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"LIVESTOCK AND CLIMATE CHANGE: APPLIED RESEARCH AND KNOWLEDGE"

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This document was prepared by Kai Hertz, Fund Coordinator (ORP/GCM) and Eugenia Saini (FONTAGRO). For direct inquiries regarding this report, please contact the fund coordinator at kaih@iadb.org or 202-623-3575.

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ABBREVIATIONS

CH_4	Methane
CO_2	Carbon Dioxide
N_2O	Nitrous Oxide
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CIAT	International Center for Tropical Agriculture
CORPOICA	Corporación Colombiana de Investigación Agropecuaria
DICTA	Dirección de Ciencia y Tecnología Agropecuaria de Honduras
fontagro	Regional Fund for Agricultural Technology
GHG	Greenhouse Gas
GRA	Global Research Alliance
IICA	Inter-American Institute for Cooperation on Agriculture
INIA Uruguay	Instituto Nacional de Investigación Agropecuaria - Uruguay
INIAF	Instituto Nacional de Innovación Agropecuaria y Forestal de Bolivia
INIAP	Instituto Nacional de Investigaciones Agropecuarias de Ecuador
INIFAP	Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias de México
INTA-MAG	Instituto Nacional de Innovación y Transferencia en Tecnología Agropecuaria de Costa Rica
INTA Nicaragua	Instituto Nicaragüense de Tecnología Agropecuaria
IDIAP	Instituto de Investigación Agropecuaria de Panamá
IPTA	Instituto Paraguayo de Tecnología Agraria
LAC	Latin America and the Caribbean
ORP	Office of Outreach and Partnerships
tas	Technical Administrative Secretariat at FONTAGRO
TC	Technical Cooperation
UNA LA MOLINA	Universidad Nacional Agraria La Molina

EXECUTIVE SUMMARY

The purpose of this report is to inform the Ministry for Primary Industries of New Zealand about the progress of projects financed under the Program "Livestock and Climate Change: Applied Research and Knowledge Dissemination" (RG-X1202) during 2017.

With resources from the Ministry for Primary Industries (MPI) and the Regional Fund for Agricultural Technology (FONTAGRO – administered by the Bank), three technical cooperation projects are being financed and in execution: (1) Silvopastoral systems in Central America; (2) Dairy systems in the Andean Region, and (3) Networking and Capacity Building. Their goal is to increase capacity on the measurement of GHG emissions from livestock systems under traditional and improved management. The projects are also to facilitate the design of mitigation strategies and the formulation of policies to promote sustainable livestock production systems with low GHG emissions in Central America and the Andes, and expanding knowledge sharing, networking and capacity building on these topics.

The main intermediary products or results achieved in 2017 are:

- *GHG emissions and economic impact of silvopastoral production systems in Central America*: Project activities are being implemented as planned. Preliminary results indicate that local estimations of GHG emissions (mainly methane) can be reduced by applying better herd management and practices, especially those related to feeding quality. Additionally, the project found that characteristics related to animal growth and feed quality may also influence GHG emissions rate, and that the lack of market differentiation could be negative related to technology adoption by farmers. The project covered around 4,000 hectares.
- *GHG emissions and improvement options for dairy systems in the Andean Region*: In Peru, two new experimental pilot sites were established, and two trials based on natural grasslands and alfalfa pastures were implemented. In Colombia a pilot plot was stablished at CORPOICA (Tibaitatá research center) with dairy cattle. Samples were collected from ten Holstein cows under production grazing on kikuyo. The trial for measuring nitrous oxide in traditional systems was conducted in the San Francisco de Chichausiri agricultural cooperative (in Junin, Junin). The experimental area was a typical scrubland (high grasses) with a history of cattle grazing and in regular to good condition. Project team members exchanged important information and experiences during workshops in Chile, Costa Rica, and Peru. These events enabled them to become acquainted with the use of collars prototypes for direct animal GHG measurement.
- *Networking and Capacity Building*: After the workshop in Costa Rica (April 2016), 25 researchers from 14 LAC countries trained in livestock production system analysis in the context of climate change; decided to create a new

initiative the “Latin American and the Caribbean Platform for Sustainable Intensification of Livestock Production”. The objective of this platform is to promote sustainable intensification of livestock production systems and value chains in LAC within the wider strategic context for adaptation and mitigation of climate change. The platform started in 2017, coordinated by CATIE. A first meeting of this platforms was organized on April 2017, where more than 50 experts on livestock systems and climate change discussed main subjects of research to create enough evidence to support new policies and programs in LAC.

