GRAZING LAND AND LIVESTOCK MANAGEMENT GREENHOUSE GAS MITIGATION METHODOLOGY

MODULE NAME:

ACCOUNTING FOR LEAKAGE

MODULE CODE:

L-GLLM

Output Parameter(s)
Parameter Name: E_LK
Parameter Description: Net greenhouse gas emissions due to leakage (t CO_2e).

Key Input Data:

E_ENT_{BSL}	Enteric emissions, t CO_2-e at baseline.
E_MAN_{BSL}	Manure emissions, t CO_2e at baseline.
E_FERT_{BSL}	Fertilizer emissions, tCO_2-e at baseline.
E_FF_{BSL}	Fossil fuel emissions, t CO_2-e at baseline.
S_BIO_{BSL}	Biotic sequestration/emission, t CO_2-e at baseline.
Y_{BSL}	Product output in the baseline case.
Y_P	Product output in the project case.
Y_{AS}	Product output from production shifted to non-project areas.

Purpose
To estimate GHG emissions caused by activity shifting and market-effects leakage related to GLLM project activities.

Applicability Conditions
The module is applicable to all grazing land and livestock management activities under this methodology.

The module is required where the project leads to a decrease greater than 3% in output relative to the baseline case.

1.0 Determination of Potential for Leakage

The following assessment shall be undertaken by all projects to determine the potential for leakage and thus whether or not calculations are required for activity shifting and market-effects leakage.

1. Estimate and justify output/yield in the baseline case and monitor output/yield in the project case. Where baseline output exceeds project output by >3% and the baseline land owner/user purchases new fields, brings new fields into production, increases livestock population outside the project boundaries, or is displaced from the project area, activity shifting leakage shall be determined per section 2.0.
2. Where baseline output exceeds project output by >3%, market-effects leakage shall be determined per section 3.0. Where project output exceeds baseline output, section 3.0 may be used to determine positive leakage.

2.0 Activity Shifting Leakage

Activity shifting leakage occurs when the driver(s) of baseline emissions that operated in the project area before the project start date are simply relocated to another area outside of the project boundary.

Where activity shifting accounting is required (see section 1.0), monitoring shall occur for all livestock operations of baseline landowners/land users. Where possible, production should be reported; where this is not possible, then common practice should be used to determine per unit area / per head emissions and estimates of numbers of head. The methods in the emissions modules should be used to estimate emissions dependent on the magnitude (A-MICROSCALE, A-SMALLSCALE, A-ENTERIC, A-MANURE, A-FERTILIZER, A-BIOTIC).

Activity shifting leakage emissions (*E_AS*) shall be equal to the summed emissions from newly farmed lands and/or increases in livestock populations outside the project boundary.

Additional product yield resulting from production shifted to non-project areas ($Y_{AS,t}$) – i.e. when land owner/user purchases new fields, brings new fields into production, increases livestock population outside project boundaries, or is displaced from the project area – shall be determined based on producer records.

3.0 Market-Effects Leakage

3.1 Introduction

This module is used for calculating leakage from GLLM project activities where there is a reduction in farm- or ranch-level output (e.g. pounds of milk or meat produced) relative to baseline output by more than 3%. When project activities result in reduced output, it is assumed that market-mediated supply and demand responses will lead to some proportion of the reduced output from within the project boundary being replaced in the marketplace by other producers outside of the project boundary. This market-mediated response comes with associated emissions, thus negating some of the GHG emission reductions observed in the project areas.

Such market-effects leakage is transmitted through price signals in the market: a reduction in output reduces supply in the market, which exerts an upward pressure on price that may incentivize increased production elsewhere. In order to quantify market effects leakage in an empirically sound manner, the outcomes of the project activity must be related to changes in GHG emissions outside of the project boundary that are attributable to the project (Vohringer 2004). As such, this methodology employs the theory developed by Murray et al. (2004) describing how market-effects leakage can be quantified using published estimates of price elasticities of supply and demand. Price elasticities describe how a change in price affects quantity supplied or demanded. For example, a price elasticity of supply of 0.4 indicates that a 1% increase (decrease) in price results in a 0.4% increase (decrease) in the quantity supplied.

