MODULE NAME:

ACCOUNTING MODULE FOR SMALL-SCALE EMISSIONS WITHIN THE US

MODULE CODE:

A-SMALLSCALE

Contents

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1. Parameters, Purpose and Applicability

1.1 Output Parameters(s):

Parameter Name	Parameter Description
S_BIO_{SS}	Net small-scale biotic sequestration/emissions (t CO_2e)
E_FERT_{SS}	Net small-scale fertilizer emissions (t CO_2e)
E_ENT_{SS}	Net small-scale enteric emissions (t CO_2e)
E_MAN_{SS}	Net small-scale manure emissions (t CO_2e)
E_FF	Net small-scale fossil fuel emissions (t CO_2e)

1.2 Key Input Data:

- Historic land management
- Planned project land management
- Soil type
- Fertilizer inputs
- Fossil fuel use
- Livestock population
- Livestock and manure management

1.3 Purpose

- To estimate emissions and net emission reductions from continental US-based grazing land and livestock management where reductions from focal sources are more than 5,000 t CO2-e annually but less than 60,000 t CO2-e annually and direct emissions are less than 60,000 t CO2-e annually.
- The module estimates both emissions in the baseline case and with project implementation.

1.4 Applicability Conditions

- The module is applicable to all continental US-based grazing land and livestock management greenhouse gas emissions under this methodology.
- Where reductions from focal sources are more than 5,000 t CO2-e annually but less than 60,000 t CO2-e annually and direct emissions are less than 60,000 t CO2-e annually (see T-XANTE) the module shall be used in all cases where the large-scale modules (A-BIOTIC, A-ENTERIC, A-MANURE and A-FERTILIZER) have not been voluntarily elected. For fossil

fuels in the US the module is mandatory for all projects where emissions reductions exceed 5,000 t CO2-e annually.

2. Calculation Procedure

For biotic sequestration the baseline shall be static, remaining fixed for the entire crediting period. *Ex ante* an estimate will be made of both baseline and with-project emissions. *Ex post* at the time of reporting, project emissions shall be calculated based on climatic conditions and other variable factors.

For fertilizer emissions, enteric emissions, manure emissions and fossil fuel emissions, the baseline shall be dynamic. *Ex ante* an estimate will be made of both baseline and with-project emissions. *Ex post* at the time of reporting, baseline and project emissions shall be calculated based on climatic conditions and other variable factors specific to the project and time period.

2.1 Model

The module uses the whole-farm calculation model COMET 2.0 available at:

http://www.cometfarm.nrel.colostate.edu/

"The COMET-Farm™ tool enables farmers and ranchers to estimate carbon sequestration and greenhouse gas emissions related to annual crop production, livestock and on-farm energy use. It provides a convenient yet rigorous way to evaluate the benefits of various conservation practices in reducing greenhouse gas emissions". "Because the tool uses detailed spatially-explicit data on climate and soil conditions for your location and allows you to enter detailed information for your field and livestock operations, it is able to produce an accurate estimate tailored to your specific situation. No prior training is needed to run the tool".

2.1.1 Running the model

The COMET-FARM model is user-friendly and provides guidance on each set of required inputs where needed. Users should enter separate parcels for each area in which differences exist in historic management, planned project management or soil type.

Field management is disaggregated by: crop / grass-hay / pasture-range / agroforestry / orchard-vineyard / CRP. Within these categories further disaggregation occurs by for example specific practice/crop, by tillage practice and by irrigation. Livestock management is disaggregated by livestock category, livestock population size, livestock management, livestock growth, manure management, and feed location and additives.

Fertilizer application and fossil fuels used should also be added where indicated (although users can elect to use A-MICROSCALE where applicable or will be required to use the large scale A-BIOTIC, A-ENTERIC, A-MANURE and A-FERTILIZER where applicable).

