

Equations included in the Irrigated Cotton Calculator under the *Carbon Credits (Carbon Farming Initiative—Reducing Greenhouse Gas Emissions from Fertiliser in Irrigated Cotton) Determination 2015.*

OVERVIEW OF CALCULATIONS

Baseline emissions are the sum of the direct and indirect emissions from synthetic fertiliser and emissions from green manure residues that would have occurred under business as usual to achieve the cotton crop yield in the project reporting year. This is calculated by multiplying the average emissions intensity over the emissions intensity reference period (the ‘baseline emissions intensity’) (tonnes CO₂-e from synthetic fertiliser and green manure residues /tonnes lint yield), by the cotton crop yield in the cotton area in the project reporting year. The emissions intensity is analogous to the nitrogen fertiliser use efficiency, NFUE (tonnes lint yield/ tonnes synthetic fertiliser nitrogen applied). That is, a decrease in emissions intensity is akin to an improvement in NFUE. A project reporting year refers to a year in the reporting period in which a cotton crop was planted in a project area.

Baseline emissions are discounted by 6.5% prior to calculating the net abatement amount for a project reporting year.

The project emissions are the sum of direct and indirect emissions from synthetic fertiliser application and emissions from green manure residues in the project reporting year.

To calculate the interim abatement amount in a project reporting year, the project emissions are subtracted from the baseline emissions. Net abatement amount for a reporting period is the sum of the interim abatement amounts in all years that are part of a reporting period. If the interim abatement amount is less than zero for a project reporting year, is taken to be zero for the purpose of calculating the net abatement amount over the reporting period.

The project area is the area of land on which the project has been, is being, or is to be carried out, which, for projects applying this Determination, is likely to be equivalent to the boundary of the farm on which cotton is grown. Abatement is calculated on the total area of cotton planted within a project area in each project reporting year (the cotton area). The cotton area in each year in the emissions intensity reference period or crediting period must be within the boundaries of the project area.

Under this Determination, proponents must use the Irrigated Cotton Calculator to determine the net abatement amount. The equations described below are implemented in the Irrigated Cotton Calculator.

CALCULATING BASELINE EMISSIONS

Annual direct nitrous oxide emissions from synthetic fertiliser application in the emissions intensity reference period

The direct emissions from synthetic fertiliser can be calculated based on the proponent's verifiable records of synthetic fertiliser application rates from all cotton growing fields (the cotton area) in a project area for each cotton crop year in the emissions intensity reference period, and the emissions factor from Fig 1 below.

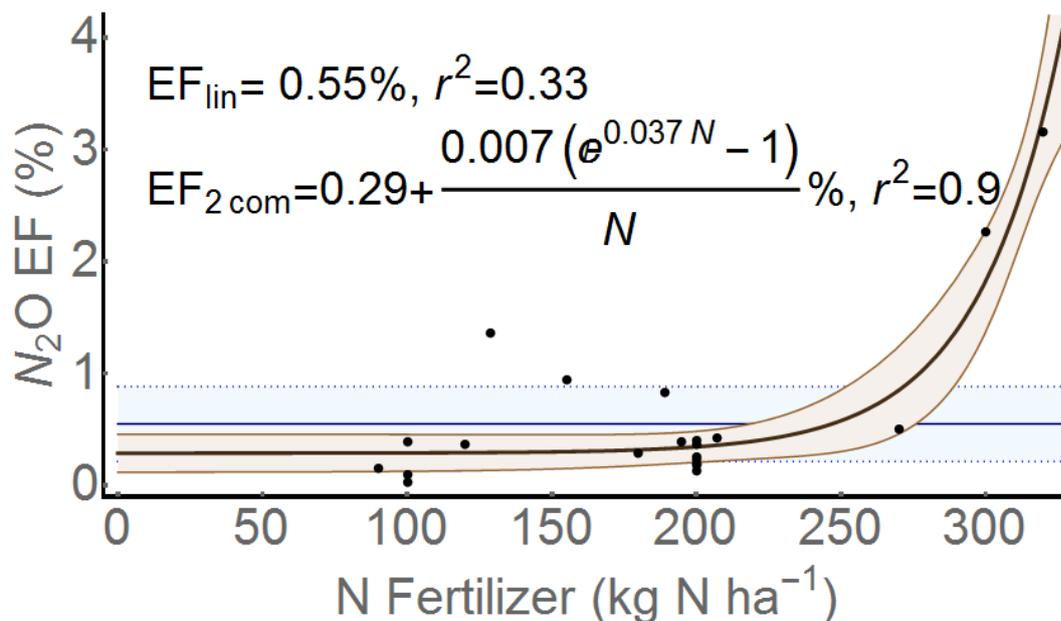


Figure 1. Linear and two component (linear + exponential) models (including 95% confidence interval) describing N₂O Emission Factors vs. N fertiliser application to cotton in Australia One (x,y) data point (300,4.79) is not shown. (Scherbak et al. (2014). Determination of Emissions Factors for Estimating Nitrous Oxide Emissions from Australia's Cotton Industry. Queensland University of Technology, Brisbane and CSIRO Division of Land and Water, Report to the Department of the Environment).

The following equations, based on the method presented in NIR (2012) (Section 6.6.2.1), are employed for calculating emissions from the application of nitrogen-containing synthetic fertilisers (excluding organic fertilisers that do not meet the definition of synthetic fertiliser in the Determination).

The annual mass of nitrogen in all synthetic fertiliser types applied in cotton area, *l*, and pre-project year, *m*, can be calculated from sum of the mass of N in each fertiliser type. This is calculated from the total mass of each synthetic fertiliser applied and the fraction of N specified for that particular synthetic fertiliser. A pre-project year is a year in the emissions intensity reference period in which cotton was planted.

$$M_{PP\text{ fert},l,m} = \sum_{i=1..n} (TM_{PP\text{ fert},i,l,m} \times X_{PP\text{ fert},i,l,m}) \quad \text{Equation (1) (derived from NIR 4D1_1)}$$

Where:

$M_{PP\text{ fert},l,m}$ = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in pre-project year, m (t N) for a total of n synthetic fertilisers

$TM_{PP\text{ fert},i,l,m}$ = Annual total mass of synthetic fertiliser, i, applied in cotton area, l, in pre-project year, m (t applied).

$X_{PP\text{ fert},i,l,m}$ = Fraction of N in synthetic fertiliser, i, applied in cotton area, l, in pre-project year, m (t N. t applied⁻¹). Obtained from manufacturer label.

