TECHNICAL REPORT WORKSHOP

"*Nitrogen fertilization, baseline and projections of greenhouse gases in Colombia*"

Carlos Felipe Torres

TECHNICAL REPORT WORKSHOP

"*Nitrogen fertilization, baseline and projections of greenhouse gases in Colombia*"

CONTENTS

"NITROGEN FERTILIZATION, BASELINE AND PROJECTIONS OF GREENHOUSE GASES IN COLOMBIA"

1. INTRODUCTION

The workshop on emissions from the use of nitrogen fertilizers, baseline and greenhouse gas (GHG) projections in Colombia includes among its objectives the strengthening of the development of greenhouse gas inventories in the country through the improvement of the N2O estimates of the soil associated with nitrogen fertilizers applied in the different crop systems. In addition, the project seeks to consolidate the use of the results of the research generated to strengthen public policies such as the Nationally Determined Contribution (NDC), the Colombian Low Carbon Development Strategy (ECDBC) and the sector mitigation plan.

2. OBJECTIVE

Train key sector institutions on emissions from the use of nitrogen fertilizers, baseline and GHG projections in Colombia.

3. DEVELOPMENT OF THE WORKSHOP

The workshop was developed with the participation of 21 representatives of institutions in the agricultural sector, including: Institute of Hydrology, Meteorology and Environmental Studies ***(IDEAM)***, Ministry of Agriculture and Rural Development ***(MADR)***, National University of Colombia, National Cereals Federation ***(FENALCE)***, National Federation of Cocoa Growers ***(FEDECACAO)***, Ministry of Environment and Sustainable Development ***(MADS)***, Colombian Corporation for Agricultural Research ***(AGROSAVIA)***, International Center for Tropical Agriculture ***(CIAT)***, National Federation of Rice Producers ***(FEDEARROZ)*** and Fertinagro.

The activity was divided into two phases, the first consisted of keynote presentations and the second consisted of a practical exercise on estimating greenhouse gas emissions from the application of nitrogenous fertilizers. The relevant aspects of each presentation and the practical exercise are detailed below:

3.1 Phase I results summary - improvement of activity data

The assumptions used in the national GHG inventory in Colombia were described for the official reports submitted to the United Nations Framework Convention on Climate Change (UNFCCC), all the production of one-year fertilizers is sold and used in that same period of time. In this way, the first and second biennial update reports (BUR) in Colombia were developed.

In the first reports, the percentage of nitrogen in the commercial mixtures used as assumption was established at 17.5% by expert consultation. The main improvement consisted of analyzing the information on the marketing statistics of fertilizers and soil conditioners, from the Colombian Agricultural Institute (ICA) with 25,000 records of sales, imports and exports of fertilizers for the 2005 and 2017 series, with a specific percentage of nitrogen In its composition, in this way the uncertainty for subcategories 3C4 and 3C5 was reduced and there is activity data to estimate CO2 emissions in category 3C3, which was not estimated in previous reports.

3.1.1 Participant feedback-Phase I[1]

MADR explains the importance of reducing uncertainty in carbon credit transactions, for example, for payment programs for reducing emissions in forest plantations. Fertinagro makes its contribution regarding the relevance of evaluating the contribution in units of Nitrogen from foliar fertilizers with their urea content in the mixture, only nitrogen-containing soil fertilizers are being taken into account in the country's statistics. In addition, it is important that the associations generate generic recommendations for crop nutrient requirements and to train agronomists for technical assistance in interpreting soil analyzes.

FENALCE exposes studies in the cultivation of Zea mays, it was found that the nutrient requirements are being overestimated between 35 to 40%, and that the recommendations of triple fractionation in fertilization of N / K have been generated from the grain industry: 20 % at the beginning, 40% in state B6 and 40% in B8 –B10. Additionally, recommendations of nitrogen units required by region and crop variety (between 125 and 170 kg / ha biannual) have been established and the calculation of fertilization efficiency indexes. Jeimar Tapasco CIAT researcher comments on the checklists developed in conjunction with FENALCE, where the key monitoring points for cultivation are described, including soil analysis, fractionation of fertilization, sanitary management, harvesting and use of water.

FEDECACAO showed statistics on the technology adoption processes of the last 10 years by cocoa farmers, where technified producers (30%) apply compound fertilizers, mainly DAP, N, P, K and minor minerals, small-scale producers economy do not fertilize. FEDECACAO estimates 176,000 hectares planted in 2019 with a projected increase of 6,000. 52,000 families are attached to the federation, 10,000 of them are part of the soil analysis program and fertilization recommendations.