I. INTRODUCTION

1.1 **This report describes the status and results accomplished from the implementation of envisioned activities under the Program "Livestock and Climate Change: Applied Research and Knowledge Dissemination" (RG-X1202) during 2017**. As per Article 11 of the Administrative Agreement signed on June 9, 2014, the Bank may provide New Zealand with a report by April 30 of each year.

1.2 **The Regional Fund for Agricultural Technology (FONTAGRO)** is an alliance of countries aimed at financing research and innovation in the agricultural sector in Latin America and the Caribbean (LAC). Since its inception in 1998, the Fund has been administered by the Bank and it has also been supported by the Inter-American Institute for Cooperation on Agriculture (IICA). Over the years, FONTAGRO has become a recognized mechanism due to its transparency, sustainability, governance and commitment by its member countries.

1.3 **The Medium Term Plan 2015-2020 of FONTAGRO sets out four priorities:**(i) Technological, institutional and organizational innovations (ii) opportunities in climate change adaptation and mitigation, (iii) Sustainable intensification and natural resources management, and (iv) Competitive territories and value chains.

1.4 **The document is organized as follows**: Section II entails an overview of the Program, followed by a description of advances in the implementation of the Program's components, including (interim) results achieved (section III), and Section IV provides preliminary conclusions.

II. PROGRAM OVERVIEW

A. PURPOSE AND DESCRIPTION OF THE PROGRAM

2.1 The Program aims at strengthening the technical and institutional capacity to measure GHG emissions from livestock under traditional and improved practices. This is to facilitate the design of mitigation strategies and the formulation of policies to promote sustainable livestock production systems in Central America and the Andean Region. The Program also promotes networking and capacity building.

2.2 Livestock and dairy production are very important activities for the livelihood of small farmers in LAC. Demand for meat, milk and dairy products has been increasing in the last decades because of urbanization, rising incomes and population growth. These activities are particularly important in Central America and the Andean region and are critical for food security. However, livestock and dairy production systems are also major utilizers of natural grasslands and pastures, and thus important contributors to GHG emissions, thus to climate change[1]. It has been found that GHG emissions (especially methane) from livestock can be reduced with better feeding and management practices, which could also result in higher productivity and better incomes for smallholders.

B. FINANCIAL INFORMATION

2.3 To date, the Bank has received from the Ministry for Primary Industries (MPI) of New Zealand resources totaling US$471,076, which represents the value of NZ$600,000 established in the Agreement. The total amount available for the program is approximately US$810,000 which includes FONTAGRO's own resources. These resources have been assigned to projects as follows (Table 1):

Table 1. Actual projects

Approval Number	Name	Executing Agency	Amount
FTG/RF-14652	GHG emissions and economic impact of silvopastoral production systems in Central America	CATIE	US$300,000
FTG/RF-14653	GHG emissions and improvement options for dairy systems in the Andean Region	IICA-Peru	US$370,000
FTG/RF-14654	Networking and Capacity Building	FONTAGRO/TAS	US$139,318

[1] See also http://www.fao.org/livestock-environment/en/ & http://www.fao.org/news/story/en/item/197623/icode/

C. PORTFOLIO OVERVIEW AND RESULTS

2.4 The table 2 below provides a general overview of each projects' disbursement status as of December 31, 2017. All projects demonstrate satisfactory advances in execution.

Table 2. Disbursement status / project

Approval Number	Approved original	Disbursed life	% Disbursement	Available amount	Project End Date
FTG/RF-14652-RG	300,000.00	300,000.00	100%	0.0	May, 27,2018
FTG/RF-14653-RG	368,000.00	368,000.00	100%	0.0	26-May-18
FTG/RF-14654-RG	139,318.00	91,318.30	66%	47,999.70	9-Jun-18

III. PROJECT PORTFOLIO EXECUTION STATUS AND RESULTS

A. SILVOPASTORAL SYSTEMS IN CENTRAL AMERICA: CATIE (FTG/RF-14652-RG)

1. OBJECTIVE

3.1 The main objective is to develop methodologies for the estimation of GHG emissions and the economic impact of different production systems in Central America. To that effect, the project contemplates a set of activities described below.

2. SUMMARY OF PROJECT ACTIVITIES

3.2 The project contemplates the implementation of activities that will define and apply methane (CH4), carbon dioxide (CO2) and nitrous oxide (N2O) measurement methods to silvopastoral systems in Central America, increase systems' productivity while reducing emissions, and disseminate the knowledge obtained. These activities and their expected outputs and results are presented in Table 3 and advances in execution are being described in the subsequent paragraphs.

