Summary of Changes to ARB's Rice Land Preparation Emission Factor and Temporal Profile

Introduction

ARB's rice land preparation emission factor and temporal profile were first adopted in 2003, based on testing of surrogate crops in the San Joaquin Valley (SJV) and on SJV practices and conditions. In April 2012, at the request of David Lusk, of the Butte County Air Quality Management District, ARB reviewed the Sacramento Valley Air Basin's (SV AB) rice land preparation emission factor (EF) and temporal profile (TP) and revised them to more accurately reflect the conditions and practices where the majority of the state's rice is grown. The 2012 adjustment to the EF resulted in a 57% decrease in annual PM10 emissions from SV AB rice land preparation operations (5,295 tpy PM10 to 2,277 tpy PM10) and a 30% decrease in total SV AB tilling emissions (7,660 tpy PM10 to 4,642 tpy PM10). The adjustment to the TP resulted in shifting SV AB seasonal emissions allocations for rice land preparation operations from 56% winter:44% summer to 20% winter:80% summer. This adjustment was applied to NASS 2005 harvested rice acreage in the SV AB for the 2008 PM2.5 SIP inventory. In April 2016, the revised emission factor and temporal profile were adopted statewide for the 2016 Ozone SIP inventory, V.1.04.

Table 1. Summary of Changes to the Rice Land Preparation Emission Factor

Date	Region	Inventory	Base Year
Sept. 2012	Sacramento Valley AB	2008 PM2.5 SIP	2005
April 2016	Statewide	2016 Ozone SIP, V.1.04	2012

Background

David Lusk, of the Butte County Air Quality Management District, contacted ARB with concerns that rice tilling emissions were over-estimated compared to rice tilling practices and climate conditions in the SV AB. While the 2003 EF was based on SJV testing, 97% of California rice is grown in the SV AB, where rice tilling activities take place later in the year and soil moisture content is significantly higher (see D. Lusk attachment).

ARB's EFs for land preparation operations are calculated as the sum of the individual EFs (lbs PM10/acre-pass) for associated crop specific operations, multiplied by the number of annual acre-passes for each operation. The largest component of the 2003 rice tilling EF was associated with summer land planing using a 3 wheel plane, an operation unique to rice tilling. Table 2 summarizes the 5 SJV tests which were the basis for EF for the 3 wheel plane emission factor (12.5 lbs PM10/acre-pass).

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Table 2. ARB's 2003 Land Planing Emission Factors for 5 Crops in the SJV[3]

Crop	Lbs PM10/acre-pass	% Soil Moisture
Melon, Float	1.1	11
Wheat, Float	20.9	2
Tomatoes, Float	14.1	3
Garbanzos, Land Plane	15.3	2
Tomatoes, Land Plane	11.1	3
Average	12.5	4.2

Mr. Lusk provided documentation for SV AB rice tilling activities, monthly historical rainfall, and winter vs. spring soil moisture content. Approximately 10% of SV AB rice tilling occurs in April (winter) and 80% in May (summer). While soil moisture content in the SJV testing averaged 4.2%, soil moisture content in the SV AB ranges from about 20% in the winter to 6% by mid-May. ARB determined that the SJV "melon float" land planing emissions testing (1.10 lbs PM10/acre-pass) best represented SV AB soil moisture content in April and May. In September 2012, ARB adjusted the land planing EF for 3 wheel plane operations from 12.5 lbs PM10/acre-pass to 1.10 lbs PM10/acre-pass. The land maintenance EF for rice was also adjusted to 1.1 lbs PM10/acre-pass as this operation is conducted using the 3 wheel plane. The the overall rice tilling EF was adjusted from 20.0 lbs PM10/acre/year to 6.32 lbs PM10/acre/year. Table 3 presents the 2003 and 2012 revised EFs for rice tilling operations.

Table 3. ARB Rice Land Preparation Emission Factors (EF):
Crop EF = ∑ (Acre-Passes * Operation EF)

			ARB PM10 Emission Factors			
			2003 Statewide		**2016 Revised Statewide**	
Rice Land Preparation Operations	**Emission Factor Category**	**Acre-Passes**	**Operation (lbs/acre-pass)**	**Crop (lbs/acre/year)**	**Operation (lbs/acre-pass)**	**Crop (lbs/acre/year)**
Chisel	Discing	1	1.2		1.2	
Land Maintenance	Land Planing	0.2	12.5		1.1	
Post Burn/Harvest Disc	Discing	0.5	1.2		1.2	
Roll	Weeding	1	0.8		0.8	
3 Wheel Plane	Land Planing	1	12.5		1.1	
Harrow Disc	Discing	1	1.2		1.2	
Stubble Disc	Discing	1	1.2	20	1.2	6.32

Summary of Changes to ARB's Rice Land Preparation Emission Factor and Temporal Profile