Price elasticities of supply and demand for the dairy and beef sectors have been derived and published in several peer-reviewed economic studies (e.g., Tvedt et al. 1991) and can be used to estimate market-effects leakage, as described below. The leakage factor for supply changes is greater when, for a given sector, there is high price elasticity of supply and low price elasticity of demand. This means that a percentage change in price will induce a greater percentage increase in supply and a lesser percentage decrease in quantity demanded. In the long-term, this may be the case for agriculture, as the price elasticity of supply is generally high and the price elasticity of demand for staple foods tends to be very low.

3.2 Leakage Factor

The default market-effects leakage factor applicable to any project using this methodology is determined using the following equation derived from Murray et al. (2004), Vohringer et al. (2004), and Murray and Baker (2011). Note that E_D is generally a negative number (demand goes down as price goes up) and E_S is generally a positive number (supply goes up as price goes up), so $LE_{M,t}$ will be a negative proportion that ranges from 0 to -1. For US-based GLLM project activities, project proponents must use the following values for the E_S and E_D:

	E_S	E_D
Dairy Sector	0.075[1]	-0.26[2]
Beef Cattle Sector	0.91[3]	-0.61[4]

Projects located outside the United States must use verifiable values for E_S and E_D based on local market data.

(1)

$$LE_{M,t} = \frac{E_S}{E_D - E_S}$$

Where:

$LE_{M,t}$ Market leakage factor at time t

E_S Elasticity of supply with respect to price

E_D Elasticity of demand with respect to price

3.3 Calculating Leakage Deduction

The net greenhouse gas emissions due to market-effects leakage are derived from the difference in output (e.g. milk or beef) between the baseline and project at time *t*, any additional output from production shifted to non-project areas (activity shifting), the market leakage factor from equation (1), and the baseline GHG emissions per unit output:

$$E\_ME = \left[\left(\frac{(Y_{P,t} + Y_{AS,t}) - Y_{BSL,t}}{Y_{BSL,t}} \right) * LE_{M,t} * e_{BSL,t} \right] \quad \textbf{(2)}$$

Where:

E_ME Net greenhouse gas emissions due to market-effects leakage (t CO_2-e)

$Y_{P,t}$ Project output at time t; lbs/kg, gal/l, etc.

$Y_{AS,t}$ Output from production shifted to non-project areas at time t; lbs/kg, gal/l, etc.

$Y_{BSL,t}$ Baseline projected output at time t; lbs/kg, gal/l, etc.

$LE_{M,t}$ Market leakage factor at time t from equation 1

[1] From http://www.keepdairystrong.com/files/State_and_Regional_Impacts_of_DMSP.pdf
[2] Value for dairy from "unconditional own-price elasticity subcategories" table at http://www.ers.usda.gov/data-products/international-food-consumption-patterns.aspx
[3] From *Elasticities in World Meat Markets* as referenced in http://www.farmdoc.illinois.edu/nccc134/conf_2000/pdf/confp23-00.pdf
[4] From http://www.agecon.ksu.edu/livestock/Extension%20Bulletins/BeefDemandDeterminants.pdf

$e_{BSL,t}$	Baseline emissions per unit output (t CO_2e/ lbs/kg, gal/l output)

The value for baseline GHG emissions per unit output, $e_{BSL,t}$ is derived from the baseline GHG emissions of each applicable SSR, which are outputs of the other accounting modules:

$$e_{BSL,t} = \left(E\_ENT_{BSL,t} + E\_MAN_{BSL,t} + E\_FERT_{BSL,t} + E\_FF_{BSL,t} + E\_BIO_{BSL,t}\right)/Y_{BSL,t} \quad \textbf{(3)}$$

Where:

$e_{BSL,t}$	Baseline emissions per unit output at time t (t CO_2-e/ lbs/kg, gal/l output)
$E\_ENT_{BSL,t}$	Enteric emissions from livestock in the baseline case at time t (t CO_2-e)
$E\_MAN_{BSL,t}$	Manure emissions in the baseline case at time t (t CO_2-e)
$E\_FERT_{BSL,t}$	Fertilizer emissions in the baseline case at time t (t CO_2-e)
$E\_FF_{BSL,t}$	Fossil fuel emissions in the baseline case at time t (t CO_2-e)
$E\_BIO_{BSL,t}$	Biotic sequestration/emissions in the baseline case at time t (t CO_2-e)
$Y_{BSL,t}$	Baseline projected output at time t; lbs/kg, gal/l, etc.

