

SECTION 7.5

AGRICULTURAL HARVEST OPERATIONS

(New August 1997)

EMISSION INVENTORY SOURCE CATEGORY

Miscellaneous Processes / Farming Operations
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EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION

620-615-5400-0000 (83980) Agricultural Harvest Operations
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METHODS AND SOURCES

The activities used to harvest agricultural commodities entrain soil and plant material into the air. These emissions may simply be due to the vehicles traveling over the soil, or via the mechanical processing of the plant material and underlying soil, or, as in the case of almonds, via the actual blowing or sweeping of the crop to remove waste materials and position it for pickup. At the time of this update, harvest particulate matter emission factors measured in California are only available for cotton, almonds, and walnuts. Table 1 shows the PM₁₀ harvest emissions estimates for these crops. As additional harvest emission factors for more crops are available, they will be incorporated into this methodology.

EMISSIONS ESTIMATION METHODOLOGY

Particulate emissions from harvest operations are computed by multiplying an emission factor by an activity factor. Agricultural harvest particulate dust emissions are estimated for walnuts, almonds, and cotton in each county in California using the following equation:

$$\text{Emissions}_{\text{crop}} = \text{Emission Factor}_{\text{crop}} \times \text{Acres Harvested}_{\text{crop}}$$

The individual crop emissions for each county are summed to produce the county and statewide particulate matter (PM) and PM₁₀ harvest emission estimates. For harvesting, the emission factors are based on measurements performed by UC Davis,¹ and harvested acreage is based on 1993 summary data from the California Department of Food and Agriculture.² The remainder of this section discusses the emission factors and acreage in more detail.

Emission Factor. The emission factors used to estimate the PM₁₀ dust emissions from agricultural harvesting are from a study performed by UC Davis under contract to Cotton

Incorporated.¹ PM₁₀ emissions were measured during 1994 harvest operations. The cotton emission factor is based on seven tests for cotton picking and six tests for stalk cutting. The tests were performed using 2, 4, and 5 row pickers, and two different types of shredders. The average emission factors are shown in the table below. For almonds, the emission factor is based on the sum of shaking, sweeping, and almond pickup emissions tests as shown below. The almond harvest emission factor was also used for walnut harvesting because similar processes and equipment are used.

Harvest PM₁₀ Emission Factors Measured by UC Davis

Agricultural Operation	Average PM₁₀ Emission Rate (lbs/acre harvested)	Number of Tests
Cotton Picking	0.42	7
Cotton Stalk Cutting	0.7	6
<i>Cotton Total</i>	<i>1.12</i>	<i>13</i>
Almond Shaking	0.13	1
Almond Sweeping	1.76	4
1st Almond Pickup	12.83	4
2nd Almond Pickup	19.48	5
<i>Almond Total</i>	<i>34.2</i>	<i>14</i>

Unlike the soil preparation operations (e.g., discing, tilling, etc.) harvest operations tend to be fairly unique for each crop. Because of this, harvest emission factors generally combine all of the operations that go into harvesting a commodity into a single factor that includes emissions from all of the relevant operations. Because of this, acre-passes, which are used in estimating emissions from soil preparation operations, are not needed for harvesting.

Currently there is insufficient data to include the effects of soil moisture, equipment types, soil type or other factors in our harvest emissions estimates. For cotton and almonds, because both of the crops are harvested during the dry season, equipment types and soil probably play the larger role in emissions levels. If future testing shows that there are substantial variations based on the operational and environmental factors, they will be incorporated into the updates of this methodology.

UC Davis directly measured PM₁₀ emissions. To compute TSP emissions, multiply the PM₁₀ by 2.22, which is the ARB's soil size speciation value for agricultural tilling dust.⁴

Acres. The acreages used for estimating harvest emissions are from the California Department of Food and Agriculture's (CDFA) summary of crop acreage² harvested in 1993. The acreage data are subdivided by county and crop type for the entire state, and are compiled from individual county agricultural commissioner reports. Complete listings of individual county

crop acreages are provided in the land preparation background document.³

Acre-Passes & Crop Calendars. As mentioned above, because harvest emission factors consolidate all of the harvest operations, acre-passes are not required to compute the harvest emissions. But, harvesting is performed at very specific times each year, so crop calendar data, which tells when harvest activities occur, is important. To get the best estimates possible, staff of the ARB met with producers of the various commodities to gather the most realistic and current information available on when harvesting occurs. Focusing on the largest acreage crops, we were able to gather updated information for about 90% of California’s crop acreage. For the crops that were not explicitly updated, we either applied an updated crop profile from a similar crop, or used one of the existing ARB profiles.