Table 3: Project Components and Activities

Component	Activities	Results	Current Status
1. Systematization of methodologies to quantify GHG emissions in livestock farms	This activity involved a literature review, a compilation of tools and methods developed globally, and a workshop with experts where it was analyzed pros and cons of various methane (CH4), carbon dioxide (CO2) and nitrous oxide (N2O) measurement methods.	Identification of limitations for the estimation of GHG emissions and selection of measurement tools and methods for the project.	Completed
2. Quantification of GHG emissions under various levels of livestock systems' intensification	Monthly collection of data was made, and included: land use, pastures, livestock production and productivity, labor, inputs and outputs. GHG (CH_4, CO_2 and N_2O) emissions were estimated with methods and tools selected in the previous activity. Two trials were established in Costa Rica to determine factors that affect emissions. One was done with dairy cows and the other with fattening cattle. The methodology utilized in the Southern Cone (product of the FONTAGRO-New Zealand project FTG/RF-1028-RG executed by INIA Uruguay) was used and also technical assistance from this team was obtained.	Identification of good practices that contribute to reduce GHG emissions in Central American farms were identified and validated in local conditions.	Completed
3. Evaluation of economic	A cost-benefit analysis was performed in various production systems under this research	It was identified that farming systems with	Completed

Component	Activities	Results	Current Status
performance of livestock production systems and their relationship with GHG emissions	and their GHG emissions estimates were obtained. A trade-off analysis was conducted considering ecological intensification to reduce GHG emissions and income per unit of product or area.	better technology and practices management can decrease emission levels.	
4. Strengthening technical capacities, and communication strategies to influence policy formulation for the promotion of low emission and high productivity livestock systems	A series of activities were implemented, including workshops, roundtables with decision makers, scientific and technical publications, policy briefs, networking with regional and national initiatives, and strengthening exchange of information through the Web, among others.	Greater awareness was obtained by implementing a result dissemination and knowledge management strategy.	Completed
5. Preparation of a Phase II to increase the knowledge on livestock, silvopastoral systems and climate change	Livestock research and development is a long-term endeavor. Results of the present project were analyzed in a workshop towards the end of third year. Positive progress and gaps were assessed, and they will serve as the basis for the preparation of a Phase II aimed at scaling up results obtained in this project.	Scaling up use of research results and addressing knowledge gaps for the improvement of livestock systems with lower GHG emissions in Central America	Completed

3. ADVANCES IN PROJECT IMPLEMENTATION AND RESULTS TO DATE

3.3 During the reporting period (2017), applied research activities and capacity building events have been implemented as will be described below[2]:

3.4 **Component 1. Systematization of methodologies to quantify GHG emissions in livestock farms.** This activity involved three main tasks: (a) farms characterization through surveys, (b) literature review and compilation of current tools for GHG emissions estimates for the livestock sector by indirect methods, and (c) a comparative analysis among countries.

3.5 With respect to the first task, several farm level surveys were conducted in each participating country and a database was created. This database led to the characterization of livestock farms and allowed for their comparison. In all cases, dual-purpose cattle were the dominant system. The database and its analysis revealed differences in farm production systems in terms of their intensification level characterized by the following variables: stocking rate, land use, pasture

[2] The complete report of this project is available in Spanish.

management, fertilization, and use of supplementary forages. Consequently, GHG emission rates can be obtained for each farm intensification level.

3.6 For the indirect estimation of GHG emissions, a literature review was conducted (second task). As a result of this exercise, seven tools for GHG quantification were identified. From those, only four tools (Cool farm tool, Exc-Ant-FAO, INTA Tool, GHG-FONTAGRO Tool[3]) were chosen based on the following parameters: geographical location, livestock management, and other variables related to GHG emissions (energy, fuel, agrochemicals, animals, and waste). These tools were validated through an expert consultation workshop applying a multi-criterion analysis. In this workshop, several public and private institutions participated (CATIE, INTA CORFOGA and MAG).

3.7 Subsequently (third task), the four selected tools for the indirect estimation of methane (CH4), nitrous oxide (N2O) and carbon dioxide (CO2) at farm level was used for GHG emissions estimations at particular farms in Costa Rica. The analysis of the data generated from the application of these tools, concluded that lower GHG emissions estimates were generated by the GHG-FONTAGRO tool compared to the IPCC methodologies. As a consequence, the GHG-FONTAGRO tool was selected for the estimation of GHG emissions by indirect methods.

3.8 Additionally, and depending on the farm intensification level, preliminary results of indirect estimates (Table 4) show that higher total GHG emissions have been found in Honduras (100.38 t CO2e/year) than in Costa Rica (94.2 t CO2e/year), and Nicaragua (81.77 t CO2e/year)[3] at medium farm intensification level.

