Errata & Clarification v1.0

Voluntary Emission Reductions in Rice Management Systems v1.0 and Regional Calibration Modules

This is a supplemental document to the ACR Methodology *Voluntary Emission Reductions in Rice Management Systems*, v1.0 and its Regional Calibration Modules. It is intended that topics in this document will be incorporated into the updated ACR Methodology *Voluntary Emission Reductions in Rice Management Systems* v2.0 and its updated Modules. As supplemental information or clarifications are needed on future versions of this methodology, updates may be found in this document.

1.1 Voluntary Emission Reductions in Rice Management Systems v1.0

The ACR Methodology *Voluntary Emission Reductions in Rice Management Systems* v1.0, and all subsequent versions of this methodology, is considered the "Parent Methodology" for both the Midsouth and California modules.

In addition to the Parent Methodology, a Project Proponent must use the most current uncertainty deductions for the Rice Growing Region where the project is located, found in the 'DNDC structural uncertainty deduction factors' addendum published on ACR's website. The addendum will be a dynamic home to future updates of any other Rice Growing Region module uncertainty deduction factors. Project Proponents are required to use the most updated uncertainty deductions as published in the addendum for the GHG Project Plan at validation.

Solar radiation is not required as an input parameter for the process-based model, though it may be provided as a climate input option. Requiring solar radiation limits the availability of daily weather data, as most weather stations have gaps in solar radiation data.

In the original ACR Rice Methodology, the model was assumed to be unbiased with normal residuals (see Section 14.1.3). The variance of the residuals does not depend on whether the situation being modeled is a baseline or project scenario. Thus,

$$\mathrm{PE}_{\mathrm{model}} = \mathrm{PE}_{\mathrm{meas}}\varepsilon_1, \varepsilon_1, \sim \mathrm{N}\ (0, \sigma^2\ )$$

$$\mathrm{BE}_{\mathrm{model}} = \mathrm{PE}_{\mathrm{meas}}\varepsilon_2, \varepsilon_2, \sim \mathrm{N}\ (0, \sigma^2\ )$$

Unfortunately, it will sometimes be the case that the model cannot be demonstrated to be unbiased using a two one-sided test (TOST) equivalence testing approach (ACR Rice Methodology, Section 14.1.2). Thus, it is necessary to introduce a slope and/or intercept to describe the relationship between modeled and measured emissions. In the event of a model that is biased (insofar as it does not pass the TOST test), structural uncertainty factors can be derived as long as the modeled result can be shown to be conservative. Specifically,

$$\mathrm{PE}_{\mathrm{model}} = \beta_0 + \beta_1 \mathrm{PE}_{\mathrm{meas}} + \varepsilon_1, \varepsilon_1, \sim \mathrm{N}\ (0, \sigma^2\ )$$

$$\mathrm{PE}_{\mathrm{model}} = \beta_0 + \beta_1 \mathrm{BE}_{\mathrm{meas}} + \varepsilon_2, \varepsilon_2, \sim \mathrm{N}\ (0, \sigma_a^2)$$

Where β_0 andβ_1 are parameters to be estimated from the data. Equivalently, we can write

$$\mathrm{PE}_{\mathrm{meas}} = \gamma_0 + \gamma_1\, \mathrm{PE}_{\mathrm{model}} + \varepsilon_1, \varepsilon_1, \sim \mathrm{N}\,(0, \sigma^2\,)$$

$$\mathrm{BE}_{\mathrm{meas}} = \gamma_0 + \gamma_1\, \mathrm{BE}_{\mathrm{model}} + \varepsilon_2, \varepsilon_2, \sim \mathrm{N}\,(0, \sigma^2\,)$$

where $\gamma_0 = -\beta_0/\beta_1$, $\gamma_1 = -1/\beta_1$, and $\sigma^2 = \sigma_a^2/\beta_1^2$. It is the latter form that we will actually use to estimate the structural uncertainty deduction. As before, our interest is in the quantity

$\mathrm{DER}_{\mathrm{model}} - \mathrm{DER}_{\mathrm{measure}}$, i.e.

$$(\mathrm{BE}_{\mathrm{model}} - \mathrm{PE}_{\mathrm{model}}) - (\mathrm{BE}_{\mathrm{measure}} - \mathrm{PE}_{\mathrm{measure}})$$

$$= (\mathrm{BE}_{\mathrm{model}} - \mathrm{PE}_{\mathrm{model}}) - [(\gamma_0 + \gamma_1\, \mathrm{BE}_{\mathrm{model}} = \varepsilon_2)\text{-}(\,(\gamma_0 + \gamma_1\, \mathrm{PE} + \varepsilon_1)]$$

$$=(1 - \gamma_1)(\mathrm{BE}_{\mathrm{model}} - \mathrm{PE}_{\mathrm{model}}) + \varepsilon$$

with $\varepsilon \sim N(0, 2\sigma^2\,(1-\rho))$. We can estimate σ^2 as the variance of the residuals measured on modeled values for the field sites, and ρ as the correlation of the residuals between project-baseline pairs. Where the model is estimated based on k pairs of modeled and measured values, and n hectares of fields are included in the project, then following the rationale of the parent methodology, constructing an approximate one-sided, 90% confidence limit for $\mathrm{DER}_{\mathrm{model}} - \mathrm{DER}_{\mathrm{measure}}$, i.e. yields an uncertainty deduction of