Nitrous oxide emissions for synthetic fertilisers applied in cotton area, l, in pre-project year m, are determined as:

$$NE_{PP\text{ fert},l,m} = M_{PP\text{ fert},l,m} \times EF_k \times C_g \quad \text{Equation (2) (derived from NIR 4D1_2)}$$

Where:

$NE_{PP\text{ fert},l,m}$ = Annual nitrous oxide emissions from synthetic fertiliser nitrogen, applied in cotton area, l, in pre-project year, m (t N₂O)

$M_{PP\text{ fert},l,m}$ = Annual total mass of N in all synthetic fertiliser types applied in cotton area, l, in pre-project year, m (t N)

EF_k = Emission factor for fertiliser nitrogen, applied to production system, k (irrigated cotton), Tier 2 values (t N₂O-N. t N⁻¹). Use $EF = 0.29 + (0.007(e^{0.037N} - 1))/N / 100$. Where N is the average synthetic fertiliser nitrogen application rate on the cotton area in kg N/ha. See Fig 1 above for the combined linear and curvilinear function. The emissions factor, EF_k , is capped at 1.83%.

C_g = Conversion factor of 44/28 to convert elemental mass of N₂O to molecular mass (t N₂O. t N₂O-N⁻¹).

Annual direct emissions in CO₂-e from synthetic fertiliser application in the emissions intensity reference period

Annual emissions in carbon dioxide equivalents (tCO₂-e) from applied synthetic fertilisers in the emissions intensity reference period is determined from the annual nitrous oxide (N₂O) emissions for all synthetic fertilisers, applied in cotton area, l, in pre-project year m, multiplied by the global warming potential of nitrous oxide.

$$E_{PP\text{ fert},l,m} = GWP_{N_2O} \times NE_{PP\text{ fert},l,m} \quad \text{Equation (3) (project based equation)}$$

Where:

$E_{PP\text{ fert},l,m}$ = Annual emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in pre-project year, m (t CO₂-e)

GWP_{N_2O} Global Warming Potential of Nitrous Oxide, N₂O, 298 (t CO₂-e. t N₂O⁻¹)

$NE_{PP\text{ fert},l,m}$ = Annual nitrous oxide emissions from synthetic fertiliser nitrogen, applied to cotton area, l, in pre-project year, m (t N₂O)

Annual CO₂ emissions from urea application in the emissions intensity reference period

In addition to N₂O emissions, urea when applied to soils releases carbon dioxide (CO₂) and water (H₂O). Carbon dioxide is produced when urea is hydrolysed and, being from a non-biogenic source is included in the greenhouse gas assessment boundary. When urea (CO(NH₂)₂) is applied as a fertiliser it is hydrolysed into ammonium (NH₄⁺), hydroxyl ion (OH⁻) and bicarbonate (HCO₃⁻). The bicarbonate that is formed then converts to carbon dioxide (CO₂) and water (H₂O).

Urea is formed from the reaction of ammonia (NH₃) and carbon dioxide (CO₂). Since the CO₂ used to form urea commonly originates from methane in natural gas (a fossil fuel), this source of carbon must be included in the greenhouse gas accounting (IPCC, 2006). Each atom of nitrogen applied will release half an atom of carbon as CO₂ and thus, 0.733 t of CO₂ are required per tonne of urea (IPCC, 2006, volume 3, Chapter 3). This equates to an emission factor of 1.571 t CO₂ t N⁻¹ applied in addition to the emissions of nitrous oxide.

Annual emissions from urea for cotton area, l, in each pre-project year, m, of the emissions intensity reference period can be determined from the annual total mass of urea applied multiplied by its emissions factor:

$$E_{PPUrea,l,m} = M_{PPUrea,l,m} \times EF_{Urea} \quad \text{Equation (4) (IPCC 2006)}$$

Where:

$E_{PPUrea,l,m}$ = Annual emissions from urea applied in cotton area, l, in pre-project year, m (t CO₂-e)

$M_{PPUrea,l,m}$ = Annual total mass of urea applied in cotton area, l, in pre-project year, m (t urea applied)

EF_{Urea} = Emission factor for urea, 0.733 (t CO₂ (t urea applied)⁻¹).

Total annual direct emissions from synthetic fertiliser nitrogen and urea application in the emissions intensity reference period

Total annual direct emissions in each pre-project year are calculated as the sum of direct emissions from synthetic fertiliser nitrogen ($E_{PPfert,l,m}$) and urea ($E_{PPUrea,l,m}$).

$$E_{PPdirect,l,m} = E_{PPfert,l,m} + E_{PPUrea,l,m} \quad \text{Equation (5) (project based equation)}$$

Where:

$E_{PPdirect,l,m}$ = Total annual direct emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in pre-project year, m (t CO₂-e)

$E_{PPfert,l,m}$ = Annual emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in pre-project year, m (t CO₂-e)

$E_{PPUrea,l,m}$ = Annual emissions from urea applied in cotton area, l, in pre-project year, m (t CO₂-e)

Annual indirect emissions from synthetic fertiliser application in the emissions intensity reference period

Emission from N₂O can also take place via two indirect pathways: (i) leaching and run-off, and (ii) volatilisation. Additional or excess nitrogen (N) applied to the land via the use of synthetic fertiliser can bypass biological retention mechanisms of the soil to join overland water streams (runoff) and/or leach through the soil via soil macropores or pipe drains.

Annual indirect emissions due to leaching and runoff from synthetic fertiliser in the emissions intensity reference period

The annual mass of synthetic fertiliser N lost through leaching and runoff in cotton area, l, in pre-project year, m, can be calculated as:

$$M_{lr_{PPfert,l,m}} = M_{PPfert,l,m} \times FRAC_{LEACH} \times FRAC_{WET} \text{ (t N)} \quad \text{Equation (6) (derived from NIR 4D3_6)}$$

Where :

$M_{lr_{PPfert,l,m}}$ = Annual mass of N from synthetic fertiliser lost through leaching and runoff in cotton area, l, in pre-project year, m (t N leaching and runoff)

$M_{PPfert,l,m}$ = Annual total mass of N in all synthetic fertiliser types applied in cotton area, l, in pre-project year, m (t N) for a total of n synthetic fertilisers, as calculated in Equation 1.

$FRAC_{LEACH}$ = Fraction of total mass of synthetic fertiliser lost by leaching and runoff in cotton area (dimensionless). A value of 0.3 is applied as the IPCC (2006) default fraction.