Using these data, it was possible to create detailed temporal profiles that help to indicate when PM emissions from harvesting may be highest. The detailed background document³ for soil preparation operations includes detailed crop calendars for each crop that has updated information.

TEMPORAL ACTIVITY AND GROWTH

Temporal activity for harvesting is derived by summing, for each county, the operations that occur for each crop during each month. For harvesting this is currently very straightforward because we are able to estimate emissions for only three crops. The approximate percentage of activity that occurs during each month for cotton, walnuts, and almonds is shown below. With these profiles, it is possible to easily compute monthly emissions estimates based on the annual total emissions provided in Table 1. Refer to Appendix A for details on how the monthly temporal profiles were developed. Growth in this category varies by county and is based on either agricultural production or crop acreage. For many counties, agricultural growth is set to zero.

CES	Hours	Days	Weeks
83980	24	7	52

Percent of Acres Harvested

Crop	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Cotton	0	0	0	0	0	0	0	0	0	50	50	0
Almond/ Walnut	0	0	0	0	0	0	0	0	50	50	0	0

ASSUMPTIONS AND LIMITATIONS

1. The current harvest emission factors assume that harvesting produces the same emissions level of emissions under all conditions for all equipment for all crops.

2. It is assumed that walnut harvest operations are sufficiently similar to almond harvest operations so that the almond harvest emissions factors may be used for walnuts.
3. Crop calendar data collected for San Joaquin Valley crops and practices were extrapolated to the same crops in the remainder of the State.

CHANGES IN THE METHODOLOGY

This is a new methodology. Prior to this update, PM₁₀ emissions from harvesting were not estimated for California.

COMMENTS AND RECOMMENDATIONS

Studies are ongoing by the University of California, Davis, to better quantify emissions from harvest operations. They are attempting to quantify emissions from different types of harvest operations on different soil using different equipment. As the UCD results become available and are approved, they will be incorporated into the emission estimation methodology.

SAMPLE CALCULATIONS

The text and table below summarizes the data computations necessary to estimate the harvest emissions in Fresno county. The following steps are performed:

- Step 1: Crop Acreage. For each crop, determine the quantity of acres harvested. The acres harvested for cotton, almonds, and walnuts in Fresno county during 1993 are shown in the 'Acres' column the table. These data are available from the county agricultural commissioner annual reports or the CDFA. The 1993 acreage data are summarized in the agricultural tilling background document.³
- Step 2: Emission Factor. Assign the appropriate harvest emission factor.
- Step 3: Compute Emissions. Multiply the acres for each crop by the appropriate emission factor, then divide by 2000 lbs/ton to compute annual tons of PM₁₀ emissions.
Emissions = (Acres x Emission Factor)/2000.
- Step 4: Compute Totals. After the dust harvest dust emissions for each crop in the county are computed, sum the emissions for each crop to compute the total available particulate matter emissions from harvest operations.

**Estimating Harvest Operation Emissions
in Fresno County**

Crop	Acres	Emission Factor (lbs PM₁₀/acre)	PM₁₀ Emissions (tons PM₁₀/yr)
Cotton	377700	1.12	211
Almonds	36503	34.2	624
Walnuts	2502	34.2	42.8
Total	416705		878

ADDITIONAL CODES

SOURCE CATEGORY GROWTH AND CONTROL CODES

Various

SOURCE CATEGORY CODE POLLUTANT SPECIATION PROFILES

For All: PM = 321, VOC = not applicable

SOURCE CATEGORY CODE REACTIVITY FACTORS

Not Applicable

REFERENCES

1. Flocchini, R.G, Ashbaugh, L.L., Southard, R.J., Matsumura, R.T., Evaluation of Fugitive PM₁₀ Emissions from Cotton Production, Annual Report, 1995. University of California, Davis, Crocker Nuclear Laboratory. For Cotton Incorporated, Contract No. 95-189.
2. California Agricultural Statistics Service. 1993 acreage extracted from agricultural commissioner's reports. Sacramento, CA. Phone (916) 654-1533.
3. Gaffney, P.H. Agricultural Land Preparation: Geologic Particulate Matter Emission Estimates, Background Document. California Air Resources Board. September 1997.
4. Houck, J.E., Chow, J.C., Watson, J.G., et al. Determination of Particle Size Distribution and Chemical Composition of Particulate Matter from Selected Sources in California, Final Report. Desert Research Institute & OMNI Environmental. Prepared for California Air Resources Board. Agreement No. A6-175-32. June 30, 1989.

