Voluntary Emission Reductions in Rice Management Systems – California Module

Version 1.0

Prepared by:

Terra Global Capital, LLC

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Applied Geosolutions, LLC

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American Carbon Registry
c/o Winrock International
2451 Crystal Drive, Suite 700
Arlington, Virginia 22202 USA
acr@winrock.org

The outline of this Regional Calibration Module follows the steps as required in the parent methodology *Voluntary Emission Reductions in Rice Management Systems* (http://americancarbonregistry.org/carbon-accounting/carbon-accounting/emission-reductions-in-rice-management-systems). This module must be used in conjunction with the parent methodology. All definitions and acronyms outlined in the parent methodology are relevant for this module.

1 Regional Calibration Module for Project Activities in California

California is the second largest rice-producing state in the United States, producing rice on approximately 585,000 acres (236,741 ha) and contributing $774 million to the state's economy. [1] Before 1990, in California, the most common post-harvest straw management option was burning. However, burning was significantly phased down between 1991 and 2000, and is now only practiced on a limited and highly regulated basis for disease control purposes. Currently, the most commonly used techniques for straw management on rice fields, listed in order of degree of use, are (UCCE, 2007): (1), chopping and/or disking, followed by winter-flooding and sometimes rolling, (2) chopping and/or disking without winter-flooding or (3) burning in the fall and/or spring for disease control. In 2007, the University of California Cooperative Extension estimated that rice straw burning occurred on 13% of the area, winter flooding on 60% of the area, and incorporation without winter flooding on the 27% of the area. Straw burning events must be scheduled in the Baseline Scenario as they occur according to surveys and historical data. Straw burning during the Crediting Period must follow all appropriate laws in the jurisdiction in which the Project is located. It is estimated that 3 to 5% of the rice acreage has straw baled for use later for various purposes (California Rice Commission 2009).

This methodology allows Project Proponents to voluntarily generate CH_4 emission reductions by (1) removing rice straw from the field after harvest and before winter flooding, (2) replacing water seeding with dry seeding, and (3) early drainage at the end of the growing season. Reducing winter flooding acreage in the California Rice Growing Region cannot be used for crediting under this version of the module.[2]

1.1.1 Step 1 - Definition of Included Project Activities

The following Project Activities are included in this Regional Calibration Module and do not have to be validated in a GHG Project Plan.

[1] Planted acres for 2011, all rice varieties, from *California Agricultural Statistics: 2011 Crop Year*. USDA National Agricultural Statistics Service - California Field Office. Available at http://www.cdfa.ca.gov/statistics/ or www.nass.usda.gov/ca.

[2] Future versions may allow reduced winter flooding if it can be demonstrated that impacts on waterfowl habitat are neutral or positive.

	Project Activity	Rice Growing Region
ACT1	Removal of straw after harvest (e.g., by baling)	California
ACT2	Dry seeding	California
ACT3	Early drainage	California

Note that it is allowed to combine Project Activities. Table 1 provides definitions for key terminology related to these Project Activities.

Table 1. Definitions of eligible Project Activities for the California Sacramento and San Joaquin Valley Rice Growing Region.

Project Activity	Definition
Straw baling and removal	After harvest, rice straw residue is traditionally left on agricultural fields. However, rice straw can be removed by baling. Baled straw can be sold even though the market is small. Rice straw can be used for erosion control, animal bedding, as an alternative feed for cow and calf producers (DANR, publication 8425), or for other purposes noted in 8.3.2 of the parent methodology.
Dry seeding	A seeding method that involves broadcasting or drilling dry seeds into dry or moist, non-puddled soil. Dry seeding often allows for quicker land preparation and reduces the irrigation water required for crop establishment. Dry seeding can occur through spreading seeds onto the soil surface and transferring soil on top of the seeds or by drilling seeds into a prepared seedbed, a practice known as "drill seeding". Alternatively, seeding normally occurs by distributing seeds on inundated fields using small airplanes, a practice known as "water seeding".
Early drainage	Early Drainage is defined as terminating water applications and draining a field at least 5 days earlier than the drainage date under conventional management ("Conventional Drainage Date").[3] Since there is not one single procedure to determine the Conventional Drainage Date that is used by all producers across all Rice Growing Regions, the procedure to set the Conventional Drainage Date as used by a specific participating grower shall be recorded in the GHG project plan.