AGROSAVIA presented to the audience about the entity's work in estimating nutritional requirements for blackberry, banana, corn, sorghum and avocado crops. Its technology transfer program focuses on promoting organic fertilization, developing biofertilizers for cocoa and bananas. Within its lines of research, is the estimation of GHG emissions in the agricultural and livestock sector, using different methodologies adapted and validated for contrasting conditions in the country, the results of these investigations have recently been socialized with the Low Sustainable Development Project In Carbon for the Orinoquía Region.

The Colombian low-carbon development strategy highlighted the relevance of the workshop to know what the unions do in GHG studies as input for the construction of the NDC.

3.2 Presentation Summary [2]

The first presentation was by the Agricultural Engineer Juan Carlos Hernández, Technical Manager in Colombia of the Fertinagro company. His presentation was to present statistics on the import and production of fertilizers, characterize the main inorganic nitrogenous fertilizers in Colombia and make a description of the demand for nitrogen fertilization in Colombia in crops of

[1] Photographic record available in annexes 1
[2] Photographic record available in annexes 2

economic importance. By way of context, fertilizers contribute ¼ of anthropogenic GHG emissions from their production, use and disposal.

Fertilizer statistics show that in Colombia around 1,500 fertilizer references are being marketed by 35 to 40 companies, of which 10 carry out import, manufacture and marketing and between 25 to 30 are internal producing companies. Fertilizers and imported raw materials enter the country mainly through the Buenaventura seaport (55%), this is directly related to the location of the processing companies in the Colombian Pacific.

The country imported 1,621,760 tons of fertilizers for 2018, of which 1,070,728 contain nitrogen (66%). 33% of imports are urea, 29% potassium chloride (KCL), 10% monoammonium phosphate (MAP), 9.3% ammonium sulfate (SAM), 9.1% diammonium phosphate (DAP) and 5% calcium nitrate. The countries of origin are Russia, China and the United States. Of these nitrogen sources, urea (CO (NH2) 2) contains 20% carbon and amides (CO (CH3) 2HN2) 16.2%, additionally constituting a source of CO2 release.

In Colombia, the main crops demanding nitrogenous fertilizers in order of importance are: coffee, oil palm, sugar cane, irrigated rice, pastures in dairy cattle and rainfed rice; in an estimated area of 3,037,809 hectares. The Latin American region has low requirements for nitrogen applied by tropical crops such as fruit trees, compared to other regions of the world such as Asia, whose cereal production is highly dependent on nitrogen sources.

The Ministry of Agriculture and Rural Development presented the goal of reducing GHG emissions agreed in common agreement with SISCLIMA entities, including IDEAM, the Low Carbon Development Strategy and other ministries, of 20% with their own resources and in 30% with international cooperation raised in the NDC. The prioritized subsectors with the potential to reduce emissions and removals are forest plantations, the increase in hectares planted with palm and cocoa. The use of technologies in rice, rational grazing and reconversion of livestock in silvopastoral systems. The mitigation proposals are also based on adequate fertilization for each crop, management and use efficiency.

To obtein these reduction objectives, the country should concentrate efforts on making direct measurements of emission factors in order to reduce the uncertainty of national GHG inventories, strengthen agricultural extension programs in the management of climate change, and improve precision. of activity data.

The last presentation was made by the agrometeorologist Carlos Felipe Torres, currently Colombia does not contribute representatively to global anthropogenic GHG emissions (about 0.56% of global emissions), the national GHG inventory in Colombia is developed using the guidelines of the Intergovernmental Panel on Climate Change (IPCC 2006 and 2019). The emissions from synthetic fertilizers are reported in the AFOLU sector (agriculture, forestry and other land uses).

Subcategories 3C4 and 3C5-Direct and indirect N2O emissions from managed soils, estimate the quantification of nitrogen as input to agricultural and livestock systems, and are emitted into the atmosphere. Nitrogen inputs include: Synthetic Nitrogen Fertilizers (FSN); organic nitrogen applied as a fertilizer, such as animal manure, compost, sewage sludge, waste (FON); nitrogen from urine and manure deposited on pastures by grazing animals (FPRP), nitrogen from crop residues (aerial and underground), including nitrogen-fixing and forage crops during pasture renewal (FCR); Nitrogen mineralization related to the loss of soil organic matter as a result of changes in land use or mineral soil management (FSOM) and organic soil management (FOS).

For the 1990 to 2014 time series, direct N2O emissions have represented for the country an average of 14,753 Gg of CO2eq per year. The historical average participation in order of importance is: nitrogen deposited in pastures (72%), organic soil management (14.2%), synthetic nitrogenous fertilizers (8.5%), mineralization due to change in the use or management of soil (3.7%), crop residues (1.4%) and organic nitrogen fertilizer (0.4%)[3].