Note that in theory it is possible that the sum of project output and output from production shifted to non-project areas ($Y_{P,t}$ + $Y_{AS,t}$) is greater than baseline output $Y_{BSL,t}$. In that case per section 1.0, "positive leakage" may optionally be calculated. In equation (2) E-ME will be a negative number, and in effect there will be positive market-effects leakage, since increased output from the project plus activity shifting means that less output needs to be produced elsewhere, as compared to the baseline case. However there may still be emissions from activity shifting leakage, so overall emissions from leakage (E-LK in Equation (4)) may be positive even if E_ME is negative.

4.0 Summing Market Effects and Activity Shifting Leakage

The total emissions from leakage will be equal to the market-effects leakage plus activity shifting leakage:

$$E\_LK = E\_ME + E\_AS \quad \textbf{(4)}$$

Where:

E_LK	Net greenhouse gas emissions due to leakage (t CO_2-e)
E_ME	Net greenhouse gas emissions due to market-effects leakage (t CO_2-e)
E_AS	Net greenhouse gas emissions due to activity shifting leakage (t CO_2-e)

Note that if E_ME is negative and E_AS is zero, E_LK will be negative and because E_LK is subtracted from net emission reductions, there will be "positive leakage;" in other words, increased output attributable to the project activity, relative to the baseline case, is displacing production elsewhere and displacing the emissions associated with that production.

4.0 Input Data Sources and Requirements

4.1 Data for validation

Parameter	$Y_{BSL,t}$
Units	lbs, kg, gallons, litres
Description	*Baseline projected output at time t.*
Relevant Section	**2.3**
Relevant Equation(s)	**2, 3**
Source of Data	Based on average output for the 5 years prior to project start date. If 5 years of historic data is unavailable, based on common practice.
Data Requirements	
Collection Procedure	Producer records if available for 5 years prior to project start date. If common practice values are being used, based on publicly available verifiable data from peer-reviewed publications, USDA National Agricultural Statistics Service, university extension publications, or expert opinion.
Revision Frequency	At each verification.
Comments	

Parameter	$Y_{P,t}$
Units	lbs, kg, gallons, litres
Description	*Project output at time t.*
Relevant Section	**2.3**
Relevant Equation(s)	**2**
Source of Data	As monitored each year based on producer records.
Data Requirements	
Collection Procedure	Per existing procedures used by the producer.
Revision Frequency	At each verification.
Comments	

Parameter	$Y_{AS,t}$
Units	lbs, kg, gallons, litres
Description	*Output from production shifted to non-project areas at time t.*
Relevant Section	**2.3**
Relevant Equation(s)	**2**
Source of Data	As monitored each year based on producer records.
Data Requirements	
Collection Procedure	Per existing procedures used by the producer.
Revision Frequency	At each verification.
Comments	

Parameter	$E\_ENT_{BSL,t}$
Units	*(t CO_2-e)*
Description	*Enteric emissions from livestock in the baseline case at time t (t CO2-e).*
Relevant Section	**2.3**
Relevant Equation(s)	**3**
Source of Data	Derived in A-ENTERIC or A-MICROSCALE
Data Requirements	
Collection Procedure	
Revision Frequency	At each verification.
Comments	From A-ENTERIC when annual enteric emissions are >5,000 tCO_2-e. For annual emissions <5,000 tCO_2-e, set $E\_ENT_{BSL,t}$=$E\_ENT_{MS,BSL}$ from A- MICROSCALE.

