

Agriculture – Crops - Tilling Area Source Category Calculation Methodology Sheet

I. Source Category: Agriculture – Crops - Tilling

II. Pollutants: PM10 and PM2.5

III. SCC: 2801000003

IV. Description:

This document describes the methodology to be used to calculate emissions of particulate matter with an aerodynamic diameter of less than or equal to 2.5 microns (PM_{2.5}) and particulate matter with an aerodynamic diameter of less than or equal to 10 microns (PM₁₀) from agricultural tilling activities. Fugitive dust emissions are produced by the mechanical disturbance of the soil during tilling operations.

V. Current Methodology:

The methodology used to calculate emissions from agricultural tilling activities is based on Section 4.8.1.2 - *Agricultural Crops (1990-1999)* of EPA's *Procedures Document for National Emission Inventory, Criteria Air Pollutant (1985-1999)*¹ (i.e., the Trends Document). PM_{2.5} emissions are computed by multiplying an emission factor by an activity factor. The agricultural tilling emission factor provided in the 4th edition of U.S. EPA's AP-42 document is used to estimate soil preparation emissions. The activity factor is based on the number of acres of each crop in production for each county, with adjustment factors for the silt content of the soil and number of passes/tillings. Because different crops need different operations to prepare the soil, each crop also has its own acre-pass value. Acre-passes are the number of passes, per acre, that are typically needed to prepare a field for planting a particular crop. The specific crop types included in the methodology are: corn, spring wheat, rice, fall-seeded small grain, soybeans, cotton, sorghum, forage, permanent pasture, other crops, fallow. Additional adjustments are applied to account for crop lands subject to no till, ridge till, and mulch till practiced by county. By combining the crop acreage, crop specific acre-pass data, and the agricultural tilling emission factor, we estimate the particulate matter produced by agricultural land preparation operations.

VI. Emission Calculation:

A. Emission Factor

The emission factor used to estimate the dust emissions from agricultural land preparations is from U.S. EPA's AP-42¹. This emission factor was developed in 1981 based on test data measured in California and Kansas by Midwest Research Institute. Because of a lack of more detailed estimates, this single emission factor is used for all land preparation operations, all locations, and all seasons.

¹ U.S. Environmental Protection Agency. *Compilation of Air Pollutant Emission Factors, AP-42, Section 11.2.2, Fourth Edition.* September 1985.

The EPA emission factor does not include an association between soil moisture and emissions. Because it is known that dust emissions are reduced when soil moisture is higher, California ARB staff has incorporated an emission correction during the wettest months of the year. The correction was based on some limited agricultural dust source test data, as well as the control factor used for watering at construction sites and their best judgment. During December and March, California ARB reduced the emission factor by 25% from the standard uncorrected value. In January and February, often the wettest months, the emission factor is reduced by 50%. This produces a seasonal emissions profile that is more consistent with California's actual ambient air dust levels, and also better reflects that soil preparation operations typically do not occur while the soil is excessively wet or muddy.

1. Equation:

$$\text{Emission Factor (lbs PM/acre-pass)} = k (4.8) (s)^{0.6}$$

2. Variables:

a. k. Particle size fraction of interest (EPA default = 0.042 for PM_{2.5} or 0.21 for PM₁₀) For PM the value of 'k' used in California is 0.148. This is based on the EPA estimate that 33% of the total particulate entrained to the air during agricultural operations is 30 microns or less. Of this, analysis of California soil samples indicates that about 45% of the 30 micron or less sized particles are 10 microns or less in aerodynamic size (i.e., PM). So, the California PM particle size multiplier is 0.148 (i.e., 0.33 x 0.45 = 0.148). Maryland decided to use the EPA default values listed above for the particle size fraction. For the percent soil silt value, the EPA default value of 18% soil silt is used for most counties.

b. s. Average percent soil silt content (EPA default = 18%). The silt content of the soil is expressed as the fraction "s" in the equation for emission calculation. The silt content specific to each county should be used. This can be determined by comparing the USDA² surface soil map with the USDA³ county map to derive the type of soil in each county. The EPA identifies silt contents for 8 distinct soil types in Table 4.8-6 of the Trends Document. The silt contents for the 8 soil types are listed below:

<u>Soil Type</u>	<u>Silt Content (fraction)</u>
Silt Loam	0.52
Sandy Loam	0.33
Sand	0.12
Loamy Sand	0.12
Clay	0.29
Clay Loam	0.29
Organic Material	0.10-0.82
Loam	0.40