The 2003 TP allocated more than half of rice tilling emissions (54%) to the winter inventory (November through April), when most rice fields in the SV AB are flooded. D. Lusk's proposed TP allocated 15% of emissions to the winter months and 85% of emissions to the summer months. However, his approach allocated unequal fractions of some operation specific emissions to the months in which those operations took place (e.g., 14% and 86% for operations that took place respectively during April and May). ARB's approach is to allocate identical fractions of operation specific emissions to the months in which they occur (e.g., 50% to each month for operations taking place during two months). ARB adjusted the temporal profile for SV AB rice land preparation operations to reflect the months that rice tilling operations took place. The TP adopted for the SV AB in 2012 reflects ARB's approach and allocates 80% of emissions to the summer months and 20% to the winter months. These changes were effective as of September 2012, and used for the 2005 SIP PM 2.5 inventory. In April 2016, the 2012 SV AB rice land preparation emission factor and temporal profile were adopted statewide for the 2016 Ozone SIP Inventory, V. 1.04. Table 4 presents the 2003 rice tilling TP, David Lusk's proposed TP and the TP adopted for the SV AB in 2012 and statewide in April 2016.

Table 4. Temporal Profiles Proposed and Adopted for Rice Land Preparation Operations

TP Vintage and Region	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2003 Statewide	0.000	0.000	0.082	0.444	0.444	0.000	0.000	0.000	0.000	0.010	0.010	0.010
SV AB Proposed/1	0.000	0.000	0.030	0.100	0.800	0.040	0.000	0.000	0.000	0.010	0.010	0.010
Adopted: 2012 SV AB and 2016 Statewide/2	0.000	0.000	0.020	0.140	0.720	0.060	0.000	0.000	0.000	0.020	0.020	0.020

1 D. Lusk's proposed TP allocated unequal fractions of operation-specific emissions to the months in which they took place (e.g., for 3 wheel plane, April 14%, May 86%).

2 ARB's adopted TP distributes operation-specific emissions equally to the months in which they occur (e.g., for 3 wheel plane, April 50%, May 50%).

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September 2012

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June 2016
Updated to reflect statewide adoption of the reduced rice tilling emission factor and temporal profile.

Summary of Changes to ARB's Rice Land Preparation Emission Factor and Temporal Profile

References

1. Spencer, J. Miscellaneous Process Methodology 7.4, Agricultural Land Preparation. California Air Resources Board. July 2012 update.
2. United States Department of Agriculture, National Agricultural Statistics Service, California County Agricultural Commissioners' Data for Crop Year 2005. http://www.nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/index.
3. Flocchini, R.G., James, T.A., et al. Sources and Sinks of PM10 in the San Joaquin Valley (Interim Report), a study for United State Department of Agriculture Special Research Grants Program. Contract Nos. 94-33825-0383 and 98-38825-6063. August 10, 2001. https://www.arb.ca.gov/research/apr/reports/l2022.pdf
4. California Air Resources Board. Summary of Fugitive Dust and Ammonia Emission Inventory Changes for the SJVUAPCD Particulate Matter SIP, Revision 2.1. May 2003. http://www.valleyair.org/Air_Quality_Plans/docs/2003%20PM10%20Plan/PDF%202003%20PM10%20Plan%20adpt%20app/App%20C-EI%20Changes.pdf
5. California Air Resources Board. Detailed Documentation for Fugitive Dust and Ammonia Emission Inventory Changes for the SJVUAPCD Particulate Matter SIP. April 2003. http://www.valleyair.org/Air_Quality_Plans/docs/2003%20PM10%20Plan/PDF%202003%20PM10%20Plan%20adpt%20ref/R12-Inventory%20Doc%20Memos%20SJV%204_2003.pdf
6. Cassel, T., Trzepla-Nabaglo, K, and Flocchini, Robert. PM10 Emission Factors for Harvest and Tillage of Row Crops. Crocker Nuclear Lab, University of California at Davis, Davis, CA 95616. April 2003. http://www.epa.gov/ttn/chief/conference/ei12/poster/cassel.pdf
7. H. Yu, P. Gaffney, Computing Agricultural PM10 Fugitive Dust Emissions Using Process Specific Emission Rates and GIS Poster. California Air Resources Board. Presented at EPA 12th International Emission Inventory Conference April 2003. https://www3.epa.gov/ttnchie1/conference/ei12/fugdust/yu.pdf
8. Conversation with Steve Birdsong and Carl Hoff, Butte County Rice Growers Association: 5/24/12 and Cass Mutters, UCD Farm Advisor. May 24, 2012, attached.
9. Lusk, D. Butte County Rice Land Planing/Floating Emission Factor Review and Documentation of Farming Practices. Butte County Air Quality Management District. May 25, 2012; attached.