$FRAC_{WET}$ = Fraction of N available for leaching and runoff (dimensionless) (Appendix 6J.1 of NIR 2012). Use irrigated crop system factor =1.

N₂O losses from leaching and runoff from synthetic fertiliser

Annual nitrous oxide production from leaching and runoff (t N₂O-N. (t N leaching and runoff)⁻¹) is calculated as:

$$NEI_{PPirl,m} = M_{lr_{PPfert,l,m}} \times EF_k \times C_g \quad \text{Equation (7) (NIR 4D3_9)}$$

Where:

$NEI_{PPirl,m}$ = Annual nitrous oxide emissions from leaching and runoff from synthetic fertilisers in cotton area, l, in pre-project year, m (t N₂O)

$M_{lr_{PPfert,l,m}}$ = Annual mass of N lost through leaching and runoff from synthetic fertilisers in cotton area, l, in pre-project year, m (t N leaching and runoff)

EF_k = Emission factor for leaching and runoff . Use EF 0.0075 tonnes N₂O-N/tonne N.

C_g = Factor to convert N₂O-N emissions to N₂O emissions, 44/28 (t N₂O. t N₂O-N⁻¹).

Annual indirect emissions due to volatilisation and redeposition of ammonia in the emissions intensity reference period

Volatilisation is the indirect pathway that involves the transfer of N to NH₃ and NO_x from managed soils. The application of synthetic fertilisers is a source of N as NH₃ and NO_x, IPCC (2006), v4, Section 11.2.2.

The average annual mass of N volatilised ($M_{V_{PPfert,l,m}}$) from synthetic fertiliser in cotton area, l, in pre-project year, m (t NH₃-N and NO_x-N) can be calculated as the volatilised fraction of N in synthetic fertiliser:

$$M_{vPPfert,l,m} = M_{PPfert,l,m} \times FRAC_{GASF} \quad \text{Equation (8) (derived from NIR 4D3_1)}$$

Where :

$M_{vPPfert,l,m}$ = Annual mass of N volatilised from synthetic fertiliser, applied in cotton area, l, in pre-project year, m (t N volatilised)

$M_{PPfert,l,m}$ = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in pre-project year, m (t N) for a total of n synthetic fertilisers, as calculated in Equation 1.

$FRAC_{GASF}$ = Fraction of synthetic fertiliser N that is volatilised as NH_3 -N and NO_x -N (dimensionless). For synthetic fertiliser, the IPCC (2006) default value of 0.1 ($FRAC_{GASF}$) is used.

Annual N_2O emissions from volatilisation and redeposition in the emissions intensity reference period

Annual nitrous oxide emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in pre-project year m, is determined as:

$$NE_{PPv,l,m} = M_{vPPfert,l,m} \times EF_v \times C_g \quad \text{Equation (9) (Derived from NIR 4D1_4)}$$

Where:

$NE_{PPv,l,m}$ = Annual nitrous oxide emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in pre-project year, m (t N_2O)

$M_{vPPfert,l,m}$ = Annual mass of N volatilised from synthetic fertiliser, applied in cotton area, l, in pre-project year, m (t N volatilised)

EF_v = Emission factor for fertiliser nitrogen, applied to production system, k (irrigated cotton), Tier 2 values (t N_2O -N. t N^{-1}). Use $EF = 0.29 + (0.007(e^{0.037N} - 1))/N / 100$. Where N is the average synthetic fertiliser nitrogen application rate on the cotton area in kg N/ha. See Fig 1 above for the combined linear and curvilinear function. The emissions factor, EF_k , is capped at 1.83%. This equation should apply the same EF_v as applied in Equation 2.

C_g = Conversion factor of 44/28 to convert elemental mass of N_2O to molecular mass (t N_2O . t N_2O -N $^{-1}$).

Total annual indirect emissions from synthetic fertiliser in the emissions intensity reference period

The total annual indirect emissions of CO_2 -e in the emissions intensity reference period can be determined via the summation of the emissions from both pathways multiplied by the Global Warming potential of N_2O :

$$E_{PPindirect,l,m} = (NE_{PPlr,l,m} + NE_{PPv,l,m}) \times GWP_{N_2O} \quad \text{Equation (10) (project based equation)}$$

Where:

$E_{PPindirect,l,m}$ = Total annual indirect emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in pre-project year, m, (t CO_2 -e)

$NE_{PPlr,l,m}$ = Annual nitrous oxide emissions from leaching and runoff from synthetic fertiliser applied in cotton area, l, in pre-project year, m (t N_2O)

$NE_{PPv,l,m}$ = Annual nitrous oxide emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in pre-project year, m (t N₂O)

GWP_{N2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

The formulas used to calculate emissions from the above sources for the pre-project years in the emissions intensity reference period are the same formulas used for the project reporting years.

Annual synthetic fertiliser emissions in the emissions intensity reference period

The annual emissions from synthetic fertiliser in cotton area, l, in pre-project year, m, is calculated as the sum of direct and indirect emissions for the cotton area in that year.

$$E_{PPfert_total,l,m} = E_{PPdirect,l,m} + E_{PPindirect,l,m} \quad \text{Equation (11) (project based equation)}$$

Where:

$E_{PPfert_total,l,m}$ = Total annual emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in pre-project year, m (t CO₂-e)

$E_{PPdirect,l,m}$ = Total annual direct emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen and urea applied in cotton area, l, in pre-project year, m, (t CO₂-e)

$E_{PPindirect,l,m}$ = Total annual indirect emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in pre-project year, m, (t CO₂-e).

Emissions from residues of green manures

Green manure crops (legumes such as Faba bean and Vetch) are planted in the late summer or winter as the crop immediately before the cotton crop. They are dependent on rainfall and yields may vary from negligible to approximately 4 t/ha. In this Determination, a yield of 2 t/ha is assumed because no yield is harvested as a basis for measurement. The standard emissions coefficients for residues (0.0075 tonne N₂O-N/tonne N) are used. Because green manures are dryland (non-irrigated) crops they use State-based emission factors for indirect emissions from leaching and runoff. The emissions factors for crops grown on a project area which spans State boundaries are the average of the respective State coefficients. Green manures are not necessarily planted over the whole cotton area and their contribution is based on the area of green manure reported as being planted.