3.9 In general, enteric fermentation is the main source of the emissions, representing 79, 75 and 85% of total emissions at medium levels of intensification in Costa Rica, Honduras and Nicaragua farms, respectively. Methane gas emissions from enteric fermentation are higher in those farms where grazing is the main practice, whereas the use of fodder banks and concentrates (indicators of system intensification) contribute to a reduction in emissions.

3.10 The same research indicates fertilization as the second source of GHG emissions in Costa Rica, and fuel in Honduras and Nicaragua for each level of intensification. In “high technology farms”, nitrogen fertilizers are mostly used for crops and cut and carry forages, whereas in pastures used under grazing the application of manure collected in milking parlors is the most common practice. The use of electricity and fossil fuel (gasoline and diesel) at farm level is basically for machinery operation and transport.

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[3] Fontagro’s tool is a model built from data related to local livestock production systems that better represents the local production conditions and thus the GHG emission rate. It was designed based on the methodology recommended by IPCC.

Table 4. Indirect GHGs estimates by farm level intensification and country

Farm Intensification level	High		Medium		Low	
	t CO2e/year	%	t CO2e/year	%	t CO2e/year	%
			Costa Rica			
Enteric fermentation	54.74	82%	74.63	79%	68.29	84%
Manure	1.37	2%	1.88	2%	1.56	2%
Fuel	2.77	4%	5.12	5%	5.39	7%
Fertilization	6.55	10%	12.02	13%	5.26	6%
Electricity	1.53	2%	0.56	1%	0.46	1%
Total	66.94	100%	94.2	100%	80.96	100%
			Honduras			
Enteric fermentation	57.35	67%	75.11	75%	58.59	70%
Manure	2.65	3%	5.18	5%	2.71	3%
Fuel	25.96	30%	19.24	19%	21.34	26%
Fertilization	0.05	0%	0.67	1%	0.32	0%
Electricity	0.02	0%	0.17	0%	0.21	0%
Total	86.02	100%	100.38	100%	83.17	100%
			Nicaragua			
Enteric fermentation	65.46	80%	69.5	85%	79.82	88%
Manure	0.85	1%	0.9	1%	0.96	1%
Fuel	9.69	12%	8.52	10%	8.79	10%
Fertilization	4.92	6%	2.74	3%	1.37	2%
Electricity	0.11	0%	0.12	0%	0.2	0%
Total	82.02	100%	81.77	100%	91.15	100%

Source: Own estimates (2017)

3.11 Additionally, this research estimated GHG emissions per unit of product (milk) for each country and farm intensification level. Results show that Costa Rica has higher level of GHG emissions per kilo of milk and for each farm intensification level, compared to Honduras and Nicaragua. However, Costa Rica and Honduras present higher emissions rates per unit of milk at medium intensification level than Nicaragua (Table 5). The information obtained from this research will permit introducing new practices or technologies aimed at increasing farm productivity in a sustainable manner, i.e. decrease GHG emissions per unit of milk while increasing productivity.

Table 5. Indirect GHG's estimates by unit of product (kg CO2e per kg of milk)

Farm Intensification level	High	Medium	Low
Costa Rica	1.5	2.23	2.91
Nicaragua	0,31	0,32	0,33
Honduras	0,14	0,24	0,23

Source: Own estimates (2017)

3.12 In Panama, the research focused on estimating GHG emissions during two weather seasons (dry and humid). The estimates show that GHG emissions are higher during the dry season, probably due to the weather impact on forage quality (Figure 1). The research also found a negative correlation between GHG

emissions and milk production per cow, regardless of the season (Figure 2 and 3).

Figure 1. Dairy milk production and GHG emissions during two seasons in Panama

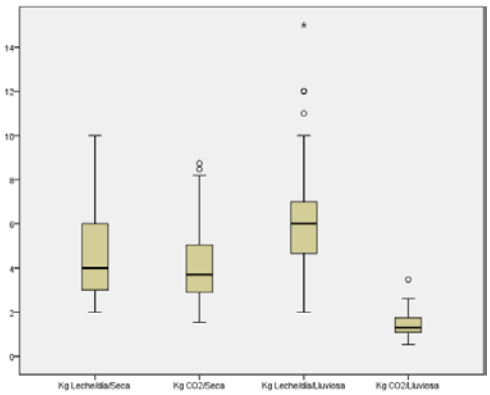


Figure 2. Relation between GHG emissions and milk production during the dry season