1.1.2 Step 2 - Rice Growing Region

This regional calibration module is valid within California.

1.1.3 Step 3 - Development of performance standard

A performance standard is proposed for ACT1 - removal of straw after harvest and ACT 2 - dry seeding.

No legal requirements exist that relate to removal of straw after harvest or dry seeding. As a consequence, these Project Activities will be surplus to applicable regulations.

[3] This methodology does not endorse a specific procedure to set the Conventional Drainage Date or the early drainage date. Producers are advised to use the judgment of extension staff or other experts to determine a drainage date that is appropriate for their specific circumstances.

Based on discussions with industry experts, including P. Buttner (CalRice), R. Mutters, L. Espino, and G Nader (University of California Cooperative Extension), the following baseline adoption rates are estimated.

- A continuous flooding and water seeded regime is estimated to be used on over 96% of the acreage in California. As a consequence, the adoption of dry seeding is estimated to be less than 4%.
- The current estimate for baling adoption in California is on average 4% of California rice acres per year. This percentage fluctuates slightly annually with various straw markets.

Both ACT1 and ACT2 have a baseline adoption rate of less than 5%, and therefore pass the common practice test. No Project-specific demonstration of additionality is required.

1.1.4 Step 4 - Identification of Critical and Non-Critical Management Parameters

The pre-approved Project Activities in this methodology potentially affect (1) the duration and frequency of the winter flooding period, (2) post-harvest rice straw residue management, and (3) seeding practices. The potential critical input parameters are outlined in Table 2.

Table 2. Critical (C) and Non Critical (NC) Management Parameters for Project Activities included in this module.

	Project Activity		
	ACT1	ACT2	ACT 3
Management Parameter	Removal of straw after harvest	Dry seeding	Early drainage
Harvesting date	NC	NC	C
Fraction of residues left after harvest	C	NC	NC
Crop residue management (tillage) date	C	NC	NC
Crop residue management (tillage) method	C	NC	NC
Crop residue burning date (if burning was present)	C	NC	NC
Frequency of winter flooding	C[4]	NC	NC
Start Date of the winter flooding period (if any)	C	NC	NC
End Date of the winter flooding period (if any)	C	NC	NC
Spring fertilization amount	C	C	NC
Spring fertilization date	C	C	NC
Spring fertilization application method	C	C	NC
Pre-plant field preparation (tillage) date	NC	C	NC
Pre-plant field preparation (tillage) method	NC	C	NC
Planting date	NC	C	NC
Flooding date	NC	NC	NC
Fertilization amount during growing season	C	NC	NC
Fertilization date during growing season	C	NC	NC
Fertilization application method during growing season	C	NC	NC
Draining date	NC	NC	C

1.1.5 Step 5 - Structural Uncertainty Deduction

Nine different annual fluxes of CH_4 emissions were measured for a number of different management scenarios (Horwath et al., 2011, preliminary unpublished results). The same management scenarios were modeled using the DNDC model. These scenarios represent the Project Activities included in this Regional Calibration Module for California. Results from this exercise are summarized in Table 3. Further details can be found in EDF (2011).

[4] ACR will monitor the adoption of baling and take corrective action if winter flooding rates are significantly negatively affected, to ensure habitat for waterfowl is maintained.

Table 3. Modeled and measured CH_4 fluxes from field trials in California. Data reproduced with permission from EDF (2011).