Direct emissions from green manure residues

The mass of N in crop residues returned to soils is calculated as:

$$M_{PPgmres,k,l,m} = (A_{k,l,m} \times YL_{gm} \times (1 - FFOD_k) \times (NC_{AGk})) + (A_{k,l,m} \times YL_{gm} \times R_{BGk} \times NC_{BGk})$$

Equation (12) from (4D1_7)

Where:

$M_{PPgmres,k,l,m}$ = mass of N in green manure area k, of cotton area l, in pre-project year, m (t N)

$A_{k,l,m}$ = Total area of green manure area, k, of cotton area, l, in pre-project year, m (hectares)

$Y_{L_{gm}}$ = annual production per hectare of green manure crop in green manure area, k, of cotton area, l, in pre-project year, m (t dry matter/ha). This is assumed to be 2t dry matter/ha.

R_{BGk} = below ground-residue to above-ground residue ratio (t/t). Factor of 0.66 for Faba bean assumed (Rochester et.al (1998)).

NC_{AGk} = nitrogen content of above ground residues expressed as a fraction. Use 0.0227.

NC_{BGk} = nitrogen content of below ground residues expressed as a fraction. Use 0.03.

$FFOD_k$ = fraction of the crop that is removed. Use 0.

Note: Equation 12 and the parameters for the calculation of the mass of nitrogen in crop residues are being updated for the 2015 National Inventory to be implemented from 1 July 2015. The values for parameters in Equation (12) are consistent with the proposed updates.

Annual direct nitrous oxide emissions from green manure residues in the emissions intensity reference period

Annual direct nitrous oxide production from green manure residues is calculated as:

$$NE_{PPgmres,k,l,m} = (M_{PPgmres,k,l,m} \times EF_j \times C_g) \quad \text{Equation (13) from(4D1_8)}$$

Where:

$NE_{PPgmres,k,l,m}$ = annual direct nitrous oxide emissions from green manure crop residues in green manure area k, of cotton area, l, in pre-project year, m (tonnes N₂O)

$M_{PPgmres,k,l,m}$ = mass of N in green manure crop residues in green manure area k, of cotton area l, in pre-project year, m (t N)

EF_j = 0.01 (tonnes N₂O-N/tonne N). IPCC default emission factor

C_g = 44/28 factor to convert from elemental mass of N₂O to molecular mass (t N₂O. t N₂O-N⁻¹)

Annual direct emissions from green manure residues in the emissions intensity reference period

$$E_{PPgmres,direct,k,l,m} = NE_{PPgmres,k,l,m} \times GWP_{N2O} \quad \text{Equation (14) from 4D1-8}$$

Where:

$E_{PPgmres,direct,k,l,m}$ = Annual direct emissions in carbon dioxide from green manure crop residues in green manure area, k, of cotton area, l, in pre-project year, m (t. CO₂-e)

$NE_{PPgmres,k,l,m}$ = Annual direct nitrous oxide emissions from green manure crop residues in green manure area, k, of cotton area, l, in pre-project year, m (tonnes N₂O)

GWP_{N2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

Annual indirect emissions due to leaching and runoff from green manure crop residue incorporation in the emissions intensity reference period

The annual mass of N lost through leaching and runoff from green manure residues in green manure area, k, of cotton area l, in pre-project year, m (leaching and runoff) can be calculated as:

$$M_{PPgmres,lr,k,l,m} = M_{PPgmres,k,l,m} \times FRAC_{LEACH} \times FRAC_{WET} \text{ (t N)}$$

Equation (15) (derived from NIR 4D3_6)

Where :

$M_{PPgmres,lr,k,l,m}$ = Annual mass of N from green manure lost through leaching and runoff from green manure area, k, of cotton area, l, in pre-project year, m (t N leaching and runoff)

$M_{PPgmres,k,l,m}$ = Mass of N in green manure crop residues in green manure area, k, of cotton area, l, in pre-project year, m (t N), as calculated in Equation 12 .

$FRAC_{LEACH}$ = Fraction of total mass of fertiliser N in green manure lost by leaching and runoff in cotton area (dimensionless). A value of 0.3 is applied as the IPCC (2006) default fraction.

$FRAC_{WET}$ = Fraction of N available for leaching and runoff (dimensionless) (Appendix 6J of NIR 2012). Use non-irrigated crop factor for each state. NSW = 0.192; Qld=0.043; WA= 0.0.223; Vic= 0.438; NSW/Qld border = 0.118; NSW/Vic border = 0.315 (NIR 2012 Appendix 6.J.1 and averages for properties spanning borders)

Annual nitrous oxide production from leaching and runoff from green manure residues is calculated as:

$$NE_{PPgmres,lr,k,l,m} = M_{PPgmres,lr,k,l,m} \times EF_k \times C_g \quad \text{Equation (16) (NIR 4D3_9)}$$

Where:

$NE_{PPgmres,lr,k,l,m}$ = Annual nitrous oxide emissions from leaching and runoff from green manure residues in green manure area, k, of cotton area l, in pre-project year, m (t N₂O)

$M_{PPgmres,lr,k,l,m}$ = Annual mass of N from green manure lost through leaching and runoff fertiliser, in green manure area, k, of cotton area l, in pre-project year, m (t N leaching and runoff)

EF_k = Emission factor for leaching and runoff EF 0.0075 t N₂O-N/t N

C_g = Factor to convert N₂O-N emissions to N₂O emissions, 44/28 (t N₂O. t N₂O-N⁻¹).

Annual indirect emissions from green manure crop residues in the emissions intensity reference period

The annual indirect emissions of CO₂-e from green manure crop residues in the emissions intensity reference period can be determined from emissions of nitrous oxide multiplied by the Global Warming potential of N₂O:

$$E_{PPgmres,indirect,k,l,m} = NE_{PPgmres,lr,k,l,m} \times GWP_{N_2O} \quad \text{Equation (17) (project based equation)}$$

Where:

$E_{PPgmres,indirect,k,l,m}$ = Annual indirect emissions in carbon dioxide equivalents from green manure crop residues, in green manure area k, in cotton area, l, in pre-project year, m, (t CO₂-e)

$NE_{PPgmres,lr,k,l,m}$ = Annual nitrous oxide emissions from leaching and runoff from green manure residues in green manure area, k, in cotton area, l, in pre-project year, m (t N₂O)

GWP_{N2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

The formulas used to calculate emissions from the above sources for the pre-project years in the emissions intensity reference period are the same formulas used for the project reporting years.