3.2.1 Participant feedback

In the first session, the representatives of the unions of FEDEARROZ, FENALCE, FEDECACAO and MADR discussed the problems related to the times and volumes of application of fertilizers, the lack of knowledge of agricultural producers in the composition and proper use of sources. of nitrogen and the importance of working from the federations to generate fertilization plans according to the needs of each crop by region.

AGROSAVIA professionals expressed the importance of state support for the implementation of GHG mitigation practices and measures in the sector. MADR made its contributions by emphasizing FINAGRO's initiative on credit rates and agricultural incentives. In addition, IDEAM representatives shared some successful experiences in conservation agreements with producers.

3.2.2 Conclusions first session

- Measurements of nitrogen applied by crop are necessary to design climate change mitigation strategies associated with high nitrogen risks from losses in volatilization, mineralization, nitrification, denitrification, and leaching.
- Suggested that work should be done to strengthen technical assistance from the public policy of agricultural extension.
- Important the introduction of nitrogen fixing legumes in the different production systems, in the importance of massifying the practice of soil analysis as a tool to generate fertilization protocols.

3.3 Practical exercise: Calculation of GHG emissions by nitrogenous inputs under IPCC methodology 2006 and 2019[4]

The presentation focused on explaining how to follow a decision tree for estimating CO2 from the application of urea and nitro oxide emissions from the use of nitrogenous fertilizers. For the 2 cases, the IPCC 2006 methodological guide states that You must know the annual amount of fertilization with urea (ton urea year^{-1}), the kilograms of total nitrogen applied and the emission factors.
The decision tree for the direct and indirect estimation of N2O has made it possible to identify the ICA statistics and the use of IPCC default emission factors as activity data source.

3.3.1 Exercise: GHG estimation

Groups of 2 people were formed, each group worked with a different fertilizer database from 2005 to 2017, performing the following sequence of steps:

- Sum of the total volume of fertilizers per year in tons
- Assume that 17.5% of the mixture is nitrogen (assumption from the national inventory)

---

[3] Data source for Colombia's second biennial update report (IDEAM, 2018)
[4] Images of the practical exercise available in annexes 3.

- Calculate the nitrogen percentage of the total volume, according to the nitrogen content of the fertilizer, the nitrogen content is equal to the activity data to be used in the inventory.
- Calculate the difference between the assumption of 17.5% and the actual percentage of nitrogen contained in the fertilizers
- Identify urea (46% nitrogen)

Calculate CO2 emissions from Urea use[5]

- In the 3C3 spreadsheet template for estimating inventories, enter activity data (tons urea year-1)
- Consult 2006 IPCC guidelines and identify emission factors for CO2 emissions from urea application (0.20 ton C)
- Adjust for CO2 molecular weight (44/12)

Calculate N2O emissions from the use of synthetic nitrogen[6]

- In the 3C4 spreadsheet direct N2O emissions from managed soils, enter activity data in kg of total nitrogen
- Consult 2006 IPCC guidelines and identify emission factors for N2O emissions from nitrogenous synthetic fertilizers (0.01 kg N2O - N)
- Perform molecular weight adjustment for N2O (44/28)
- For direct N2O emissions from irrigated rice cultivation, enter activity data assuming the same value in kg of total nitrogen
- Consult 2006 IPCC guidelines and identify emission factors for indirect N2O emissions from irrigated rice cultivation (0.0003 kg N2O - N)
- Perform molecular weight adjustment for N2O (44/28)
- In spreadsheet 3C5 indirect N2O emissions from managed soils: nitrogen leaching and volatilization, enter activity data in kg of total nitrogen
- Consult 2006 IPCC guidelines and identify emission factors for leaching (0.0075 kg N2O – N (kg N leaching / runoff) -1, and volatilization (0.010 kg N2O – N (kg NH3 – N + NOX – N volatilized) -1
- Consult 2006 IPCC guidelines and identify the fractions that volatilize (0.10 (kg NH3 – N + NOx – N) (kg N applied) –1 and leach (0.30 kg N)
- Perform molecular weight adjustment for N2O (44/28)

In the second half of the exercise, each group had to make the projections in nitrogen requirements per hectare, from a database of planting of cocoa, corn and rice crops, which contained projected values for the series 1990 to 2030, these Activity data, for these areas the nitrogen requirements were as follows: standards (Bussines as usual), over nitrogen application (negative scenario) and controlled application (mitigation scenario). This exercise allowed participants to understand the importance of applying nitrogen sources to crops in an inefficient way.

