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**Aggregated Sources and Non-CO<sub>2</sub> Emission Sources**  
**3C2 Liming, 3C3 Urea Application**

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# Outline

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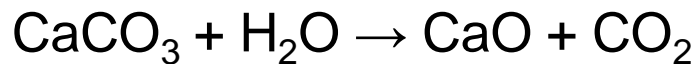
- Liming
  - Background
  - Methodology for liming
- Urea application
  - Background
  - Methodology for Urea application
- Exercise by using the IPCC Software

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# Liming: Background

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- Liming is used to reduce soil acidity and improve plant growth, particularly agricultural lands (sometimes in managed forest).
- Adding carbonates to soils in the form of lime (e.g., calcic limestone ( $\text{CaCO}_3$ ), or dolomite ( $\text{CaMg}(\text{CO}_3)_2$ ) leads to  $\text{CO}_2$  emissions as the carbonate limes dissolve and release bicarbonate ( $2\text{HCO}_3^-$ ), which evolves into  $\text{CO}_2$  and water ( $\text{H}_2\text{O}$ ).



- Estimation method
  - $\text{CO}_2$  Emission =  $AD * EF * 44/12$

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# Methodology for Liming : EF

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## ■ Emission Factor

- Atomic weight: Ca=40.08, C=12.01, O=16.0, Mg=24.3
- Molecular weight :
  - ◆ Lime:  $\text{CaCO}_3 = 100.09$
  - ◆ Dolomite:  $\text{CaMg}(\text{CO}_3)_2 = 184.41$
- EF: t-C/t-amount of lime applied/yr
  - ◆ Lime:  $\text{C}/\text{CaCO}_3 = 12.01/100.09 \doteq 0.12$
  - ◆ Dolomite:  $2\text{C}/\text{CaMg}(\text{CO}_3)_2 = 24.02/184.31 \doteq 0.13$
- Uncertainty: -50% for default EF. Note: Maximum Emissions are estimated with default EFs
- Tier.1 :Using default EF directly
- Tier.2: Using CS-EF. Maybe lower emission occurred due to site-specific effect.
- Tier.3: Using such as flux Model

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# Methodology for Liming : AD

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## ■ Activity Data

- Source data: amount of lime/dolomite applied
  - ◆ Statistical data (amount of fertilization use)
  - ◆ Sales data (assumed as sold lime is applied in the same year)
  - ◆ Survey of agriculture practice (ex, x kg/ha/yr for average)
- Note: Potential “IE” occurred between IP sector. (Domestic lime production sometimes covers CO<sub>2</sub> applied to agriculture soil)
- Tiers of AD depend on EF type. But, many countries use single national data with default EF in this category.

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# Urea Application: Background

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- Adding urea to soils during fertilisation leads to a loss of CO<sub>2</sub> that was fixed in the industrial production process. Urea (CO(NH<sub>2</sub>)<sub>2</sub>) is converted into ammonium (NH<sub>4</sub><sup>+</sup>), hydroxyl ion (OH<sup>-</sup>), and bicarbonate (HCO<sub>3</sub><sup>-</sup>), in the presence of water and urease enzymes. Similar to the soil reaction following addition of lime, bicarbonate that is formed evolves into CO<sub>2</sub> and water.



- Estimation method
  - CO<sub>2</sub> Emission = AD \* EF \* 44/12

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# Methodology for Urea application : EF

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## ■ Emission Factor

- Atomic weight: H=1.008, C=12.01, N=14.01, O=16.0
- Molecular weight :
  - ◆  $\text{CO}(\text{NH}_2)_2 = 60.062$
- EF: t-C/t-amount of urea applied/yr
  - ◆  $\text{C} / \text{CO}(\text{NH}_2)_2 = 12.01 / 60.062 \doteq 0.20$
- Uncertainty: -50% for default EF. Note: Maximum Emissions are estimated with default EF
- Tier.1 :Using default EF directly
- Tier.2: Using CS-EF
- Tier.3: Using Model taking into account various site condition

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# Methodology for Urea application : AD

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## ■ Activity Data

- Source data: amount of Urea applied
  - ◆ Production and import/export data on urea
  - ◆ Sales and usage data may be used to refine AD
  - ◆ Usage statistics
  - ◆ Survey of agriculture practice (ex, x kg/ha/yr for average)
- Tiers of AD depend on EF type. But, many countries use single national data with default EF in this category.