Observation nr.	Site	Treatment	Year	Modeled [kg C ha^{-1} yr^{-1}]	Measured [kg C ha^{-1} yr^{-1}]
1	Biggs	Drill seeded in a stale seedbed	1	126.9	199.9
2	Biggs	Water seeded in a conventional seedbed	1	366.0	294.7
3	Biggs	Water seeded in a stale seedbed	1	260.0	335.9
4	Bossio	Burned residue and winter flooded	1	33.3	13.7
5	Bossio	Incorporated residue and winter flooded	1	69.8	58.4
6	Maxwell	Burned residue and winter flooded	1	58.7	26.6
7	Maxwell	Burned residue and winter flooded	2	82.7	55.8
8	Maxwell	Residue incorporated and winter flooded	1	61.3	122.3
9	Maxwell	Residue incorporated and winter flooded	2	127.1	187.1
10	Maxwell	Residue incorporated and not winter flooded	1	50.8	36.6
11	Maxwell	Residue incorporated and not winter flooded	2	90.9	136.7

The formula for Structural Uncertainty is:

$$u_{struct} = s\sqrt{2n(1-\rho)} \cdot t_{inv}(0.90, k)$$

Where:

u_{struct}	=	Absolute deduction for structural uncertainty for the whole Project Area [kg CO_2-eq]
s	=	51.3 (estimated based on the 9 pairs of measured and simulated fluxes presented in Table 3)
ρ	=	0.06 (estimated based on the daily flux data of the fields and seasons as presented in Table 3)

k = 9

n = Project Area size in ha

$t_{inv}(0.90, k)$ = 1.36 for k=11

The addendum “DNDC structural uncertainty deduction factors for ACR methodology *Voluntary Emission Reductions in Rice Management Systems*, v1.0,” posted on the ACR website, summarizes the results of this equation. The structural uncertainty deduction factor given in that table shall be applied on a field-by-field basis.

Table A-1. Structural uncertainty deductions for projects within California

See http://americancarbonregistry.org/carbon-accounting/carbon-accounting/emission-reductions-in-rice-management-systems for the current version of this table.

1.1.6 Step 6 - Template .dnd input file

The following table is a template .dnd input file with an indication of fixed default values or if values must be added by Project Proponents. The input file is set up to represent three years.

Table 4. Template dnd input file

Line	DND Parameter	Selection procedure for value
1	Input_Parameters:	
2	--	
3	Site_data:	leave blank
4	Simulated_Year:	24
5	Latitude:	Use latitude of project area
6	Daily_Record:	0
7	--	leave blank
8	Climate_data:	0
9	Climate_Data_Type:	Fix at 1
10	NO3NH4_in_Rainfall	1
11	NO3_of_Atmosphere	0.06
12	BaseCO2_of_Atmosphere	Fix at 350
13	Climate_file_count	leave blank
14	1	no default
15	Climate_file_mode	1
16	CO2_increase_rate	0
17	--	
18	Soil_data:	0
19	Soil_Texture	Empirical soil measurements

Line	DND Parameter	Selection procedure for value
20	Landuse_Type	2
21	Density	Empirical soil measurements
22	Soil_pH	Empirical soil measurements
23	SOC_at_Surface	Empirical soil measurements
24	Clay_fraction	Empirical soil measurements
25	BypassFlow	Fix at 0
26	Litter_SOC	Fix at 0.01
27	Humads_SOC	Fix at 0.003
28	Humus_SOC	Fix at 0.987
29	Soil_NO3(-)(mg N/kg)	Fix at 0.5
30	Soil_NH4(+)(mg N/kg)	Fix at 0.05
31	Moisture	Fix at 0.405
32	Temperature	no default
33	Field_capacity	Empirical soil measurements
34	Wilting_point	Empirical soil measurements
35	Hydro_conductivity	Empirical soil measurements
36	Soil_porosity	Empirical soil measurements
37	SOC_profile_A	provide soil information
38	SOC_profile_B	provide soil information
39	DC_litter_factor	Fix at 1
40	DC_humads_factor	Fix at 1
41	DC_humus_factor	Fix at 1
42	Humad_CN	Fix at 10
43	Humus_CN	Fix at 10
44	Soil_PassiveC	Fix at 0
45	Soil_microbial_index	Fix at 1
46	Highest_WT_depth	Fix at 9.99
47	Depth_WRL_m	Fix at 0.3
48	Slope	0
49	Use_ION_file	0
50	--	
51	Crop_data:	0
52	Rotation_Number	no default
	REPEAT FROM 20 YEARS BEFORE START OF CREDITING PERIOD UNTIL 10 YEARS AFTER START CREDITING PERIOD:	
53	Rotation_ID	no default
54	Totalyear	no default
55	Years_Of_A_Cycle	no default
56	YearID_of_a_cycle	no default
57	Crop_total_Number	no default
58	Crop_ID	no default
59	Crop_Type	no default
60	Plant_time	Exact date required, for example 5 1