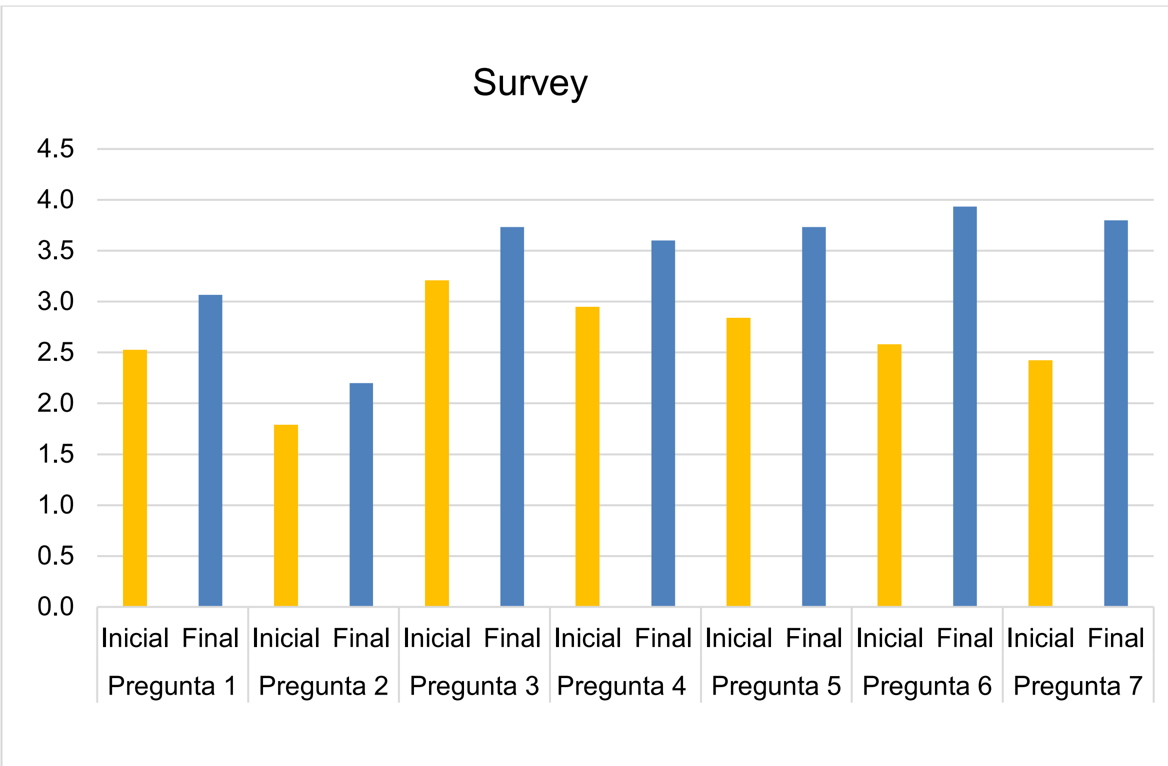
---

[5] Images of the spreadsheets available in Annex 4
[6] Images of the spreadsheets available in Annex 5

4. Transfer of knowledge[7]

As a diagnostic tool for the appropriation of knowledge, an initial and final survey was conducted of the participants, numerically rated from 1 to 5 (1 not having knowledge and 5 all knowledge) on the following questions:

- What domain do you have of the 2006 IPCC guidelines?
- What domain do you have of the 2019 IPCC refinement guides?
- Do you know the sources of direct nitrous oxide emissions from the agricultural sector?
- Do you know the sources of indirect nitrous oxide emissions from the agricultural sector?
- What level of knowledge do you have of GHG emissions from the use of synthetic nitrogenous fertilizers?
- What level of knowledge do you have of GHG emissions in managed soils?
- What level of knowledge do you have of CO2 emissions from the use of urea?



Graph 1. Learning curve

The bar graph shows that all the participants at the beginning of the workshop had a low knowledge (less than 3) about the estimation methodologies, the GHG emissions from the managed soils and the N2O sources. From the shared information and the practical exercise developed in the workshop, the general perception of the group was positive in the face of the

[7] Images of the surveys available in Annex 6

acquisition of new knowledge, clarification of questions and satisfaction of their expectations about the sources of emissions and GHG emissions.