Total annual emissions from green manure crop residues in the emissions intensity reference period

The total annual emissions from green manure crop residues in green manure area, k, in cotton area, l, in pre-project year, m, is calculated as the sum of direct and indirect emissions for the cotton area in that year.

$$E_{PPgmres,k,l,m} = E_{PPgmres,direct,k,l,m} + E_{PPgmres,indirect,k,l,m} \quad \text{Equation (18) (project based equation)}$$

Where:

$E_{PPgmres,k,l,m}$ = Total annual emissions from green manure crop residues in green manure area k, in cotton area, l, in pre-project year, m (t CO₂-e)

$E_{PPgmres,direct,k,l,m}$ = Annual direct emissions in carbon dioxide equivalents from green manure crop residues in green manure area, k, in cotton area, l, in pre-project year, m, (t CO₂-e)

$E_{PPgmres,indirect,k,l,m}$ = Annual indirect emissions in carbon dioxide equivalents from green manure crop residues in green manure area, k, in cotton area, l, in pre-project year, m, (t CO₂-e).

Average annual emissions intensity of synthetic fertiliser and green manure used in cotton crop production in the emissions intensity reference period

The average annual emissions intensity of synthetic fertiliser use and green manure residue incorporation in the emissions intensity reference period ($EI_{PPfert,gmres,l,M}$) is used to determine the baseline emissions for each project reporting year. The annual emissions intensity (CO₂-e/t.lint yield) is calculated for each year in which cotton was grown in the emissions intensity reference period. The average annual combined synthetic fertiliser and green manure residue emissions intensity ($EI_{PPfert,gmres,l,M}$) CO₂-e/t.lint yield) for the emissions intensity reference period is based on a minimum of three cotton crop years (where cotton is rotated with another crop) and a maximum of six cotton crop years (for continuously cropped areas) in the emissions intensity reference period:

$$EI_{PPfert,gmres,l,M} = \sum_{m=1..M} [(E_{PPfert_total,l,m} + E_{PPgmres,k,l,m}) / YL_{PP,l,m}] / M$$

Equation (19) (project based equation)

Where:

$EI_{PPfert,gmres,l,M}$ = Average annual emissions intensity from synthetic fertiliser and green manure crop residue direct and indirect sources for cotton area, l, over the emissions intensity reference period, M, (t CO₂-e/t.lint yield)

$E_{PPfert_total,l,m}$ = Total annual emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in pre-project year, m (t CO₂-e)

$E_{PP, gmres, k, l, m}$ = Total annual emissions from green manure crop residues, in green manure area, k, in cotton area, l, in pre-project year, m (t CO₂-e)

$Y_{L, PP, l, m}$ = Total annual lint yield in the cotton area, l, in pre-project year, m (tonnes lint yield)

m = each cotton crop year in the pre-project emissions intensity reference period. There must be a minimum of 3 cotton crop years and a maximum (M) of 6 cotton crop years included in the calculation, depending on rotations in the emissions intensity reference period.

Baseline emissions

The baseline emissions from synthetic fertiliser and green manure crop residues for each project reporting year are then calculated from the average annual emissions intensity, $EI_{PP, fert, gm}$ in the emissions intensity reference period, multiplied by the total annual lint yield, Y_P , in the project reporting year.

$$E_{baseline, gross, t} = EI_{PP, fert, gm, res} \times Y_{P, l, t} \quad \text{Equation (20) (project based equation)}$$

Where:

$E_{baseline, gross, t}$ = Baseline emissions from synthetic fertiliser applied and green manure residues incorporated to attain total yield Y_P in cotton area, l, in project reporting year, t (t CO₂-e).

$EI_{PP, fert, gm, res}$ = Average annual emissions intensity from synthetic fertiliser and green manure direct and indirect sources over the emissions intensity reference period (t CO₂-e/t.lint yield)

$Y_{P, l, t}$ = Total annual lint yield in cotton area, l, in project reporting year, t. (tonnes lint yield)

The baseline emissions are discounted by a factor of 6.5% to allow for variation in emissions intensity which would have occurred under business-as-usual conditions before the project.

$$E_{baseline, net, t} = E_{baseline, gross, t} \times 0.935 \quad \text{Equation (20a) (project based equation)}$$

Where:

$E_{baseline, net, t}$ = Net baseline emissions from synthetic fertiliser applied and green manure residues incorporated to attain total yield Y_P in cotton area, l, in project reporting year, t (t CO₂-e) after discounting business as usual variation.

$E_{baseline, gross, t}$ = Baseline emissions from synthetic fertiliser applied and green manure residues incorporated to attain total yield Y_P in cotton area, l, in project reporting year, t (t CO₂-e).

0.935 = Constant for variance discount.

CALCULATING PROJECT EMISSIONS

Annual direct nitrous oxide emissions from synthetic fertiliser application

The project reporting year direct emissions from synthetic fertiliser application can be obtained from the proponent's verifiable records of synthetic fertiliser application rates for each project reporting year and the emissions factor from Fig 1 below.

The following equations, based on the method presented in NIR (2012) (Section 6.6.2.1), are employed for the application of N-containing synthetic fertilisers.

The annual mass of N in all synthetic fertilisers applied in cotton area, l, can be deduced from the total mass of each synthetic fertiliser applied, and the fraction of N specified for that particular synthetic fertiliser:

$$\mathbf{M}_{P\text{ fert},l,t} = \sum_{i=1..n} (\mathbf{TM}_{P\text{ fert},i,l,t} \times \mathbf{X}_{i,t}) \quad \text{Equation (21) (derived from NIR 4D1_1)}$$

Where:

$\mathbf{M}_{P\text{ fert},l,t}$ = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in project reporting year, t (t N) for a total of n synthetic fertilisers.

$\mathbf{TM}_{P\text{ fert},i,l,t}$ = Annual total mass of synthetic fertiliser, i, applied in cotton area, l, in project year t (t applied)

$\mathbf{X}_{i,l,t}$ = Fraction of N in synthetic fertiliser, i, applied in cotton area, l, in project reporting year, t (t N. t applied⁻¹). Obtained from manufacturer label.