$$u_{struct} = n\big(1 - \gamma_1\big)(E[\mathrm{BE}_{\mathrm{model}} - \mathrm{PE}_{\mathrm{model}}]) = \mathrm{s}\sqrt{2\mathrm{n}(1-\rho)}\, t_{inv}\,(0.90, k-2)\,,$$

where the expectation in the left-hand term indicates the average modeled net emissions reduction on a per-hectare basis, and s is the empirical standard deviation of the regression residuals. The degrees of freedom in the inverse of the cumulative t distribution is $k - 2$, because there are two estimated parameters in the regression (compared with zero in the original derivation, where the slope was assumed to be one and the intercept was assumed to be zero). The left-hand term in the equation adjusts the original modeled net emissions reduction for the systematic departure of the model from a 1:1 line. This term will be positive when the model tends to over-predict measured emissions, and can be negative if the model tends to under-predict measured emissions on average. The second term, which is always positive, provides the adjustment for the variability in predictions around the typical model performance. The better the model is at predicting measured emissions, following adjustment by a linear calibration, the smaller the second term will be.

In the parent methodology, "Baseline adoption rate" refers to the baseline adoption rate of the project activities. When a Project Activity is implemented on less than 50% of the acres in the Rice Growing Region, it is considered a practice that is not commonly used, and is therefore eligible for a Common Practice Baseline after year ten. The flow chart is provided to better explain the different baselines allowed. Adoption rates of a specific practice are assessed on an annual basis. At validation of an initial Crediting Period, one annual adoption rate in the past five years suffices to set the baseline adoption rate. However, upon renewal of a project's Crediting Period the baseline adoption rate must be set as the average of at least two adoption rates in the five years preceding the Crediting Period. Often little data is available for a given practice initially at project start, but the practice is adopted more readily over time.

On line 644 of the parent methodology, the units of s, standard deviation, are not specified. These units should be [kg CO_2eq-/ha].

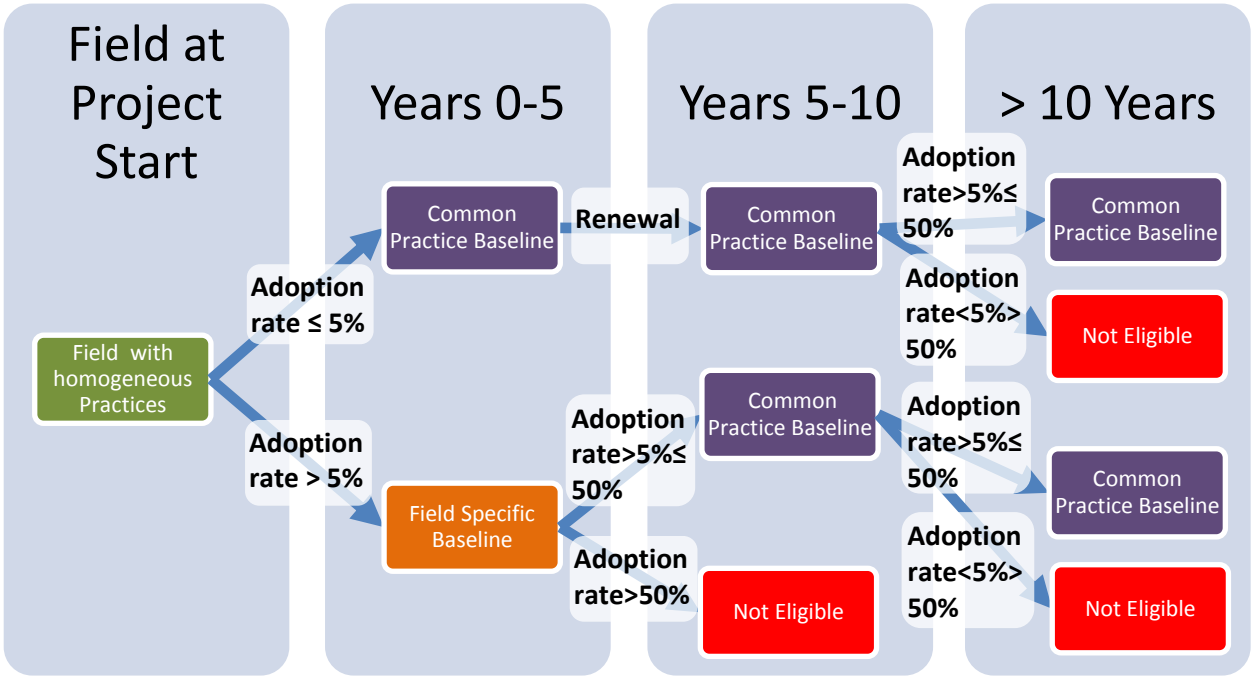

Figure 1. Flow chart of Crediting Period, Project Renewal and Baseline Update.

1.2 California Regional Calibration Module v1.0

The formula for structural uncertainty in line 77 of the California Module requires u_{struct} in the units of kg CO_2-eq. For this to be true, *s*, or standard deviation, must be in units of kg CO_2-eq/ha.

$$s = 51.3\ kg\ C - CH4/ha \cdot \frac{16\ kg\ CH_4}{12\ kg\ C} \cdot 21\ GWP_{CH_4} = 1436.4\ kg\ CO_2\_eq/ha$$

Additionally, as in the Midsouth Module, future updates to model calibration/validation and the associated uncertainty equations will be published in ACR's 'DNDC structural uncertainty deduction factors' addendum. The most updated uncertainty deduction factors for the California Rice Growing Region, as published in this addendum, are required to be used at the time of GHG Project Plan validation.