5. Conclusions

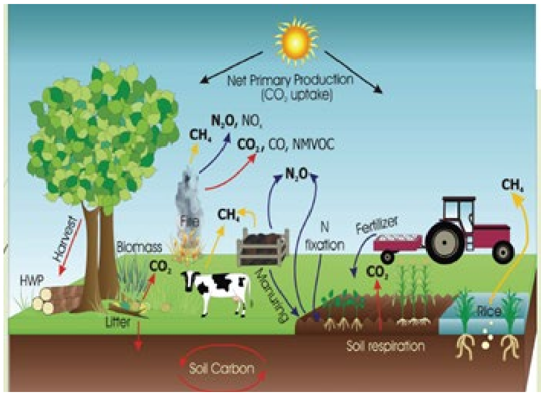
Projections for scenarios of mitigation of GHG emissions generated by managed soils should be built with the federations, who are knowledgeable in the sector and have direct influence on the producer.

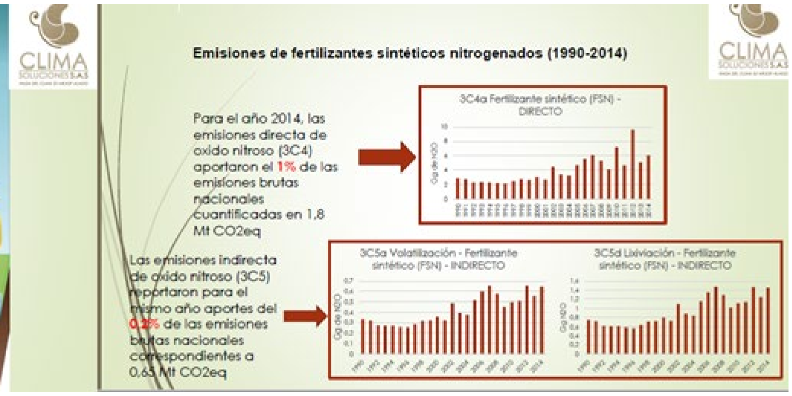
State institutions must strengthen their coordination with federations in the appropriation of the concepts and methodologies of the national inventory and GHG and generate the exchange of information to build emission factors and improve activity data for estimating emissions.

Enable knowledge exchange spaces such as courses and workshops where it is possible to deepen on the issues of climate change, in addition to extending the invitation to other important actors, for example, the Colombian federation of potato producers and the production chains of MADR.

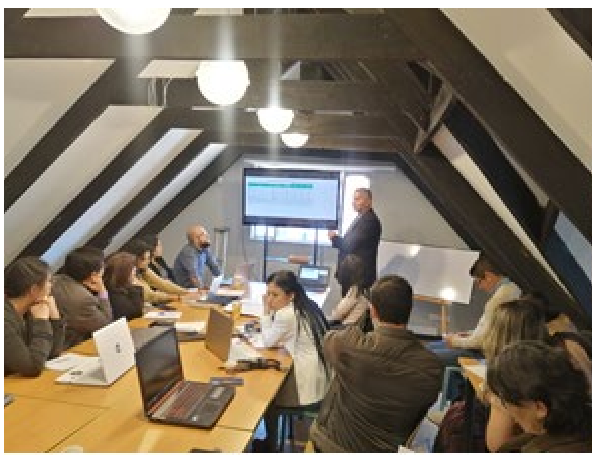
6. Annexes

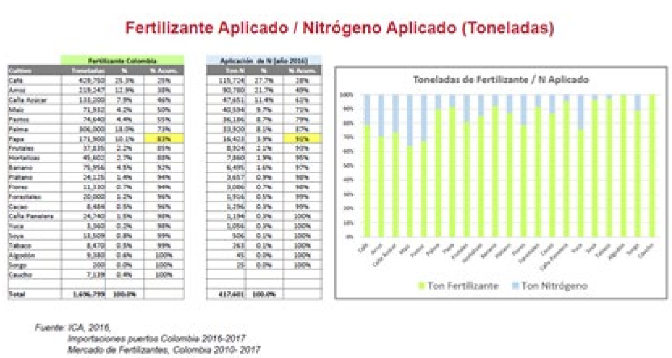
6.1 Annex 1: Photographic record presentation summary phase 1