For the project scenario, nitrous oxide emissions for synthetic fertilisers applied in cotton area, l, in project reporting year t, are determined as:

$$\mathbf{NE}_{P\text{ fert},l,t} = \mathbf{M}_{P\text{ fert},l,t} \times \mathbf{EF}_k \times \mathbf{C}_g \quad \text{Equation (22) (derived from NIR 4D1_2)}$$

Where:

$\mathbf{NE}_{P\text{ fert},l,t}$ = Annual nitrous oxide emissions from synthetic fertiliser nitrogen applied in cotton area, l, in project reporting year, t (t N₂O)

$\mathbf{M}_{P\text{ fert},l,t}$ = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in project reporting year t (t N)

\mathbf{EF}_k = Emission factor for fertiliser nitrogen, applied to production system, k (irrigated cotton), Tier 2 values (t N₂O-N. t N⁻¹). Use $EF = 0.29 + (0.007(e^{0.037N} - 1))/N / 100$. Where N is the average synthetic fertiliser nitrogen application rate on the cotton area in kg N/ha. See Fig 1 above for the combined linear and curvilinear function. The emissions factor, \mathbf{EF}_k , is capped at 1.83%.

\mathbf{C}_g = Conversion factor of 44/28 to convert elemental mass of N₂O to molecular mass (t N₂O. t N₂O-N⁻¹).

Annual project direct emissions in CO₂-e from synthetic fertiliser application

Annual project emissions in carbon dioxide equivalents (tCO₂-e) from applied synthetic fertilisers is determined from the annual nitrous oxide (N₂O) emissions for all synthetic fertilisers, applied in cotton area, l, in project reporting year t, multiplied by the global warming potential of nitrous oxide.

$$\mathbf{E}_{P\text{ fert},l,t} = \mathbf{GWP}_{N_2O} \times \mathbf{NE}_{P\text{ fert},l,t} \quad \text{Equation (23)}$$

Where:

$\mathbf{E}_{P\text{ fert},l,t}$ Annual emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in project reporting year, t (t CO₂-e)

\mathbf{GWP}_{N_2O} Global Warming Potential of Nitrous Oxide, N₂O, 298 (t CO₂-e. t N₂O⁻¹)

$\mathbf{NE}_{P\text{ fert},l,t}$ = Annual nitrous oxide emissions from synthetic fertiliser nitrogen, applied to cotton area, l, in project reporting year, t (t N₂O)

Annual project CO₂ emissions from urea application

Annual project emissions from hydrolysis of urea in cotton area, l, in each project reporting year t, can be determined from the annual total mass of urea applied multiplied by its emissions factor:

$$E_{PUrea,l,t} = M_{PUrea,l,t} \times EF_{Urea} \quad \text{Equation (24) (IPCC 2006)}$$

Where:

$E_{PUrea,l,t}$ = Annual emissions from urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

$M_{PUrea,l,t}$ = Annual total mass of urea applied in cotton area, l, in project reporting year, t (t urea applied)

EF_{Urea} = Emission factor for urea, 0.7333 (t CO₂ (t urea applied)⁻¹).

Total annual project direct emissions from synthetic fertiliser and urea application

Total annual direct emissions in each project reporting year, t, are calculated as the sum of direct emissions from synthetic fertiliser nitrogen ($E_{Pfert,l,t}$) and urea ($E_{PUrea,l,t}$)

$$E_{Pdirect,l,t} = E_{Pfert,l,t} + E_{PUrea,l,t} \quad \text{Equation (25) (project based equation)}$$

Where:

$E_{Pdirect,l,t}$ = Total annual direct emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{Pfert,l,t}$ = Annual emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{PUrea,l,t}$ = Annual emissions from urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

Annual project indirect emissions from synthetic fertiliser application

Emission from N₂O can also take place via two indirect pathways: (i) leaching and run-off, and (ii) volatilisation. Additional or excess nitrogen (N) applied to the land via the use of synthetic fertiliser, can bypass biological retention mechanisms of the soil to join overland water streams (runoff) and/or leach through the soil via soil macropores or pipe drains.

Annual indirect emissions due to leaching and runoff from synthetic fertiliser

The annual mass of synthetic fertiliser N lost through leaching and runoff in cotton area, l, in project reporting year, t, can be calculated as:

$$M_{lr_{Pfert,l,t}} = M_{Pfert,l,t} \times FRAC_{LEACH} \times FRAC_{WET} \text{ (t.N)} \quad \text{Equation (26) (derived from NIR 4D3_6)}$$

Where :

$M_{lr_{Pfert,l,t}}$ = Annual mass of N from synthetic fertiliser lost through leaching and runoff in cotton area, l, in project reporting year, t (t N leaching and runoff)

$M_{Pfert,l,t}$ = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in project reporting year, t (t N), as calculated in Equation 21.

FRAC_{LEACH} = Fraction of total mass of synthetic fertiliser lost by leaching and runoff in cotton area (dimensionless). A value of 0.3 is applied as the IPCC (2006) default fraction.

FRAC_{WET} = Fraction of N available for leaching and runoff (dimensionless). (Appendix 6J.1 of NIR 2011) Use irrigated crop system factor = 1.

Annual project N₂O emissions from leaching and runoff from synthetic fertiliser

Annual nitrous oxide production from fertiliser N leaching and runoff (t N₂O-N. t N leaching and runoff⁻¹) is calculated as

$$\mathbf{NE_{Plr,l,t}} = \mathbf{Mlr_{Pfert,l,t}} \times \mathbf{EF_{LEACH}} \times \mathbf{C_g} \quad \text{Equation (27) (derived from NIR 4D3_9)}$$

Where:

NE_{Plr,l,t} = Annual nitrous oxide emissions from leaching and runoff from synthetic fertiliser application in cotton area, l, in project reporting year, t (t.N₂O)

Mlr_{Pfert,l,t} = Annual mass of N from synthetic fertiliser lost through leaching and runoff in cotton area, l, in project reporting year, t (t N leaching and runoff)

EF_{LEACH} = Emission factor for leaching and runoff (t N₂O-N. (t N leaching and runoff)⁻¹) = 0.0075 (t N₂O-N/t N)

C_g = Conversion factor of 44/28 to convert elemental mass of N₂O to molecular mass (t N₂O. t N₂O-N⁻¹).

Annual pre-project indirect emissions due to volatilisation and redeposition of ammonia

Volatilisation is the indirect pathway that involves the transfer of N to NH₃ and NO_x from managed soils. The application of synthetic N fertilisers is a source of N as NH₃ and NO_x, IPCC (2006), v4, Section 11.2.2.