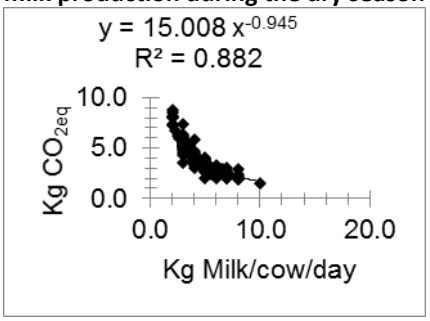
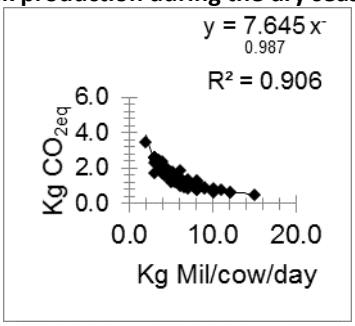


Figure 3. Relation between GHG emissions and milk production during the dry season



3.13 **Component 2. Quantification of GHG emissions under various levels of livestock systems intensification and direct / indirect methods.** This component included two main tasks: (a) pilot sites selection and monitoring (farms and experimental sites), and (b) direct assessment of GHG emissions, baseline definition, and final estimation of emissions factors (direct and indirect methods).

3.14 The quantification of GHG emissions was conducted by direct methods at experimental pilot sites and by indirect method at 70 farm pilot sites. Several experimental plots for methane (CH4) and nitrous oxide (N2O) measurement were established. These measurements are of special interest given their relevance for the quantification of local values. In addition to the gas measurements, the flux between soil and atmosphere (N2O) and between animal and atmosphere (CH4), was monitored.

3.15 In the experimental sites (CATIE and Los Diamantes) two trials were conducted for direct estimation of methane (CH4) and nitrous oxide (N2O). To conduct the direct gases estimations, two protocols for methane (CH4) and nitrous oxide (N2O) sampling were finalized. The protocol for CH4 sampling was elaborated under the SF6 technique for Costa Rica, while the protocol for N_2O sampling was

developed under the Closed-Chamber Technique (CCT)[4] [5] for Costa Rica, Honduras, Nicaragua and Panama.

3.16 For indirect measurement for GHG emissions surveys were conducted on 70 farm sites (Costa, Rica, Honduras, Nicaragua and Panama). The selection criteria for these farms was based on variables such as carrying capacity, pasture area, feeding stock, and individual animal production. Based on those variables, farms were classified in three intensification levels (low, medium and high). For farm monitoring, two main tasks were conducted. First, a protocol for CH4 emissions estimates was performed and implemented in 70 farms (approx. 15 farms in each country). Second, the indirect and direct CH4 emissions estimates were compared among farms every three months. Based on that data, new tools to increase animal productivity with low CH4 emissions were designed, and one manual on good practices for Honduras and Nicaragua was finalized[6]. Preliminary results from this activity are currently being analyzed.

3.17 To monitor the flux between soil and atmosphere, emissions of nitrous oxide (N2O) were measured by using the Closed-Chamber Technique (CCT). For that purpose, in each country, the project has established experimental plots in pastures currently under use. The "Closed-Chamber Technique" is still in validation. It is foreseen that such technique could be used for assessing the impact of nitrogen fertilizers in pastures and on GHG emissions. This report does not contain yet the conclusions of those trials, because the gas chromatography technique is still under calibration by the INTA Costa Rica lab technicians.

3.18 To monitor the flux between the animal and the atmosphere, measurements on methane (CH4) were conducted at experimental plots in "Los Diamantes" (Costa Rica). The experiment considered two types of pastures (one with the specie *Ischaemum indicum* sp. and the second with *Brachiaria* ssp.), two different grazing systems (traditional and Voisin), and a cattle herd constituted by males and females at different ages. The measure of CH4 on live animals was made by using individual collars with a collector tube and the sulfur hexafluoride (SF6) technique[7], both estimated by gasses chromatography. Daily methane emissions in grazing cattle are being measured in samples collected with portable equipment carried by the animals, not affecting their movement and behavior. Those measurements are being done only in Costa Rica.

3.19 Preliminary data show that greater levels of methane emission were observed in younger animals, and emissions levels declined as animals grew. The treatments based in different type of pasture for female and male cattle indicate that total

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[4] Rondon, M. 2000. Land use and balance of greenhouse gases in Colombia Tropical savants, Ph.D. Thesis Cornell University, USA. 211p.

[5] Klein, C., Harvey, M. 2012. Nitrous Oxide Chamber Methodology Guidelines. Ministry for Primary Industries. Wellington, UK. 1-146.