Parameter	$E\_MAN_{BSL,t}$
Units	*(t CO_2-e)*
Description	*Manure emissions in the baseline case at time t (t CO2-e).*
Relevant Section	**2.3**
Relevant Equation(s)	**3**
Source of Data	Derived in A-MANURE or A-MICROSCALE
Data Requirements	
Collection Procedure	
Revision Frequency	At each verification.
Comments	From A-MANURE when annual manure emissions are >5,000 tCO_2-e. For annual emissions <5,000 tCO_2-e, set $E\_MAN_{BSL,t}$ = $E\_MAN_{MS,BSL}$ from A- MICROSCALE.

Parameter	$E\_FERT_{BSL,t}$
Units	*(t CO_2-e)*
Description	*Fertilizer emissions in the baseline case at time t (t CO2-e).*
Relevant Section	**2.3**
Relevant Equation(s)	**3**
Source of Data	Derived in A-FERTILIZER, A-SMALLSCALE, or A-MICROSCALE
Data Requirements	
Collection Procedure	
Revision Frequency	At each verification.
Comments	From A- FERTILIZER when annual fertilizer emissions are >60,000 tCO_2-e for projects in continental US, and >5,000 tCO_2-e for projects outside US. For annual emissions <60,000 tCO_2-e but >5,000 tCO_2-e in the US, set $E\_FERT_{BSL,t}$ = $E\_FERT_{SS,BSL}$ from A-SMALLSCALE. For annual emissions <5,000 tCO_2-e, set $E\_FERT_{BSL,t}$ = $E\_FERT_{MS,BSL}$ from A- MICROSCALE.

Parameter	$E\_FF_{BSL,t}$
Units	*(t CO_2-e)*
Description	*Fossil fuel emissions in the baseline case at time t (t CO2-e).*
Relevant Section	**2.3**
Relevant Equation(s)	**3**
Source of Data	Derived in A-SMALLSCALE, or A-MICROSCALE
Data Requirements	

Collection Procedure	
Revision Frequency	At each verification.
Comments	From A- SMALLSCALE when annual fossil fuel emissions are >5,000 tCO_2-e for projects in continental US. For all other projects set $E\_FF_{BSL,t} = E\_FF_{MS,BSL}$ from A-MICROSCALE.

Parameter	$E\_BIO_{BSL,t}$
Units	*(t CO_2-e)*
Description	*Biotic sequestration/emissions in the baseline case at time t (t CO2-e).*
Relevant Section	**2.3**
Relevant Equation(s)	**3**
Source of Data	Derived in A-BIOTIC, A-SMALLSCALE, or A-MICROSCALE
Data Requirements	
Collection Procedure	
Revision Frequency	At each verification.
Comments	From A- BIOTIC when annual biotic sequestration is >60,000 tCO_2-e for projects in continental US, and >5,000 tCO_2-e for projects outside US. For annual sequestration <60,000 tCO_2-e but >5,000 tCO_2-e in the US, set $S\_BIO_{BSL,t} = S\_BIO_{SS,BSL}$ from A-SMALLSCALE. For annual emissions <5,000 tCO_2-e, set $S\_BIO_{BSL,t} = S\_BIO_{MS,BSL}$ from A- MICROSCALE.

5.0 References

Murray, B.C., Baker, J.S. 2011, ‘An output-based intensity approach for crediting greenhouse gas mitigation in agriculture: explanation and policy implications,’ Greenhouse Gas Measurement and Management 1(1):27-36.

Murray, B.C., McCarl, B.A., Lee, H., 2004, ‘Estimating Leakage from Forest Carbon Sequestration Programs,’ Land Economics 80:109-124

Tvedt, D., M. Reed, A. Maligaya, and B. Bobst. Elasticities in World Meat Markets. Agricultural Economics Research Report Series No. 55. University of Kentucky, 1991.

Vöhringer, F., Kuosmanen, T. & Dellink, R., 2004, A Proposal for the Attribution of Market Leakage to CDM Projects. HWWA Discussion Paper, Volume 262.