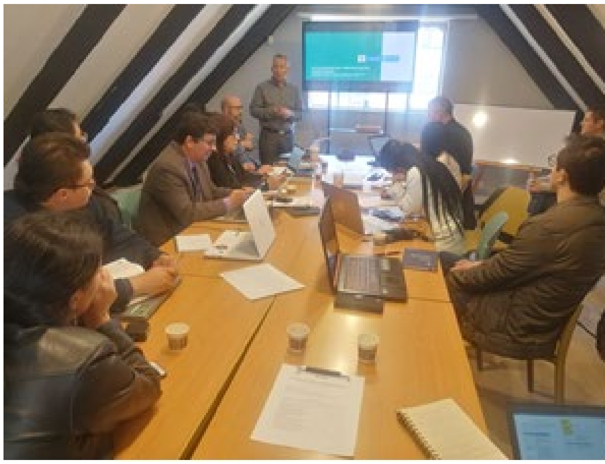



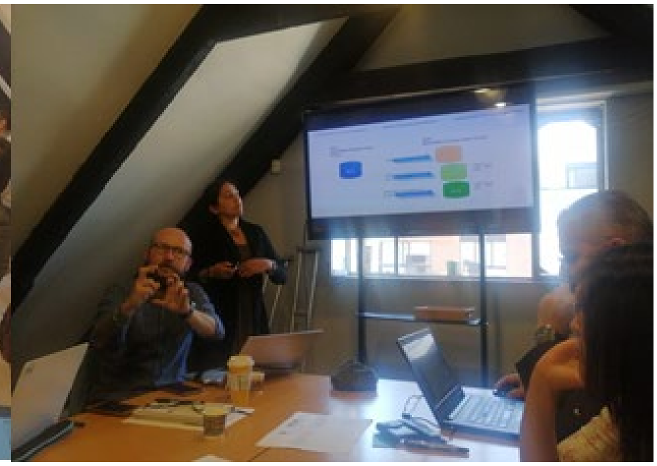


6.2 Annex 2: Photographic record summary of presentations

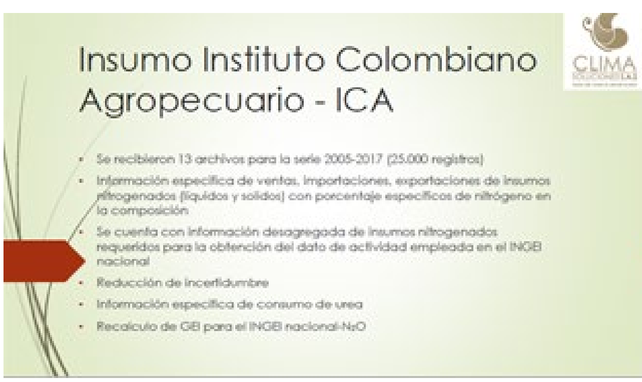








6.3 Annex 3: Photographic record practical exercise



6.4 Annex 4: Urea exercise spreadsheets

Sector	Agriculture, Forestry and Other Land Use		
Category	Urea Fertilization: Annual CO_2 emissions from Urea Fertilization		
Category code	3C3		
Sheet	1 of 1		
Equation	Equation 11.13		
Subcategories for reporting year	Annual amount of Urea Fertilization	Emission factor	Annual CO_2-C emissions from Urea Fertilization
	(tonnes urea yr^{-1})	[tonnes of C (tonne of urea)$^{-1}$]	(tonnes C yr^{-1})
			CO_2-C Emission = M * EF
	M	**EF**	**CO_2-C Emission**
(a)			0
Total			