[6] The manual is also serving as a valuable input for the preparation of the NAMA in Honduras.

[7] JOHNSON, K., JOHNSON, D. 1995. Methane emissions from cattle. Journal of Animal Science. 73: 2483-2492.

methane emissions per animal per day are similar (200 and 168 g CH_4 $animal^{-1}$ day^{-1}, respectively). In general, results indicate that factors affecting animal physiological state and age would influence voluntary consumption and thus the methane emissions rate.

3.20 **Component 3. Evaluation of economic performance of livestock production systems and their relationship with GHG emissions**. This activity is being carried out in Panama. During 2016, a farm socio-economic analysis has been finalized and a study on GHG emissions and their economic impact is still under preparation. During 2017, several benefit-cost analyses on dairy farms resulted in a negative correlation between better practices to decrease emissions and market prices (r=-0.19 Costa Rica, R = -0.24 Nicaragua, R= -0.01 Honduras, and R = -0.18 Panama), probably due to the lack of consumer awareness and market differentiation.

3.21 **Component 4. Strengthening technical capacities, and communication strategies to influence policy formulation for the promotion of low emission and high productivity livestock systems.**

3.22 During 2017, technical capacities were strengthened in each country by organizing different activities such as short trainings, seminars, farm workshops, among others. These capacity building events were further complemented by the involvement of students (undergraduate, MSc and PhDs) and farmers in project activities.

3.23 In each country, pilot plots were implemented and will act as model for future GHGs emissions estimates and test of agronomic practices.

3.24 In the region, more than 50 students and professors were trained in livestock good practices to increase productivity while decreasing GHG's emissions. Some examples are: four students from the Autonomous University of Honduras - CURLA, who are working with the DICTA; four students from the Master's Degree in Sustainable Livestock from the Central University of Nicaragua and are supporting the project activities with the INTA-CR; two students of the Master of Agroforestry and Sustainable Agriculture – CATIE, a chemistry student from the National University of Costa Rica, a Master of Forest Economics student at the University of Denmark, and an economic master's degree student from the University of La Campiña, Brazil.

3.25 Similarly, around 300 farmers were introduced to new knowledge to improve herd management and pasture quality. More awareness was created by the result dissemination and knowledge management activities given by this project. Around 15% of farmers were women.

3.26 In Costa Rica, five professionals were trained in CH4 sampling and measurements techniques (two from Peru, two from Panama and one from Costa Rica). Three

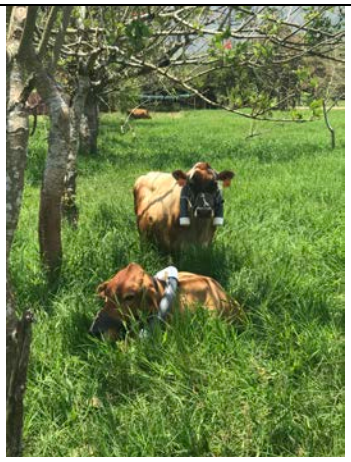
workshops on N2O measurements were organized, and several meetings with national authorities of the Ministry of Agriculture and Livestock and the Nationally Appropriate Mitigation Actions (NAMAs) from Costa Rica, were held.

3.27 In Honduras, four students from Universidad Autonoma de Honduras (CURLA) started their research together with the "Dirección de Ciencia y Tecnología Agropecuaria" (DICTA). Two workshops with 50 farmers (15% women) were organized. Furthermore, the project team leader shared preliminary results from the livestock platform research during a national congress on GHG emissions, event that was coordinated by the Ministry of Environment.

3.28 In Nicaragua, the methodologies developed by the project were incorporated in a national project named "Proyecto de Reconversión de la Ganadería", leading by the national research institute INTA Nicaragua.

3.29 In Panama, meetings with representatives from the Ministry of Agricultural Development (Ministerio de Desarrollo Agropecuario, MIDA) were held.

3.30 The above described events, aimed at expanding the technical capacities in Central America, have contributed to the following specific outputs: (a) increased laboratory capacity for gas chromatography in Costa Rica; (b) scientific and technical publications are in process; (c) presentations of project findings at international scientific events; (d) databases and project findings are being used for policy design, such as in the case of Honduras and Costa Rica that developed Nationally Appropriate Mitigation Actions (NAMAs) for the livestock sector.