UPDATED BY

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TABLE 1
1993 Agricultural Harvest PM₁₀ and TSP Emissions*

EIC: 620-615-5400-0000; CES: 85980; Activity: Acres

Air Basin	County ID #	County	Cotton Harvest Acres	Almond Harvest Acres	Walnut Harvest Acres	Total Harvest Acres	PM10 Emissions (tpy)	TSP Emissions (tpy)
GBV	2	ALPINE				0	0.0	0.0
	14	INYO				0	0.0	0.0
	26	MONO				0	0.0	0.0
LC	17	LAKE			7254	7254	124.0	275.7
LT	9	EL DORADO			37	37	0.6	1.4
	31	PLACER			109	109	1.9	4.1
MC	3	AMADOR			570	570	9.7	21.7
	5	CALAVERAS		31	731	762	13.0	29.0
	9	EL DORADO			268	268	4.6	10.2
	22	MARIPOSA				0	0.0	0.0
	29	NEVADA				0	0.0	0.0
	31	PLACER			666	666	11.4	25.3
	32	PLUMAS				0	0.0	0.0
	46	SIERRA				0	0.0	0.0
	55	TUOLUMNE				0	0.0	0.0
NC	8	DEL NORTE				0	0.0	0.0
	12	HUMBOLDT				0	0.0	0.0
	23	MENDOCINO				0	0.0	0.0
	53	TRINITY				0	0.0	0.0
	49	SONOMA			224	224	3.8	8.5
NCC	27	MONTEREY			336	336	5.7	12.8
	35	SAN BENITO			4225	4225	72.2	160.6
	44	SANTA CRUZ				0	0.0	0.0
NEP	18	LASSEN				0	0.0	0.0
	25	MODOC				0	0.0	0.0
	47	SISKIYOU				0	0.0	0.0
SC	19	LOS ANGELES				0	0.0	0.0
	30	ORANGE				0	0.0	0.0
	33	RIVERSIDE	3830			3830	2.1	4.8
	36	SAN BERNARDINO				0	0.0	0.0
SCC	40	SAN LUIS OBISPO		2400	2890	5290	90.5	201.0
	42	SANTA BARBARA			524	524	9.0	19.9
	56	VENTURA				0	0.0	0.0
SD	37	SAN DIEGO				0	0.0	0.0
SED	13	IMPERIAL	8919			8919	5.0	11.1
	15	KERN	96243	22904	516	119662	454.4	1009.7
	19	LOS ANGELES				0	0.0	0.0
	33	RIVERSIDE	6250			6250	3.5	7.8
	36	SAN BERNARDINO				0	0.0	0.0
SF	1	ALAMEDA			119	119	2.0	4.5
	7	CONTRA COSTA			1440	1440	24.6	54.7
	21	MARIN				0	0.0	0.0
	28	NAPA			310	310	5.3	11.8
	38	SAN FRANCISCO				0	0.0	0.0
	41	SAN MATEO				0	0.0	0.0
	43	SANTA CLARA			925	925	15.8	35.2
	48	SOLANO		286	764	1050	18.0	39.9
	49	SONOMA			144	144	2.5	5.5
SJV	10	FRESNO	377700	36503	2502	416705	878.5	1952.2
	15	KERN	204516	48670	1096	254283	965.5	2145.6
	16	KINGS	266315	1907	5797	274019	280.9	624.2
	20	MADERA	51400	39176	981	91557	715.5	1589.9
	24	MERCED	79200	66519	6435	152154	1291.9	2870.8
	39	SAN JOAQUIN		36100	30600	66700	1140.6	2534.6
	50	STANISLAUS		70000	25800	95800	1638.2	3640.4
	54	TULARE	148065	10866	25087	184018	697.7	1550.5
SV	4	BUTTE		36061	15554	51615	882.6	1961.4
	6	COLUSA		17500	4575	22075	377.5	838.9
	11	GLENN		16700	6120	22820	390.2	867.2
	31	PLACER			316	316	5.4	12.0
	34	SACRAMENTO		170	360	530	9.1	20.1
	45	SHASTA			975	975	16.7	37.1
	48	SOLANO		1144	3057	4201	71.8	159.6
	51	SUTTER		3619	17683	21302	364.3	809.5
	52	TEHAMA		5642	11217	16859	288.3	640.6
	57	YOLO		5875	7486	13361	228.5	507.7
	58	YUBA		1527	7155	8682	148.5	329.9
Totals			1242438	423600	194848	1860886	11271	25047

PM Fraction: PM₁₀ = TSP x 0.45 (TSP Emissions = PM₁₀/0.45)

* Emissions are only computed for crops which have California specific emission factors.