Line	DND Parameter	Selection procedure for value
61	Harvest_time	Exact date required, for example 9 11
62	Year_of_harvest	1
63	Ground_Residue	1 if no baling is applied, otherwise 0.25 or empirical measurement
64	Yield	Exact data required
65	Rate_reproductive	0.044
66	Rate_vegetative	0.015
67	Psn_efficiency	0.4
68	Psn_maximum	47
69	Initial_biomass	12.5
70	Cover_crop	0
71	Perennial_crop	0
72	Grain_fraction	0.6
73	Shoot_fraction	0.3
74	Root_fraction	0.1
75	Grain_CN	30
76	Shoot_CN	65
77	Root_CN	65
78	TDD	3000
79	Water_requirement	508
80	Max_LAI	6
81	N_fixation	1.05
82	Vascularity	1
83	Tillage_number	Supply number of tillage events
	REPEAT FOR ALL TILLAGE EVENTS:	
84	Tillage_ID	Index value running from 1 until the number of tillage events
85	Month/Day/method	Exact date required, for example 4 23 3
	(end of tillage event enumeration)	
94	Fertil_number	Supply number of fertilization events
	REPEAT FOR EACH FERTILIZATION EVENT:	
95	fertilization_ID	1
96	Month/Day/method	Exact date required, for example 4 30 1
97	Depth	15
98	Nitrate	0
99	AmmBic	0
100	Urea	0
101	Anh	130
102	NH4NO3	0
103	NH42SO4	0
104	NH4HPO4	0
105	Release_rate	1

Line	DND Parameter	Selection procedure for value
106	Inhibitor_efficiency	0
107	Inhibitor_duration	0
108	Urease_efficiency	no default
109	Urease_duration	no default
	(end of fertilization event enumeration)	
141	Manure_number	0
142	Plastic_applications	no default
143	Ventilation	no default
144	Weed_number	no default
145	Weed_Problem	no default
146	Flood_number	3
147	Leak_type	1
148	Water_control	0
149	Leak_rate	0.08
	REPEAT FOR EACH FLOODING EVENT:	
150	Flooding_ID	1
151	Flood_Month/Day	Exact date required, for example 1 1
152	Drain_Month/Day	Exact date required, for example 1 31
153	Water_N	0
154	Shallow_flood	0
	(end of flooding event enumeration)	
168	Irrigation_number	Fixed at 0
169	Irrigation_type	Fixed at 0
170	Irrigation_Index	Fixed at 0
171	Grazing_number	Fixed at 0
172	Cut_number	Fixed at 0
	(end of crediting year enumeration)	
435	Crop_model_approach 0	-

2 References

Agriculture and Natural Resources (ANR) of the University of California 2010. Rice Producers' Guide to Marketing Rice Straw. ANR Publication 8425.

California Rice Commission. 2009. Environmental and conservation balance sheet for the California rice industry. Available online at http://calrice.thewebhounds.com/Environment/Balance+Sheet/Chapter+4+-+Air+Quality.htm

Environmental Defense Fund (EDF) 2011. Final report for NRCS project 69-3A75-7-87. Creating and Quantifying Carbon Credits from Voluntary Practices on Rice Farms in the Sacramento Valley: Accounting for Multiple Benefits for Producers and the Environment.