**AGRICULTURAL TILLING**

***a. Source Category Description***

Fugitive dust emissions from agricultural tilling include the airborne soil particulate emissions produced during the preparation of agricultural lands for planting. Fugitive dust emissions from agricultural tilling were estimated for PM10-PRI, PM10-FIL, PM25-PRI, and PM25-FIL. Since there are no PM-CON emissions for this category, PM10-PRI emissions are equal to PM10-FIL emissions and PM25-PRI emissions are equal to PM25-FIL.

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **SCC Level 1** | **SCC Level 2** | **SCC Level 3** | **SCC Level 4** |
| 2801000003 | Miscellaneous Area Sources | Agriculture Production - Crops | Agriculture - Crops | Tilling |

Particulate emissions from agricultural tilling were computed by multiplying a crop specific emissions factor by an activity factor, as discussed below.

***b. Emission Factor Equation***

The county-level emissions factors for agricultural tilling (in lbs per acre) are specific to the crop and tilling type and were calculated using the following equation:1,2

*EF = 4.8 × k × s0.6 × pcrop,tilling type*

where:

*k* = dimensionless particle size multiplier (PM10 = 0.21; PM2.5 = 0.042),

*s* = silt content of surface soil (%),

*p* = number of passes or tillings in a year for a given crop and tillage type.

The silt content of surface soil is defined as the percentage of particles (mass basis) of diameter smaller than 75 micrometers (µm) found in the soil to a depth of 10 centimeters (cm). Silt contents were assigned by comparing the United States Department of Agriculture (USDA) surface soil survey map to a USDA county map and assigning a soil type to each county. Table 1 shows silt content assumed for each soil type.

**Table 1. Silt Content for Soil Types in USDA Surface Soil Map**

|  |  |
| --- | --- |
| **Soil Type** | **Silt Content (%)** |
| Silt Loam | 52 |
| Sandy Loam | 33 |
| Sand | 12 |
| Loamy Sand | 12 |
| Clay | 29 |
| Clay Loam | 29 |
| Organic Material | 10-82 |
| Loam | 40 |

Table 2 shows the number of passes or tillings in a year for each crop for conservation use and conventional use.3 No till, mulch till, and ridge till tillage systems are classified as conservation use, while 0 to 15 percent residue and 15 to 30 percent residue tillage systems are classified as conventional use.

**Table 2. Number of Passes or Tillings per Year.**

|  |  |  |
| --- | --- | --- |
| **Crop** | **Conservation Use** | **Conventional Use** |
| Barley | 3 | 5 |
| Beans and Peas | 3 | 3 |
| Canola | 3 | 3 |
| Corn | 2 | 6 |
| Cotton | 5 | 8 |
| Cover | 1 | 1 |
| Fallow | 1 | 1 |
| Fall-seeded Wheat | 3 | 5 |
| Forage | 3 | 3 |
| Hay | 3 | 3 |
| Oats | 3 | 5 |
| Peanuts | 3 | 3 |
| Permanent Pasture | 1 | 1 |
| Potatoes | 3 | 3 |
| Rice | 5 | 5 |
| Rye | 3 | 5 |
| Sorghum | 1 | 6 |
| Soybeans | 1 | 6 |
| Spring Wheat | 1 | 4 |
| Sugarbeets | 3 | 3 |
| Sugarcane | 3 | 3 |
| Sunflowers | 3 | 3 |
| Tobacco | 3 | 3 |

***c. Activity***

The basis of agricultural tilling emission estimates was the number of acres of crops tilled in each county by crop type and tillage type. These data were obtained from the *2008* *National Crop Residue Management Survey*, developed by the [Conservation Technology Information Center (CTIC)](https://www.ctic.org/).4 Data summaries are available on the CTIC. The five types of tilling for which emission estimates were calculated are:

Conservation Till Conventional Till

No till/strip till 0 to 15 percent residue till (Intensive Till)

Mulch till 15 to 30 percent residue till (Reduced till)

Ridge till

Note that the 2008 activity data for highly erodible land (HEL) overlap the other crop-type‑specific data. Therefore, the HEL and Treated HEL data are not included in the calculation of emissions estimates. A summary of national-level acres planted in 2008 for each tilling type are presented in Table 3. Due to data nondisclosure agreements with CTIC, the EPA cannot release the county-level tillage data by crop type.