Dairy cattle with CH_4 tubes. Costa Rica

Experimental plot for N_2O measurements
Guillermo Valdivia's farm. Nicaragua

Pilot plot in Nicaragua

Student taking data. CURLA, Honduras

Workshop on GHG emissions and productivity. Nicaragua

B. DAIRY SYSTEMS IN THE ANDEAN REGION. IICA-PERU (FTG/RF-14653-RG):

1. OBJECTIVE

3.31 The general objective of this project is to improve the positioning in the IPCC of the countries from the Andean Region on the estimates of GHG emissions (methane and nitrous oxide) originated by agricultural activities, especially from dairy production. In order to achieve this goal, the project seeks to build institutional capacity for measuring the mentioned GHG and improve the dairy systems in the Andean Region without affecting the natural environment.

2. PROJECT ACTIVITIES

3.32 The project, executed by the Inter American Institute for Cooperation on Agriculture (IICA), contemplates the financing of activities that will define and apply methane and nitrous oxide measurement methods to dairy production systems in the Andean Region. To that effect, two pilot sites are to be identified in Colombia and Peru. These activities and their expected outputs and results are presented in Table 6 and advances in execution described in the subsequent paragraphs.

Table 6: Project Components and Activities

Component	Activities	Expected results	Current Status
1. Bio-physical and socio-economic characterization of livestock production systems in pilot sites.	Analyzes information to characterize project sites under traditional and improved livestock systems. Topics analyzed included: soil maps, climate data, pastures, human and livestock population, production systems, inputs, outputs, prices, etc.	Two pilot sites identified in Colombia and Peru.	Completed
2. Measurement of enteric methane and nitrous oxide on traditional and improved dairy production systems in pilot project sites.	Treatments including addition of bovine urine or nitrogen fertilizer and inhibitors of nitrogen mineralization will be performed. The sulfur hexafluoride (SF6) technique was used to measure enteric methane, according to the methodology proposed by Johnson et al (1995) and Grainger et al (2007). For the measurement of nitrous oxide (N2O) in the soil, an experiment using closed chambers was established in each pilot site on pastures of various qualities. The design of chambers and the sampling methodologies followed the protocols established by Rochette and Erick-Hamel (2008) and the methodology itself was adjusted to local conditions.	Training was provided to at least two professionals per participating institution.	Completed
3. Evaluation of feeding strategies and their effects on enteric methane and nitrous oxide emissions.	Experiments comparing diets of low and high digestibility were stablished in each pilot site. For the experiments, a cross-over design was utilized with “n” animals x 2 treatments x 2 periods. Pastures and supplements were analyzed and their digestibility determined, and the emission measured in each animal	Capacity established in at least four institutions of the Andes for the measurement of GHG emissions.	On track

Component	Activities	Expected results	Current Status
	during a seven-day period, using the methodology developed in the FONTAGRO-New Zealand project in the Southern Cone (FTG/RF-1028-RG).		
4. Development of scenarios to mitigate enteric methane and nitrous oxide emissions under various dairy production systems.	The LIFE-SIM (Livestock Feeding Strategies Simulation Models, Leon-Velarde et al, 2006) models was utilized to measure the enteric methane and nitrous oxide emissions under various dairy production systems. These models integrated livestock production responses with bio- economic analysis and methane emissions. The model was calibrated with results of the previous activity (3).	Capacity established in at least four institutions of the Andes for the modeling of scenarios to mitigate GHG emissions. Development of strategies to increase livestock productivity and reduce GHG emissions.	Pending
5. Strengthening research capacity on measurement of GHG emissions and contribution to policy formulation for the promotion of sustainable dairy systems	A virtual platform was created to exchange information on livestock and GHG emissions among researchers, extensionists, students and decision makers. Information was exchanged with other projects supported by FONTAGRO and New Zealand in Central America and the Southern Cone. Other linkages were established with decision makers from the Ministries of Agriculture and the Environment, the academia and civil society to discuss policy issues to promote more sustainable livestock systems. Policy briefs were prepared, and roundtables organized for these purposes. Andean countries which at present are not members of the GRA will be encouraged to become members.	Development of strategies to increase livestock productivity and reduce GHG emissions. Contributions to policy dialogue. Increased number of members of GRA.	Pending

3. ADVANCES IN PROJECT IMPLEMENTATION AND RESULTS TO DATE

3.33 During 2017, the project made important progresses in the implementation of the planned activities. Both in Peru as well as in Colombia, pilot sites were established, and first estimations of methane and nitrate oxide were performed.