Butte County Rice Land Planing/Floating Emission Factor Review

and Documentation of Farming Practices (David Lusk, May 24, 2012)

Goal: Review rice agricultural tilling emission factor development and applicability to Butte County due to significant impact on the Winter PM2.5 inventory.

Literature research: Reviewed reference documents for Miscellaneous Process Methodology 7.4: Agricultural Land Preparation.

Emission Factor for Rice: Developed using soil emissions testing in the San Joaquin Valley for cotton and wheat and applied statewide. For Rice, significant component is land planing/floating at 12.5 lb/acre-pass. This factor was developed using data from melon, tomato, wheat, and garbanzo bean land preparation activities in July, August, and September. The soil moisture for the melon sampling of 11% is more representative of the land preparation activities for rice crops in Butte County. The moisture content for the other land planing/floating sampling was 2-3% and the resulting emission factors 10 to 20 times larger than for melons.

Looking at other data collected to determine emission factors, a sampling for cotton discing in Nov/Dec shows 13% moisture content and emission factor about 5 to 25% of the other discing values.

Rainfall Butte County (Chico) versus San Joaquin Valley (Fresno):

To determine if Butte County soils are likely to have a higher moisture content than the studies, staff reviewed the monthly rainfall for the past 40 years and compared the average rainfall from both areas. Since the "Winter Inventory" is from November to April, staff started this comparison beginning in October to estimate the potential for soils to be more moist when beginning the winter inventory period. The 50 year trend average rainfalls below indicate that that Butte County soils are more likely to be wetter.

Location	JAN	FEB	MAR	APR	…	OCT	NOV	DEC	TOTAL
Butte	5.37	4.17	3.48	1.75	…	1.51	3.19	4.05	25.41
Fresno	2.10	2.05	1.94	1.01	…	0.63	1.20	1.62	11.13
% of SJV	256%	203%	179%	174%	…	238%	267%	250%	228%

Crop Calendar: According to Methodology 7.4, crop calendars were determined using information from growers in the San Joaquin Valley and applied as representative statewide. District staff contacted several local growers to determine if the calendar profile was representative of Butte County. Because of the local weather patterns, some rice crop land preparation begins in April, such as discing; however, local growers perform a more significant amount of this preparation in May.

Butte County Rice Land Planing/Floating Emission Factor Review

and Documentation of Farming Practices (David Lusk, May 24, 2012)

Recommendations:

1. Adjust Land Planing/Floating emission factor to better represent the soil moisture content in rice fields. Suggest using data from land preparation for melons as the basis for the factor change: 119 mg/m^2=1.06 lb/acre-pass (round to 1.1 lb/acre-pass). This change supported by flooded field conditions until March, rainfall at least twice the sampling area, and sampling was performed in late summer versus rice land preparation activities occurring in spring.

2. Adjust Temporal Activity calendar for Rice to reflect the northern California rice season.

Crop Profile	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rice	0	0	0.03	0.1	0.8	0.04	0	0	0	0.01	0.01	0.01

Results of Recommendation:

Current Winter Inventory for PM2.5

EIC	EICSUM	SEASON	CONTROL_TYPE	PM2.5 (tons/day)
620-614-5400-0000	620-FARMING OPERATIONS	WINTER	GROWN AND CONTROLLED	0.596

Proposed:

EIC	EICSUM	SEASON	CONTROL_TYPE	PM2.5 (tons/day)
620-614-5400-0000	620-FARMING OPERATIONS	WINTER	GROWN AND CONTROLLED	0.157

Butte County Rice Land Planing/Floating Emission Factor Review

and Documentation of Farming Practices (David Lusk, May 24, 2012)

Documentation of Farming Practice Discussions:

Steve Birdsong and Carl Hoff, Butte County Rice Growers Association: 5/24/12 Farming practices discussion. Discing begins in the 2nd or 3rd week of April with approximately 85% of the soils work in May. Almost all (95+%) of landplaning would occur in May. Estimated land preparation allocation April 10%, May 85%, June-Mar 5%. Some chiseling and straw stomping could occur in November if rains are delayed or light.

Cass Mutters, UCD Farm Advisor: 5/24/12: Discussed effect of moisture on soils in Butte County and what % moisture could be found in the soils between October and the end of April. Suggested that valley-wide, approximately 50% of the rice acres were flooded and Butte County would include a potentially higher percentage because water is more readily available. This amount could be substantiated through irrigation district records. Typically, one inch of rain will penetrate about 12 inches into the soil. Since much of the rice soils are clay based (almost 50%), the soil strength is high and emissions would be minimized. If additional analysis is necessary could obtain the daily evaporation rate from a nearby FEMA station and analyze moisture evaporation versus rainfall to estimate soil moisture content. Estimated that winter soil moisture content was 20%. Soils dry to about 5-6% by mid-May each year. Irrigation/field flooding stops in March. Discing begins in April.