment SCCs (Cont'd)**

FIPS	COUNTY	VOC	NOx	CO	CO2	SO2	PM10-PRI	PM25-PRI	NH3
48385	Real County	3.07	27.61	28.64	3,599.19	0.46	2.48	2.41	0.57
48387	Red River County	41.51	396.88	378.72	51,525.83	11.40	34.80	33.76	8.23
48389	Reeves County	5.48	54.27	49.70	6,926.79	1.10	4.60	4.46	1.14
48391	Refugio County	27.97	256.82	304.74	36,429.39	6.71	22.74	22.06	10.50
48393	Roberts County	13.01	122.25	129.05	15,514.94	3.47	10.54	10.23	2.96
48395	Robertson County	49.61	459.25	465.56	62,649.64	13.16	41.56	40.32	11.49
48397	Rockwall County	5.68	53.31	58.15	7,160.33	1.41	4.59	4.45	1.59
48399	Runnels County	60.23	557.55	714.99	76,532.84	8.95	45.69	44.31	24.07
48401	Rusk County	28.88	270.14	256.72	35,788.99	4.23	24.05	23.33	5.23
48403	Sabine County	2.70	25.48	23.76	3,382.98	0.68	2.28	2.22	0.49
48405	San Augustine County	5.76	53.82	51.22	7,130.23	1.43	4.84	4.69	1.04
48407	San Jacinto County	9.06	83.36	80.78	11,221.25	2.25	7.61	7.38	1.65
48409	San Patricio County	57.79	543.22	679.77	81,505.64	14.53	47.55	46.14	28.79
48411	San Saba County	16.51	149.69	164.19	20,273.24	3.13	13.17	12.77	4.06
48413	Schleicher County	9.66	92.67	95.22	11,954.96	1.49	7.85	7.61	2.48
48415	Scurry County	24.23	246.19	238.32	32,042.15	7.10	20.54	19.92	7.17
48417	Shackelford County	20.15	185.12	201.48	23,936.45	5.34	16.21	15.73	4.66
48419	Shelby County	19.52	183.02	173.68	24,298.12	4.87	16.42	15.93	3.58
48421	Sherman County	65.63	610.35	857.86	85,850.76	17.05	49.39	47.91	33.37
48423	Smith County	36.36	352.97	318.73	45,786.14	5.41	30.50	29.58	6.54
48425	Somervell County	6.03	58.53	52.76	7,585.62	1.62	5.12	4.96	1.08
48427	Starr County	32.67	288.02	353.13	42,250.59	6.39	26.41	25.62	11.70
48429	Stephens County	15.24	143.42	141.27	18,246.99	2.90	12.52	12.15	2.89
48431	Sterling County	4.12	37.78	39.23	4,727.94	0.60	3.30	3.20	0.78
48433	Stonewall County	17.74	160.41	199.46	21,338.00	4.55	13.65	13.24	5.57
48435	Sutton County	6.53	60.08	62.07	7,523.30	0.96	5.24	5.08	1.24
48437	Swisher County	50.85	489.78	620.24	67,378.46	5.30	39.09	37.92	23.32
48439	Tarrant County	14.65	139.32	133.33	18,119.23	3.71	12.19	11.82	2.85
48441	Taylor County	43.17	387.71	505.96	53,266.56	11.14	32.81	31.82	15.49
48443	Terrell County	3.16	28.94	30.91	3,657.28	0.58	2.53	2.45	0.66
48445	Terry County	67.12	694.50	752.74	94,108.48	7.60	54.94	53.30	29.33
48447	Throckmorton County	26.39	234.41	294.47	31,306.58	7.13	20.30	19.69	7.96
48449	Titus County	19.17	185.32	168.83	23,996.60	5.36	16.25	15.76	3.44
48451	Tom Green County	44.90	439.29	512.37	59,797.33	7.08	35.64	34.57	18.52
48453	Travis County	24.71	230.35	253.75	31,519.51	5.91	20.11	19.51	7.68
48455	Trinity County	11.53	108.39	101.93	14,377.40	2.89	9.73	9.43	2.08
48457	Tyler County	6.39	59.61	57.48	7,916.39	1.94	5.38	5.22	1.20
48459	Upshur County	20.99	202.49	185.26	26,209.71	5.85	17.76	17.23	3.78
48461	Upton County	7.52	70.81	79.17	9,216.27	1.41	5.98	5.80	2.18
48463	Uvalde County	25.79	241.43	292.21	33,946.69	7.27	20.78	20.16	10.61
48465	Val Verde County	11.03	97.79	105.32	12,700.44	2.78	8.93	8.66	2.11
48467	Van Zandt County	55.91	543.20	489.12	70,459.32	8.33	46.92	45.51	10.02
48469	Victoria County	40.48	367.16	445.07	52,385.28	10.77	32.70	31.73	15.30
48471	Walker County	17.89	162.81	162.87	21,885.95	4.66	14.93	14.48	3.37
48473	Waller County	28.16	263.74	267.04	35,728.84	8.57	23.62	22.91	6.48
48475	Ward County	1.58	15.22	14.32	1,919.52	0.31	1.31	1.27	0.29
48477	Washington County	37.16	345.62	327.60	46,718.32	9.98	31.47	30.52	6.81
48479	Webb County	19.59	165.95	186.78	22,732.13	4.98	15.94	15.46	3.75
48481	Wharton County	81.14	755.00	935.36	109,998.32	22.14	65.83	63.88	36.59
48483	Wheeler County	23.61	231.67	230.84	29,973.03	4.63	19.38	18.79	6.00
48485	Wichita County	39.82	334.89	537.22	48,009.22	10.01	27.83	26.98	18.20
48487	Wilbarger County	50.00	442.14	620.55	61,676.89	13.37	36.96	35.84	20.25
48489	Willacy County	50.46	460.69	622.88	70,601.68	10.14	40.45	39.26	27.05
48491	Williamson County	77.96	732.70	855.26	102,407.88	18.72	62.97	61.10	29.98
48493	Wilson County	45.01	422.45	422.40	56,512.04	12.93	37.51	36.39	10.36
48495	Winkler County	1.18	10.85	11.20	1,354.44	0.22	0.95	0.92	0.22
48497	Wise County	42.30	412.12	370.69	53,612.06	11.40	35.93	34.85	7.71
48499	Wood County	28.13	273.03	246.74	35,426.18	4.18	23.58	22.88	5.07
48501	Yoakum County	44.37	453.29	499.74	61,512.12	4.96	36.06	34.98	19.20
48503	Young County	33.57	302.52	370.36	40,606.83	9.26	26.04	25.25	10.14
48505	Zapata County	5.27	44.76	49.71	6,198.33	0.99	4.29	4.16	1.00
48507	Zavala County	13.89	120.25	148.95	17,298.17	3.60	11.13	10.80	4.44
<b>48000</b>	<b>Statewide Total</b>	<b>7,666.36</b>	<b>72,598.27</b>	<b>80,562.96</b>	<b>9,847,290.80</b>	<b>1,768.59</b>	<b>6,215.17</b>	<b>6,028.95</b>	<b>2,461.37</b>