# Exercise by using IPCC software: Liming

- Identify Land type
- Identify Lime Type: two types, Limestone / Dolomite can be chosen from the dropdown list.
- Select EF: default EF is only shown in the dropdown list
- Input data of annual amount of lime applied to soil (must be a new estimation in the next cycle)

2006 IPCC Categories

- 2.H.2 - Food and Beverages
- 2.H.3 - Other (please specify)
- 3 - Agriculture, Forestry, and Other
  - 3.A - Livestock
  - 3.B - Land
  - 3.C - Aggregate sources and no
    - 3.C.1 - Emissions from biomass
      - 3.C.1.a - Biomass burnin
      - 3.C.1.b - Biomass burnin
      - 3.C.1.c - Biomass burnin
      - 3.C.1.d - Biomass burnin
      - 3.C.2 - Liming
      - 3.C.3 - Urea application
      - 3.C.4 - Direct N2O Emission
      - 3.C.5 - Indirect N2O Emission
      - 3.C.6 - Indirect N2O Emission
      - 3.C.7 - Rice cultivations
      - 3.C.8 - Other (please specify)
    - 3.D - Other
      - 3.D.1 - Harvested Wood Pro
      - 3.D.2 - Other (please specify)
  - 4 - Waste
    - 4.A - Solid Waste, Diagonal

Annual CO<sub>2</sub>-C emissions from Liming

Worksheet

Sector: Agriculture, Forestry, and Other Land Use  
 Category: Aggregate Sources and Non-CO<sub>2</sub> Emissions Sources on Land  
 Subcategory: 3.C.2 - Liming  
 Sheet: 1 of 1

Data

Gas: CARBON DIOXIDE (CO<sub>2</sub>)

Land Types	Subcategories for reporting year	Lime Type	M	EF	CO <sub>2</sub> -C Emissions	CO <sub>2</sub> Emissions
			Annual amount of lime (tonnes / yr)	Emission Factor (tonnes of C / tonne of lime)	Annual C emissions from liming (tonnes C / yr)	Annual CO <sub>2</sub> emissions from liming (tonnes CO <sub>2</sub> / yr)
					CO <sub>2</sub> -C Emissions = M * EF	CO <sub>2</sub> -C Emissions = CO <sub>2</sub> -C Emissions * 44/12
(Total)	(Total)	Limestone	0	0.12	0	0
	(Total)	Dolomite	0	0.13	0	0
Total			0		0	0

# Exercise by using IPCC software: Urea application

- Identify Land type
- Select EF: default EF is shown in the dropdown list
- Input data of annual amount of urea fertization to soil

2006 IPCC Categories

- 2.H.2 - Food and Beverages
- 2.H.3 - Other (please specify)
- 3 - Agriculture, Forestry, and Other
  - 3.A - Livestock
  - 3.B - Land
  - 3.C - Aggregate sources and non-aggregate sources
    - 3.C.1 - Emissions from biomass
      - 3.C.1.a - Biomass burning
      - 3.C.1.b - Biomass burning
      - 3.C.1.c - Biomass burning
      - 3.C.1.d - Biomass burning
    - 3.C.2 - Liming
    - 3.C.3 - Urea application
    - 3.C.4 - Direct N2O Emission
    - 3.C.5 - Indirect N2O Emission
    - 3.C.6 - Indirect N2O Emission
    - 3.C.7 - Rice cultivations
    - 3.C.8 - Other (please specify)
  - 3.D - Other
    - 3.D.1 - Harvested Wood Products
    - 3.D.2 - Other (please specify)

Annual CO2 emissions from Urea Fertilization

Worksheet

**Sector:** Agriculture, Forestry, and Other Land Use  
**Category:** Aggregate Sources and Non-CO2 Emissions Sources on Land  
**Subcategory:** 3.C.3 - Urea application  
**Sheet:** 1 of 1

Data

**Gas** CARBON DIOXIDE (CO2)

Land Types	Subcategories for reporting year	M	EF	CO2-C Emissions	CO2 Emissions
		Annual amount of Urea Fertilization (tonnes / yr)	Emission Factor (tonnes of C / tonne of urea)	Annual CO2-C emissions from Urea Fertilization (tonnes C / yr)	Annual CO2 emissions from Urea Fertilization (tonnes CO2 / yr)
				CO2-C Emissions = M * EF	CO2-C Emissions = CO2-C Emissions * 44/12
(Total)	(Total)	0.2	0	0	0
Total		0		0	0