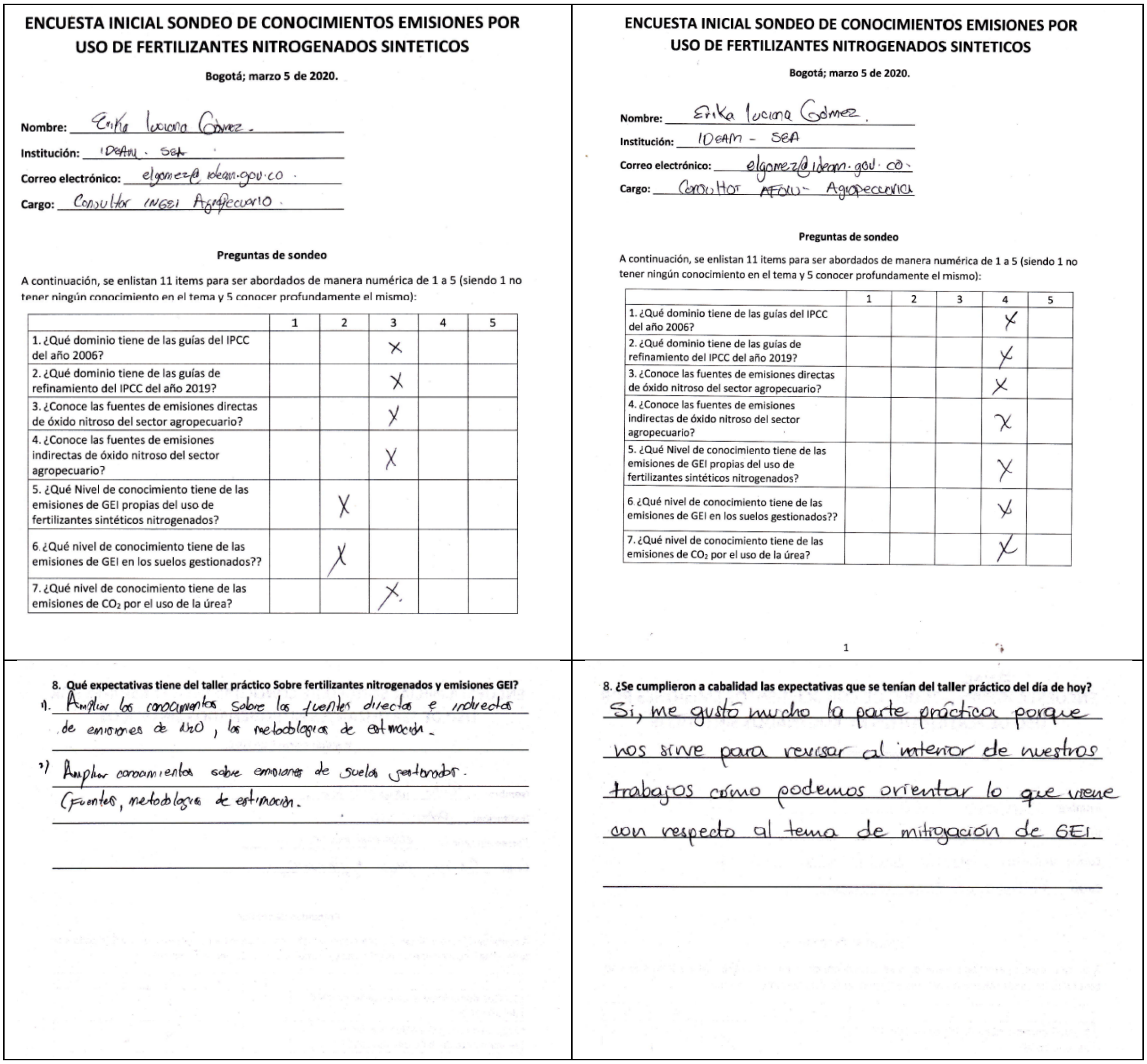
6.5 Annex 5: Spreadsheets N2O exercise

Sector		Agriculture, Forestry and Other Land Use				
Category		Direct N_2O Emissions from Managed Soils				
Category code		3C4				
Sheet		1 of 2				
Equation		Equation 11.1				
Anthropogenic N input type		Annual amount of N applied		Emission factor for N_2O emissions from N inputs		Annual direct N_2O-N emissions produced from managed soils
		(kg N yr^{-1})		[kg N2O-N (kg N input)$^{-1}$]		(kg N_2O-N yr^{-1})
				Table 11.1		$N_2O-N_{N\ inputs}$ = F * EF
		F		EF		N_2O-N_{inputs}
Anthropogenic N input types to estimate annual direct N_2O-N emissions produced from managed soils	synthetic fertilizers	F_{SN}: N in synthetic fertilizers		EF_1		-
Anthropogenic N input types to estimate annual direct N_2O-N emissions produced from flooded rice	synthetic fertilizers	F_{SN}: N in synthetic fertilizers		EF_{1FR}		-
Total						

Sector	Agriculture, Forestry and Other Land Use				
Category	Indirect N_2O Emissions from Managed Soils: N_2O from Atmospheric Deposition of N Volatilised from Managed Soils				
Category code	3C5				
Sheet	1 of 2				
Equation	Equation 11.9				
Anthropogenic N input type	Annual amount of synthetic fertilizer N applied to soils	Fraction of synthetic fertilizer N that volatilises	Fraction of applied organic N fertilizer materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilises	Emission factor for N_2O emission from atmospheric deposition of N on soils and water surfaces	Annual amount of N_2O-N produced from atmospheric deposition of N volatilised from managed soils
	(kg N yr^{-1})	(kg NH_3-N + NO_x-N) (kg of N applied)$^{-1}$	(kg NH_3-N + NO_x-N) (kg of N applied or deposited)$^{-1}$	(kg N_2O-N) (kg NH_3-N + NO_x-N volatilized)$^{-1}$	(kg N_2O-N yr^{-1})
		Table 11.3	Table 11.3	Table 11.3	$N_2O_{(ATD)}$-N = [(F_{SN} * $Frac_{GASF}$) + (F_{ON} + F_{PRP}) * $Frac_{GASM}$)] * EF_4
	F_{SN}	$Frac_{GASF}$	$Frac_{GASM}$	EF_4	$N_2O_{(ATD)}$-N
(a)					-
Total					