The outputs shall be:

- annual soil carbon stock change in baseline scenario and project scenario:

$\Delta C_{BSL,p}$	Annual change in carbon stock in the baseline scenario for parcel *p*; t CO_2-e/yr
$\Delta C_{P,p}$	Annual change in carbon stock in the project scenario for parcel *p*; t C/yr

- uncertainty in carbon stock change in baseline scenario and project scenario:

$\Delta C_{BSL,ERROR,p}$	Uncertainty in annual change in carbon stock in the baseline scenario for parcel *p*; t CO_2-e/yr
$\Delta C_{P,ERROR,p}$	Uncertainty in annual change in carbon stock in the project scenario for parcel *p*; t CO_2-e/yr

- annual N_2O flux in baseline scenario and project scenario:

$N2O_{BSL,p}$	Annual flux of nitrous oxide in the baseline scenario for parcel *p*; t CO_2-e/yr
$N2O_{P,p}$	Annual flux of nitrous oxide in the project scenario for parcel *p*; t CO_2-e/yr

- uncertainty in N_2O flux in baseline scenario and project scenario:

$N2O_{BSL,ERROR,p}$	Uncertainty in nitrous oxide flux in the baseline scenario for parcel *p*; t CO_2-e/yr
$N2O_{P,ERROR,p}$	Uncertainty in nitrous oxide flux in the project scenario for parcel *p*; t CO_2-e/yr

- annual enteric methane in baseline scenario and project scenario:

ENT_{BSL}	Annual enteric emissions in the baseline scenario; t CO_2-e/yr
ENT_{P}	Annual enteric emissions in the project scenario for parcel *p*; t CO_2-e/yr

- uncertainty in enteric methane in baseline scenario and project scenario:

$ENT_{BSL,ERROR}$ Uncertainty in enteric emissions in the baseline scenario; t CO_2-e/yr

$ENT_{P,ERROR}$ Uncertainty in enteric emissions in the project scenario for parcel *p*; t CO_2-e/yr

- annual manure methane in baseline scenario and project scenario:

MAN_{BSL} Annual enteric emissions in the baseline scenario; t CO_2-e/yr

MAN_P Annual enteric emissions in the project scenario for parcel *p*; t CO_2-e/yr

- uncertainty in manure methane in baseline scenario and project scenario:

$MAN_{BSL,ERROR}$ Uncertainty in enteric emissions in the baseline scenario; t CO_2-e/yr

$MAN_{P,ERROR}$ Uncertainty in enteric emissions in the project scenario for parcel *p*; t CO_2-e/yr

- annual fossil fuel emissions in baseline scenario and project scenario:

$FUEL_{BSL,}$ Annual fossil fuel emission in the baseline scenario; t CO_2-e/yr

$FUEL_P$ Annual fossil fuel emissions in the project scenario; t CO_2-e/yr

2.2 Biotic Sequestration

Biotic sequestration derived from COMET 2.0 will be summed for both baseline and project scenario and converted to carbon dioxide equivalents:

$$\Delta C_{BSL} = \sum_p \Delta C_{BSL,p} \quad \textbf{(1)}$$

Where:

ΔC_{BSL} Annual change in carbon stock in the baseline scenario; t CO_2-e/yr

$\Delta C_{BSL,p}$ Annual change in carbon stock in the baseline scenario for parcel *p*; t CO_2-e /yr

$$\Delta C_P = \sum_p \Delta C_{P,p} \quad \textbf{(2)}$$

Where:

ΔC_P Annual change in carbon stock in the project scenario; t CO_2-e/yr

$\Delta C_{P,p}$ Annual change in carbon stock in the project scenario for parcel *p*; t CO_2-e /yr

The net small-scale biotic sequestration (prior to consideration of uncertainty) will be equal to the changes occurring in the project case minus changes occurring in the baseline case:

$$S\_BIO_{ss,\,prelim} = \Delta C_P - \Delta C_{BSL} \quad \textbf{(3)}$$

Where:

$S\_BIO_{SS,prelim}$	Net small scale biotic sequestration/emission prior to uncertainty deductions; t CO_2-e
ΔC_P	Annual change in carbon stock in the project scenario; t CO_2-e/yr
ΔC_{BSL}	Annual change in carbon stock in the baseline scenario; t CO_2-e/yr

Calculation of uncertainty requires the propagation of errors across the various parcels and between the baseline and project cases:

$$\Delta C_{BSL,ERROR} = \sqrt{\sum_p \left(\Delta C_{BSL,ERROR,p}\right)^2} \quad \textbf{(4)}$$

Where:

$\Delta C_{BSL,ERROR,p}$	Uncertainty in annual change in carbon stock in the baseline scenario; t CO_2-e/yr
$\Delta C_{BSL,ERROR,p}$	Uncertainty in annual change in carbon stock in the baseline scenario for parcel *p*; t CO_2-e/yr

$$\Delta C_{P,ERROR} = \sqrt{\sum_p \left(\Delta C_{P,ERROR,p}\right)^2} \quad \textbf{(5)}$$

Where:

$\Delta C_{P,ERROR,p}$	Uncertainty in annual change in carbon stock in the project scenario; t CO_2-e/yr
$\Delta C_{P,ERROR,p}$	Uncertainty in annual change in carbon stock in the project scenario for parcel *p*; t CO_2-e/yr

$$S\_BIO_{SS,\,ERROR} = \sqrt{\left(\Delta C_{BSL,ERROR}\right)^2 + \left(\Delta C_{P,ERROR}\right)^2} \quad \textbf{(6)}$$

Where:

$S\_BIO_{SS,ERROR}$	Total uncertainty for small scale biotic sequestration/emission; t CO_2-e/yr
$\Delta C_{BSL,ERROR,p}$	Uncertainty in annual change in carbon stock in the baseline scenario; t CO_2-e/yr

$\Delta C_{P,ERROR,p}$	Uncertainty in annual change in carbon stock in the project scenario; t CO_2-e/yr

As COMET-FARM calculates 95% confidence intervals, deductions begin where uncertainty exceeds 15% of the mean:

If $S\_BIO_{SS,ERROR}$ ≤ 15% of $S\_BIO_{SS,prelim}$ then no deduction for uncertainty is required ($S\_BIO_{SS,prelim}$ = S_BIO_{SS}).

If $S\_BIO_{SS,ERROR}$ > 15% of $S\_BIO_{SS,relim}$ then the modified value for S_BIO to account for uncertainty shall be:

$$S\_BIO_{SS} = S\_BIO_{SS,\,prelim} - \left(S\_BIO_{SS,ERROR} - \left(S\_BIO_{SS,\,prelim} * 15\%\right)\right) \quad \textbf{(7)}$$

Where:

S_BIO_{SS}	Net small scale biotic sequestration/emission; t CO_2-e
$S\_BIO_{SS,prelim}$	Net small scale biotic sequestration/emission prior to uncertainty
$S\_BIO_{SS,ERROR}$	Total uncertainty for small scale biotic sequestration/emission; %

2.2.1 Permanence

The number of credits to be held in the ACR buffer pool is determined as a percentage of the total carbon stock benefits.

$$Buffer_{GLLM} = S\_BIO_{SS} * \left(1 - Buffer\%\right) \quad \textbf{(8)}$$

Where:

$Buffer_{GLLM}$	Buffer withholding for GLLM projects; t CO_2-e
S_BIO_{SS}	Net small scale biotic sequestration/emission; t CO_2-e
Buffer%	Buffer withholding percentage; %

Buffer withholding percentages are based on the project's overall risk classification. This risk classification is derived using an ACR-approved risk assessment tool per the *ACR Forest Carbon Project Standard.* The risk assessment yields a percentage of ERTs generated by the project activity that must be deposited into the ACR buffer pool to mitigate future reversals. The buffer deposit may be made in project ERTs or alternately in ERTs of any other type and vintage. Alternately if the Project Proponent has elected to use another ACR-approved risk mitigation product in lieu of a buffer contribution, *Buffer%* = 0.

2.3 Fertilizer Emissions

Fertilizer emissions derived from COMET-FARM will be summed for both baseline and project scenario and converted to carbon dioxide equivalents:

$$N2O_{BSL} = \sum_{p} N2O_{BSL,p} \quad (8)$$

Where:

$N2O_{BSL}$ Annual flux of nitrous oxide in the baseline scenario; t CO_2e/yr

$N2O_{BSL,p}$ Annual flux of nitrous oxide in the baseline scenario for parcel *p*; t CO_2e/yr

$$N2O_{P} = \sum_{p} N2O_{P,p} \quad (9)$$

Where:

$N2O_{P}$ Annual flux of nitrous oxide in the project scenario; t CO_2e/yr

$N2O_{P,p}$ Annual flux of nitrous oxide in the project scenario for parcel *p*; t CO_2e /yr