B. Annual Emissions

1. Equation

$$E_{ALP\ i} = \frac{EF_{ALP\ i} \times A_i \times P_i}{2000}$$

2. Variables

- a. E_{ALP} . Annual PM emissions of pollutant i from agricultural land preparations (tons per year)
- b. $EF_{ALP\ i}$. Emissions factor for pollutant i (pounds per acre-pass)
- c. A_i . Acres of crop I harvested in county j. The acreages used for estimating soil preparation emissions can be collected from the Extension Service.
- d. P_i . Number of passes or tillings per acre in a year. The number of tillings for 1990 through 1998 was determined for each crop type, and for conservation and conventional use. Harvesting is not included in the tilling total. The value for “p” should be used to calculate an average number of tillings, rather than a single value for each implement usage. Values for “p” from the National Air Pollutant Emissions Trends Procedures Document, 1985-1999- Table 4.8-7 are copied below. The tilling data in the table below, and tilling data for other crops not listed in the table below are provided by the Conservation Information Technology Center (CTIC)³

Crop	Number of Tillings	
	Conservation Use	Conventional Use
Corn	2	6
Spring Wheat	1	4
Rice	5	5
Fall-Seeded Small Grain	3	5
Soybeans	1	6
Cotton	5	8
Sorghum	1	6
Forage	3	3
Permanent Pasture	1	1
Other Crops	3	3
Fallow	1	1

VII. Point Source Adjustments:

PM2.5 emissions from agriculture (crops) have not been reported in the point source inventory; therefore, no adjustment of the area source emissions is required.

VIII. Adjustments for Controls:

No data on controls is available.

IX. Spatial Adjustments:

No data on spatial adjustments is available.

X. Temporal Adjustments:

Soil preparation activities tend to be performed during daylight hours in the early spring and fall months.

XI. Assumptions:

- A. The silt content of surface soil by county (USDA soil map).
- B. The number of tillings, for categories not included in the table above, were determined by contact with the CTIC.
- C. Number of passes or tillings in a year, by crop type (CTIC).
- D. Acres of land planted by county, crop type, tilling method (CTIC).
- E. Acres reported in the CTIC database for no till, mulch till and ridge till are considered conservation tillage.
- F. Those with 0 to 15 percent residue, and 15 to 30 percent residue are considered conventional tillage.

XII. Rule Effectiveness:

PM2.5 emissions from agriculture (crops) may be regulated rules related to soil conservation, soil erosion, and sediment control. It is not possible at present to estimate the effectiveness (if any) of these regulations in reducing PM2.5 emissions.

XIII. Uncertainties/Shortcomings of Methodology

- A. Estimates for the number of tillings per year by crop for conservation tilling and conventional tilling derived from a study in 1996 are used for the entire country.
- B. Emission factors for PM are derived from limited testing and may not be geographically representative.
- C. The current emission factor equation does not take soil moisture into account

XIV. Recommendations to Improve Methods/Data

- A. Obtain and use local data on number of acre-passes for each crop type. [*State Department of Agriculture or Agricultural Extension Service*]
- B. Determine local planted acres by crop type if appropriate. [*State Department of Agriculture or Agricultural Extension Service*]

C. Specify local planting, tilling temporal distribution factors. [*State Department of Agriculture or Agricultural Extension Service*]

D. Investigate whether it is appropriate to develop a correction factor to reduce tilling emissions during months of high precipitation.

E. Investigate whether regulations related to soil conservation, soil erosion, and sediment control have any effect on reducing PM_{2.5} emissions.

XV. Additional Information/Guidance:

NEI Methodology Description:

www.epa.gov/ttn/chief/net/index.html#doc

Area Source Emissions Model:

www.epa.gov/ttn/chief/software/asem/index.html

NEI Methodology Description:

www.epa.gov/ttn/chief/trends/procedures/

1999 NEI v 2. Documentation

<http://www.epa.gov/ttn/chief/net/doc>

XVI. References:

Conservation Technology Information Center, *National Crop Residue Management Survey*, 1990-1996.

Maryland Department of the Environment, *Calculation Methodologies (draft)*, June 2002.

New Jersey Department of Environmental Protection, PM_{2.5} Area Source Category Calculation Methodology Sheet, Agriculture –Paved Roads, October 2002.

Soil Conservation Service Soil Geography - NATSGO Map Series Dominant Surface Soil Texture, Data Source: USDA-SCS 1982 NRI & Soil-5 Databases & 1984 MLRA Map: U.S. Department of Agriculture, Sept 1988: L.D. Spivey, Jr. & R.L. Glenn. 1988.

U.S. Department of Soil Conservation Service, Major Land Resource Areas of the United States Adjusted to County Boundaries for Compilations of Statistical Data. USGS National Atlas Base. Agricultural Handbook 296. 1978.

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *Procedures Document for National Emission Inventory, Criteria Air Pollutants, 1985-1999*. EPA-454/R-01-006. Section 4.8.1.7.2.2. March 2001.