Sector	Agriculture, Forestry and Other Land Use			
Category	Indirect N_2O Emissions from Managed Soils: N_2O from N leaching/runoff from Managed Soils			
Category code	3C5			
Sheet	2 of 2			
Equation	Equation 11.10			
Anthropogenic N input type	Annual amount of synthetic fertilizer N applied to soils	Fraction of all N additions to managed soils that is lost through leaching and runoff	Emission factor for N_2O emission from N leaching and runoff	Annual amount of N_2O-N produced from managed soils in regions where leaching and runoff occurs
	(kg N yr^{-1})	[kg N (kg of N additions)$^{-1}$]	[kg N_2O-N (kg N leaching and runoff)$^{-1}$]	(kg N_2O-N yr^{-1})
		Table 11.3	Table 11.3	$N_2O_{(L)}$-N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * $Frac_{LEACH-(H)}$ * EF_5
	F_{SN}	$Frac_{LEACH-(H)}$	EF_5	$N_2O_{(L)}$-N
(a)				-
Total				

6.6 Annex 6: Example of survey



ENCUESTA INICIAL SONDEO DE CONOCIMIENTOS EMISIONES POR USO DE FERTILIZANTES NITROGENADOS SINTETICOS

Bogotá; marzo 5 de 2020.

Nombre: Erika Luciana Gómez.

Institución: IDEAM - SEA

Correo electrónico: elgomez@ideam.gov.co

Cargo: Consultor INGEI Agropecuario

Preguntas de sondeo

A continuación, se enlistan 11 items para ser abordados de manera numérica de 1 a 5 (siendo 1 no tener ningún conocimiento en el tema y 5 conocer profundamente el mismo):

	1	2	3	4	5
1. ¿Qué dominio tiene de las guías del IPCC del año 2006?			X		
2. ¿Qué dominio tiene de las guías de refinamiento del IPCC del año 2019?			X		
3. ¿Conoce las fuentes de emisiones directas de óxido nitroso del sector agropecuario?			X		
4. ¿Conoce las fuentes de emisiones indirectas de óxido nitroso del sector agropecuario?			X		
5. ¿Qué Nivel de conocimiento tiene de las emisiones de GEI propias del uso de fertilizantes sintéticos nitrogenados?		X			
6 ¿Qué nivel de conocimiento tiene de las emisiones de GEI en los suelos gestionados??		X			
7. ¿Qué nivel de conocimiento tiene de las emisiones de CO_2 por el uso de la úrea?			X		

ENCUESTA INICIAL SONDEO DE CONOCIMIENTOS EMISIONES POR USO DE FERTILIZANTES NITROGENADOS SINTETICOS

Bogotá; marzo 5 de 2020.

Nombre: Erika Luciana Gómez.

Institución: IDEAM - SEA

Correo electrónico: elgomez@ideam.gov.co.

Cargo: Consultor AFOLU - Agropecuaria

Preguntas de sondeo

A continuación, se enlistan 11 items para ser abordados de manera numérica de 1 a 5 (siendo 1 no tener ningún conocimiento en el tema y 5 conocer profundamente el mismo):

	1	2	3	4	5
1. ¿Qué dominio tiene de las guías del IPCC del año 2006?				X	
2. ¿Qué dominio tiene de las guías de refinamiento del IPCC del año 2019?				X	
3. ¿Conoce las fuentes de emisiones directas de óxido nitroso del sector agropecuario?				X	
4. ¿Conoce las fuentes de emisiones indirectas de óxido nitroso del sector agropecuario?				X	
5. ¿Qué Nivel de conocimiento tiene de las emisiones de GEI propias del uso de fertilizantes sintéticos nitrogenados?				X	
6 ¿Qué nivel de conocimiento tiene de las emisiones de GEI en los suelos gestionados??				X	
7. ¿Qué nivel de conocimiento tiene de las emisiones de CO_2 por el uso de la úrea?				X	

1

8. Qué expectativas tiene del taller práctico Sobre fertilizantes nitrogenados y emisiones GEI?

1). Ampliar los conocimientos sobre las fuentes directas e indirectas de emisiones de N2O, las metodologías de estimación.

2) Ampliar conocimientos sobre emisiones de suelos gestionados. (Fuentes, metodologías de estimación.

8. ¿Se cumplieron a cabalidad las expectativas que se tenían del taller práctico del día de hoy?

Si, me gustó mucho la parte práctica porque nos sirve para revisar al interior de nuestros trabajos cómo podemos orientar lo que viene con respecto al tema de mitigación de GEI.

This work is supported by USDA Foreign Agricultural Service program “Enhancing Capacity for Low Emission Development Strategies (EC-LEDS).” The view expressed are those of the authors and do not necessarily reflect the views or policies of USDA.