The average annual mass of N volatilised and redeposited (**Mv_{Pfert,l,t}**) from synthetic fertiliser in cotton area, l, in project reporting year, t (t NH₃-N and NO_x-N) can be calculated as the volatilised fraction of N in each synthetic fertiliser:

$$\mathbf{Mv_{Pfert,l,t}} = \mathbf{M_{Pfert,l,t}} \times \mathbf{FRAC_{GASF}} \quad \text{Equation (28) (derived from NIR 4D3_1)}$$

Where :

Mv_{Pfert,l,t} = Annual mass of N volatilised from synthetic fertiliser, applied in cotton area, l, in project reporting year, t (t N volatilised)

M_{Pfert,l,t} = Annual total mass of N in all synthetic fertiliser types, applied in cotton area, l, in project reporting year, t (t N), as calculated in Equation 21.

FRAC_{GASF} = Fraction of synthetic fertiliser N that is volatilised as NH₃-N and NO_x-N (dimensionless). Use IPCC (2006) default value of 0.1 (FRAC_{GASF}).

Annual project N₂O emissions from volatilisation and redeposition

Annual emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in project reporting year t, is determined as:

$$NE_{Pv,l,t} = Mv_{Pfert,l,t} \times EF_v \times C_g$$

Equation (29) (Derived from NIR 4D3_5)

Where:

$NE_{Pv,l,t}$ = Annual nitrous oxide emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in project reporting year, t (t N₂O)

$Mv_{Pfert,l,t}$ = Annual mass of N volatilised from synthetic fertiliser applied in cotton area, l, in project reporting year, t (t. N)

EF_v = Emission factor for fertiliser nitrogen, applied to production system, k (irrigated cotton), Tier 2 values (t N₂O-N. t N⁻¹). Use $EF = 0.29 + (0.007(e^{0.037N} - 1))/N / 100$. Where N is the average synthetic fertiliser nitrogen application rate on the cotton area in kg N/ha. See Fig 1 above for the combined linear and curvilinear function. The emissions factor, EF_k , is capped at 1.83%. This equation should apply the same EF_v as applied in Equation 22.

C_g = Conversion factor of 44/28 to convert elemental mass of N₂O to molecular mass (t N₂O. t N₂O-N⁻¹).

Total annual project indirect emissions from synthetic fertiliser

The total annual indirect emissions of CO₂-e can be determined via the summation of the emissions from both pathways multiplied by the Global Warming potential of N₂O:

$$E_{Pindirect,l,t} = (NE_{Plr,l,t} + NE_{Pv,l,t}) \times GWP_{N2O} \quad \text{Equation (30) (Project based equation)}$$

Where:

$E_{Pindirect,l,t}$ = Total annual indirect emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in project reporting year, t (t CO₂-e)

$NE_{Plr,l,t}$ = Annual nitrous oxide emissions from leaching and runoff from synthetic fertiliser applied in cotton area, l, in project reporting year, t (t N₂O)

$NE_{Pv,l,t}$ = Annual nitrous oxide emissions from N volatilised from synthetic fertiliser applied in cotton area, l, in project reporting year, t (t N₂O)

GWP_{N2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

The formulas used to calculate the above components of the project are the same as for the baseline emissions sources. However the annual project total emissions are estimated for a single year, t, whilst baseline emissions are derived as the average of emissions intensity over a minimum of three cotton crops (t CO₂-e/ t.lint yield) in the emissions intensity reference period multiplied by the total yield in the cotton area in the project reporting year and the variance discount.

Annual project synthetic fertiliser emissions

The project emissions apply to the synthetic N fertiliser used on the cotton crop in year, t. The project emissions are determined as the sum of direct and indirect sources for the cotton area in year, t.

$$E_{P, fert_total,l,t} = E_{Pdirect,l,t} + E_{Pindirect,l,t} \quad \text{Equation (31) (Project based Equation)}$$

Where:

$E_{P, fert_total,l,t}$ = Total annual emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{Pdirect\ l,t}$ = Total annual direct emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen and urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{Pindirect\ l,t}$ = Total annual indirect emissions in carbon dioxide equivalents from synthetic fertiliser nitrogen applied in cotton area, l, in project reporting year, t (t CO₂-e)

Project emissions from residues of green manures

Direct emissions from green manure residues

The mass of N in crop residues returned to soils is calculated as:

$$M_{Pgmres,k,l,t} = (A_{k,l,t} \times YL_{gm} \times (1 - FFOD_k) \times (NC_{AGk})) + (A_{k,l,t} \times YL_{gm} \times R_{BGk} \times NC_{BGk})$$

Equation (32) from (4D1_7)

Where:

$M_{Pgmres,k,l,t}$ = mass of N in green manure residues in green manure area k, of cotton area l, in project reporting year, t (t N)

$A_{k,l,t}$ = Total area of green manure k, in cotton area l, in project reporting year, (hectares).

YL_{gm} = annual production of green manure crop in green manure area, k, of cotton area, l, in project reporting year t (t dry matter/ha). This is assumed to be 2t dry matter/ha.

R_{BGk} = below ground-residue to above-ground residue ratio (t/t). Factor of 0.66 for Faba bean assumed (Rochester et.al (1998)).

NC_{AGk} = nitrogen content of above ground residues expressed as a fraction. Use 0.0227.

NC_{BGk} = nitrogen content of below ground residues expressed as a fraction. Use 0.03.

$FFOD_k$ = fraction of the crop that is removed. Use 0.

Note: Equation 12 and the parameters for the calculation of the mass of nitrogen in crop residues are being updated for the 2015 National Inventory to be implemented from 1 July 2015. The values for parameters in Equation (12) are consistent with the proposed updates.

Annual project direct nitrous oxide production from green manure residues

Annual project direct nitrous oxide production from green manure residues is calculated as:

$$NE_{Pgmres,k,l,t} = (M_{Pgmres,k,l,t} \times EF_{jk} \times C_g) \quad \text{Equation (33) from(4D1_8)}$$

Where:

$NE_{Pgmres, k, l,t}$ = Annual direct nitrous oxide emissions from green manure crop residues in green manure area, k, of cotton area, l, in project reporting year, t (tonnes N₂O)

$M_{Pgmres,k,l,t}$ = Mass of N in green manure crop residues in green manure area, k, of cotton area, l, in project reporting year, t (t N)

EF_{jk} = 0.01 (tonnes N₂O-N/tonne N) IPCC default emission factor for residue emissions

C_g = 44/28 factor to convert from elemental mass of N₂O to molecular mass

Annual direct emissions from green manure residues

$$E_{Pgmres, direct\ k,l,t} = NE_{Pgmres,k,l,t} \times GWP_{N2O} \quad \text{Equation (34) from 4D1-8}$$

Where:

$E_{Pgmres, direct\ k,l,t}$ = Annual direct emissions from green manure crop residues i in green manure area, k , of cotton area, l , in project reporting year, t (t. CO₂-e)

$NE_{Pgmres,k,l,t}$ = Annual direct nitrous oxide emissions from green manure crop residues in green manure area, k , of cotton area, l , in project reporting year, t (tonnes N₂O)

GWP_{N2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

Annual project indirect emissions due to leaching and runoff from green manure crop residue incorporation

The annual mass of N lost through leaching and runoff from green manure residues in green manure area k of cotton area, l , in project reporting year, t can be calculated as:

$$M_{Pgmres,lr, k,l,t} = M_{Pgmres,k,l,t} \times FRAC_{LEACH} \times FRAC_{WET} \text{ (t N)}$$

Equation (35) (derived from NIR 4D3_6)

Where :

$M_{Pgmres,lr,k,l,t}$ = Annual mass of N from green manure lost through leaching and runoff from green manure area, k , of cotton area, l , in project reporting year, t (t N leaching and runoff)

$M_{Pgmres,k,l,t}$ = Mass of N in green manure residues incorporated in green manure area k , of cotton area, l , in project reporting year, t (t N), as calculated in Equation 32 .

$FRAC_{LEACH}$ = Fraction of total mass of fertiliser N in green manure lost by leaching and runoff in cotton area (dimensionless). A value of 0.3 is applied as the IPCC (2006) default fraction.

$FRAC_{WET}$ = Fraction of N available for leaching and runoff (dimensionless) (Appendix 6J.1 of NIR 2012). Use non-irrigated crop factor for each state. NSW = 0.192; Qld=0.043; WA= 0.0223; Vic= 0.438; NSW/Qld border = 0.118; NSW/Vic border = 0.315 (NIR 2012 Appendix 6.J.1 and averages for properties spanning borders)

N₂O losses from leaching and runoff from green manure residues

Annual nitrous oxide production from leaching and runoff from green manure residues is calculated as:

$$NE_{Pgmres,lr, k,l,t} = M_{Pgmres,lr,k,l,t} \times EF_k \times C_g \quad \text{Equation (36) (NIR 4D3_9)}$$

Where:

$NE_{P_{gmres,lr,k,l,t}}$ = Annual nitrous oxide emissions from leaching and runoff from green manure residues in green manure area k of cotton area l, in project reporting year, t (t N₂O)

$M_{P_{gmres,lr,k,l,t}}$ = Annual mass of N from green manure lost through leaching and runoff fertiliser in green manure area k, of cotton area l, in project reporting year, t (t N leaching and runoff)

EF_k = Emission factor for leaching and runoff . $EF = 0.0075$ t N₂O-N/t N

C_g = Factor to convert N₂O-N emissions to N₂O emissions, 44/28 (t N₂O. t N₂O-N⁻¹).

Annual project indirect emissions from green manure crop residues

The total annual indirect emissions of CO₂-e from green manure crop residues can be determined from emissions of nitrous oxide multiplied by the Global Warming potential of N₂O:

$$E_{P_{gmres,indirect,k,l,t}} = NE_{P_{gmres,lr,k,l,t}} \times GWP_{N_2O} \quad \text{Equation (37) (project based equation)}$$

Where:

$E_{P_{gmres,indirect,k,l,t}}$ = Annual indirect emissions in carbon dioxide equivalents from green manure crop residues, in green manure area k, in cotton area, l, in project reporting year, t (t CO₂-e)

$NE_{P_{gmres,lr,k,l,t}}$ = Annual nitrous oxide emissions from leaching and runoff from green manure residues in green manure area k, in cotton area, l, in project reporting year, t (t N₂O)

GWP_{N_2O} = Global warming potential of N₂O, 298 (t CO₂-e. t N₂O⁻¹).

Total annual project emissions from green manure crop residues

The total annual emissions from green manure crop residues in green manure area k, in cotton area, l, in project reporting year, t, is calculated as the sum of direct and indirect emissions for the cotton area in that year.

$$E_{P_{gmres,k,l,t}} = E_{P_{gmres,direct,k,l,t}} + E_{P_{gmres,indirect,k,l,t}} \quad \text{Equation (38) (project based equation)}$$

Where:

$E_{P_{gmres,k,l,t}}$ = Total annual emissions from green manure crop residues, in green manure area k, applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{PP_{gmres,direct,k,l,t}}$ = Annual direct emissions in carbon dioxide equivalents from green manure crop residues in green manure area k, in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{PP_{gmres,indirect,k,l,t}}$ = Annual indirect emissions in carbon dioxide equivalents from green manure crop residues in green manure area k, in cotton area, l, in project reporting year, t (t CO₂-e).

Total Project Emissions

Total emissions in the project reporting year t, are the sum of emissions from direct and indirect synthetic fertiliser emissions and emissions from green manure crop residue incorporation:

$$E_{project,l,t} = E_{P_{fert,l,t}} + E_{P_{gmres,k,l,t}} \quad \text{Equation (39) (Project based equation)}$$

Where:

$E_{\text{project},l,t}$ = Total project emissions in project reporting year, t (t CO₂-e)

$E_{\text{Pfert},l,t}$ = Total annual emissions from synthetic fertiliser nitrogen and urea applied in cotton area, l, in project reporting year, t (t CO₂-e)

$E_{\text{Pgmres},k,l,t}$ = Total annual emissions from green manure crop residues, applied in cotton area, l, in project reporting year, t (t CO₂-e)

NET GREENHOUSE GAS ABATEMENT

The annual net greenhouse gas abatement (the interim abatement amount), E_t (tonnes CO₂-e), in each project reporting year is calculated from the difference between the net baseline emissions and the total project emissions for the project reporting year, t, of the reporting period:

$$E_t = (E_{\text{baseline,net},l,t}) - (E_{\text{project},l,t}) \quad \text{Equation (40) Project Based Equation}$$

Where:

E_t = annual emission reductions in project reporting year (interim abatement amount), t (t CO₂-e)

$E_{\text{baseline,net},l,t}$ = Net baseline emissions in project cotton area l, in reporting year, t (t CO₂-e)

$E_{\text{project},l,t}$ = Total project emissions in project cotton area l, in reporting year, t (t CO₂-e)

The net abatement amount for a reporting period is the sum of the E_t values for all project reporting years in the reporting period.

If E_t is less than zero for a project reporting year, it is taken to be zero for the purpose of calculating the net abatement amount for the reporting period.