The net small-scale fertilizer emissions (prior to consideration of uncertainty) will be equal to the changes occurring in the project case minus changes occurring in the baseline case:

$$E\_FERT_{SS,prelim} = N2O_{BSL} - N2O_{P} \quad (10)$$

Where:

$E\_FERT_{SS,prelim}$ Net small scale fertilizer emissions prior to uncertainty deductions; t CO_2-e

$N2O_{BSL}$ Annual flux of nitrous oxide in the baseline scenario; t CO_2e/yr

$N2O_{P}$ Annual flux of nitrous oxide in the project scenario; t CO_2e/yr

Calculation of uncertainty requires the propagation of errors across the various parcels and between the baseline and project cases:

$$N2O_{BSL,ERROR} = \sqrt{\sum_{p} \left(N2O_{BSL,ERROR,p}\right)^2} \quad (11)$$

Where:

$N2O_{BSL,ERROR,}$ Uncertainty in nitrous oxide flux in the baseline scenario; t CO_2e/yr

$N2O_{BSL,ERROR,p}$ Uncertainty in nitrous oxide flux in the baseline scenario for parcel *p*; t CO_2e/yr

$$N2O_{P,ERROR} = \sqrt{\sum_{p}\left(N2O_{P,ERROR,p}\right)^2} \quad (12)$$

Where:

$N2O_{P,ERROR}$	Uncertainty in nitrous oxide flux in the project scenario; t CO_2e/yr
$N2O_{P,ERROR,p}$	Uncertainty in nitrous oxide flux in the project scenario for parcel *p*; t CO_2e/yr

$$E\_FERT_{SS,ERROR} = \sqrt{\left(N2O_{BSL,ERROR}\right)^2 + \left(N2O_{P,ERROR}\right)^2} \quad (13)$$

Where:

$E\_FERT_{SS,ERROR}$	Total uncertainty for small scale fertilizer emissions; t CO_2e/yr
$N2O_{BSL,ERROR,}$	Uncertainty in nitrous oxide flux in the baseline scenario; t CO_2e/yr
$N2O_{P,ERROR}$	Uncertainty in nitrous oxide flux in the project scenario; t CO_2e/yr

As COMET-FARM calculates 95% confidence intervals, deductions begin where uncertainty exceeds 15% of the mean[1]:

If $E\_FERT_{SS,ERROR}$ ≤ 15% of $E\_FERT_{SS,prelim}$ then no deduction for uncertainty is required ($E\_FERT_{SS,prelim} = E\_FERT_{SS}$).

If $E\_FERT_{SS,ERROR}$ > 15% of $E\_FERT_{SS,prelim}$ then the modified value for E_FERT to account for uncertainty shall be:

$$E\_FERT_{SS} = E\_FERT_{SS,prelim} - \left(E\_FERT_{SS,ERROR} - \left(E\_FERT_{SS,prelim} * 15\%\right)\right) \quad (14)$$

Where:

E_FERT_{SS}	Net small scale fertilizer emissions; t CO_2-e
$E\_FERT_{SS,\ prelim}$	Net small scale fertilizer emissions prior to uncertainty deductions; t CO_2-
$E\_FERT_{SS,\ ERROR}$	Total uncertainty for small scale fertilizer emissions; t CO_2e/yr

[1] Were COMET output to change from 95% to 90% confidence interval the calculations should change to 90% +/- 10% instead of 95% +/- 15%.

2.4 Enteric Emissions

The net small-scale enteric emissions (prior to consideration of uncertainty) will be equal to the changes occurring in the project case minus changes occurring in the baseline case:

$$E\_ENT_{SS,prelim} = ENT_{BSL} - ENT_P \quad (15)$$

Where:

$E\_ENT_{SS,prelim}$	Net small scale enteric emissions prior to uncertainty deductions; t CO_2-e
ENT_{BSL}	Annual enteric emissions in the baseline scenario; t CO_2e/yr
ENT_P	Annual enteric in the project scenario; t CO_2e/yr

Calculation of uncertainty requires the propagation of errors across the various parcels and between the baseline and project cases:

$$E\_FERT_{SS,ERROR} = \sqrt{(ENT_{BSL,ERROR})^2 + (ENT_{P,ERROR})^2} \quad (16)$$

Where:

$E\_ENT_{SS,ERROR}$	Total uncertainty for small scale enteric emissions; t CO_2e/yr
$ENT_{BSL,ERROR,}$	Uncertainty in enteric emissions in the baseline scenario; t CO_2e/yr
$ENT_{P,ERROR}$	Uncertainty in enteric emissions in the project scenario; t CO_2e/yr

As COMET-FARM calculates 95% confidence intervals, deductions begin where uncertainty exceeds 15% of the mean:

If $E\_ENT_{SS,ERROR}$ ≤ 15% of $E\_ENT_{SS,prelim}$ then no deduction for uncertainty is required ($E\_ENT_{SS,prelim} = E\_MAN_{SS}$).

If $E\_ENT_{SS,ERROR}$ > 15% of $E\_ENT_{SS,prelim}$ then the modified value for *E_ENT* to account for uncertainty shall be:

$$E\_ENT_{SS} = E\_ENT_{SS,prelim} - (E\_ENT_{SS,ERROR} - (E\_ENT_{SS,prelim} * 15\%)) \quad (17)$$

Where:

E_ENT_{SS}	Net small scale enteric emissions; t CO_2-e
$E\_ENT_{SS,\ prelim}$	Net small scale enteric emissions prior to uncertainty deductions; t CO_2-e
$E\_ENT_{SS,\ ERROR}$	Total uncertainty for small enteric fertilizer emissions; t CO_2e/yr

2.5 Manure Emissions

The net small-scale manure emissions (prior to consideration of uncertainty) will be equal to the changes occurring in the project case minus changes occurring in the baseline case:

$$E\_MAN_{SS,prelim} = MAN_{BSL} - MAN_P \tag{18}$$

Where:

$E\_MAN_{SS,prelim}$	Net small scale manure emissions prior to uncertainty deductions; t CO_2-e
MAN_{BSL}	Annual manure emissions in the baseline scenario; t CO_2e/yr
MAN_P	Annual manure in the project scenario; t CO_2e/yr

As COMET-FARM calculates 95% confidence intervals, deductions begin where uncertainty exceeds 15% of the mean:

If $E\_MAN_{SS,ERROR}$ ≤ 15% of $E\_MAN_{SS,prelim}$ then no deduction for uncertainty is required ($E\_MAN_{SS,prelim} = E\_MAN_{SS}$).

If $E\_MAN_{SS,ERROR}$ > 15% of $E\_MAN_{SS,prelim}$ then the modified value for *E_MAN* to account for uncertainty shall be:

$$E\_MAN_{SS} = E\_MAN_{SS,prelim} - \left(E\_MAN_{SS,ERROR} - \left(E\_MAN_{SS,prelim} * 15\%\right)\right) \tag{19}$$

Where:

E_MAN_{SS}	Net small scale manure emissions; t CO_2-e
$E\_MAN_{SS,\ prelim}$	Net small scale manure emissions prior to uncertainty deductions; t CO_2-e
$E\_MAN_{SS,\ ERROR}$	Total uncertainty for small manure fertilizer emissions; t CO_2e/yr

2.6 Fossil Fuel Emissions

Net fossil fuel emissions are equal to the difference between emissions in the baseline and project cases:

$$E\_FF = FUEL_{BSL} - FUEL_P \tag{20}$$

Where:

E_FF	Net fossil fuel emissions; t CO_2e
$FUEL_{BSL,}$	Annual fossil fuel emission in the baseline scenario; t CO_2-e/yr
$FUEL_P$	Annual fossil fuel emissions in the project scenario; t CO_2-e/yr

3. Input Data Sources and Requirements

In choosing key parameters or making important assumptions based on information that is not specific to the project circumstances, such as in use of existing published data, Project Proponents must retain a conservative approach: that is, if different values for a parameter are equally plausible, a value that does not lead to overestimation of net GHG emissions reductions or net sequestration must be selected.

It is a requirement that project developers include an explanation and justification for all parameters selected and used in the module.

3.1 Data for validation

Parameter	Various as required by COMET-FARM model
Units	
Description	
Relevant Section	
Relevant Equation(s)	
Source of Data	
Data Requirements	
Collection Procedure	
Revision Frequency	
Comments	Use of defaults rather than entering in project specific data shall be justified