**Table 3. Acres Planted by Tillage Type, Fallow and Pasture in 2008**

|  |  |  |
| --- | --- | --- |
| **Tillage System** | **Actual National Number of Acres Planted in 2008 (million acres)** | |
| ***Conservation*** | |
| No-Till/Strip Till | 74.86 |
| Ridge-Till | 2.32 |
| Mulch-Till | 49.43 |
| ***Conventional*** | |
| Reduced-Till (15-30% cover) | 63.31 |
| Intensive-Till (<15% cover) | 105.13 |
| Total | 295.05 |

The following equation was used to determine the emissions from agricultural tilling for 2008.1,2 The county-level activity data are the acres of land tilled for a given crop and tilling type. The equation is adjusted to estimate PM10 and PM2.5 emissions using the following parameters: a particle size multiplier, the silt content of the surface soil, the number of tillings per year for a given crop and tilling type, and the acres of land tilled for a given crop and tilling type.

*E = Σc × k × s0.6 × pcrop,tilling type × acrop,tilling type*

where: *E* = PM10-FIL or PM25-FIL emissions

*c* = constant 4.8 lbs/acre-pass

*k* = dimensionless particle size multiplier (PM10=0.21; PM2.5=0.042)

*s* = percent silt content of surface soil, defined as the mass fraction of particles smaller than 75 μm diameter found in soil to a depth of 10 cm

*p* = number of passes or tillings in a year

*a* = acres of land tilled (activity data)

***e. Controls***

No controls were accounted for in the emission estimations.

***f. 2011 Updates***

Since the CTIC has not prepared an updated National Crop Residue Management (CRM) Survey for 2011, activity data for this category were updated using growth factors derived from state-level USDA statistics on various crop types.5 These growth factors were then matched by state and crop type and applied to the 2008 activity data at the county level. See Table 5 for how USDA and CRM categories were matched.

**Table 5. Crosswalk between Crop Residue Management Category and USDA Data**

| **CRM Category** | **USDA Data Items** |
| --- | --- |
| Barley | BARLEY - ACRES HARVESTED |
| Beans and Peas | SUM OF BEANS AND PEAS HARVESTED |
| Canola | CANOLA - ACRES HARVESTED |
| Corn | CORN, GRAIN - ACRES HARVESTED |
| Cotton | COTTON - ACRES HARVESTED |
| Cover | TOTAL ACRES HARVESTED |
| Fallow | TOTAL ACRES HARVESTED |
| Forage | FORAGE, ALFALFA, HAY - ACRES HARVESTED |
| Hay | FORAGE (EXCL ALFALFA), HAY - ACRES HARVESTED |
| Oats | OATS - ACRES HARVESTED |
| Peanuts | PEANUTS - ACRES HARVESTED |
| Permanent Pasture | TOTAL ACRES HARVESTED |
| Potatoes | POTATOES - ACRES HARVESTED |
| Rice | RICE - ACRES HARVESTED |
| Rye | RYE - ACRES HARVESTED |
| Sorghum | SORGHUM, GRAIN - ACRES HARVESTED |
| Soybeans | SOYBEANS - ACRES HARVESTED |
| Sugarbeets | SUGARBEETS - ACRES HARVESTED |
| Sugarcane | SUGARCANE, SUGAR & SEED - ACRES HARVESTED |
| Sunflower | SUNFLOWER - ACRES HARVESTED |
| Tobacco | TOBACCO - ACRES HARVESTED |
| Wheat | WHEAT - ACRES HARVESTED |
| Winter Wheat | WHEAT, WINTER - ACRES HARVESTED |

In addition, for those categories where a specific state/crop combination match was not made, the number of acres tilled were grown using a growth factor based on the total number of farm acres in those states.

***g. References***

1. *The Role of Agricultural Practices in Fugitive Dust Emissions*, T.A. Cuscino, Jr., et al., California Air Resources Board, Sacramento, CA, June 1981.

2. Memorandum from Chatten Cowherd of Midwest Research Institute, to Bill Kuykendal of the U.S. Environmental Protection Agency, Emission Factor and Inventory Group, and W.R. Barnard of E.H. Pechan & Associates, Inc., September 1996.

3. *Agricultural Activities Influencing Fine Particulate Matter Emissions*, Woodard, Kenneth R., Midwest Research Institute, March 1996.

4. *National Crop Residue Management Survey*, [Conservation Technology Information Center](https://www.ctic.org/), 2008.

5. [USDA Quickstats 2.0](https://quickstats.nass.usda.gov/), Accessed May 2019.