3.34 Component 1. Bio-physical and socio-economic characterization of livestock production systems in pilot sites.

3.35 Since 2016 and in 2017, dairy production systems in Junin (Peru) were analyzed and characterized according to their bio-physical traits (meters above sea level, “masl”; soil maps, climate data, pastures - natural grasslands or alfalfa) and socio-economic characteristics (human and animal population, production systems, inputs, outputs, prices, among others). Based on this analysis, two pilots sites were considered: a) the Agrarian Cooperative “San Francisco de Chichausiri” under traditional herd management based on natural grasslands; and b) the Regional Development Institute (IRD-Sierra - UNA La Molina, 3,200 masl) under improved herd management based on alfalfa pastures. The bio-

socio-economic characterization of the prevalent dairy production systems in the participating countries was developed in a report completed in 2015 with secondary information. Table 1 summarizes the characteristics of these systems.

Table 1. Prevalent livestock production systems in the Andean region (Bolivia, Colombia, Ecuador and Peru)

Attribute	Bolivia	Colombia	Ecuador	Peru
Region	High Andean Region			
Altitude	3,500-3,800 masl	2,500-4,000 masl	2,400-3,500 masl	3,500-4,300 masl
Climate	12.5 °C, 72% RH, 300-350 mm	13.5 °C, 81% RH, 500-1500 mm	13.3 °C, 77% RH, 500-2000 mm	9.5 °C, 66% RH, 500-600 mm
Food System	Green alfalfa (rainy season), rangeland (dry season), wheat middling and barley hay	Grazing on kikuyo grass (*Pennisetum clandestinum*) for 50 to 70 days, commercial balanced food	Grazing on kikuyo grass (*Pennisetum clandestinum*) and holcus (*Holcus lanatus*)	Rangelands Hay (eventually during the dry season)
Livestock	Creole and cross-bred 95%	Holstein 76%	Creole and cross-bred 98%	Creole and cross-bred 87%
Milk Production	1,470 L (210 days) (e.g. Oruro)	4,260 L (305 days) (e.g. Cundinamarca)	2,103 L (340 days) (e.g. Pichincha)	1,600 L (200 days) (e.g. Puno)
Producers	55% small-scale 30% medium-scale	27% small-scale 37% medium-scale	56% small-scale	80% small-scale

3.36 Component 2. Measurement of enteric methane and nitrous oxide on traditional and improved dual dairy production systems in pilot sites.

3.37 In the context of this component, two activities were carried out during 2017: (a) the design and implementation of experimental trials in pilot sites considering traditional and improved production systems, and (b) training in GHG measurements. Preparatory work was done including the acquirement of equipment and materials and prototypes for the quantification of CH4 and N2O were developed during 2016 and 2017[8]. During 2017 and based in protocols for measuring CH4 and N2O prepared the year before, the experiments were continuously calibrated to measure GHGs from pilot sites.

3.38 Experiments aimed at quantifying methane and nitrous oxide were conducted. The experiments were designed under the sulfur hexafluoride tracer methodology (Berndt et al., 2014) and the static chamber methodology (Klein & Harvey, 2015), respectively. Methane trials aimed at quantifying the emissions of sheep in intensive production systems; cattle in traditional pasture systems; and cattle in improved pasture systems. These trials were conducted in Peru. On the other hand, a trial with dairy cattle under traditional and strategic

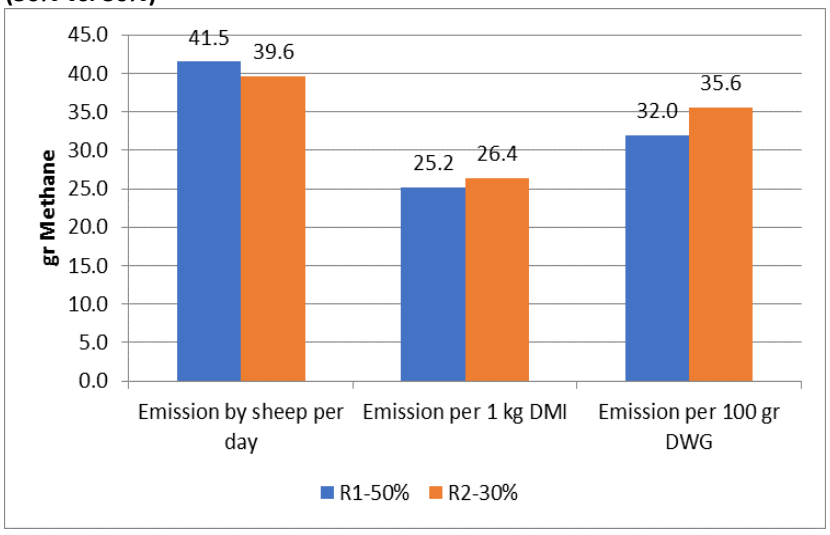
[8] It is worth mentioning, that the CH4 and N2O prototypes for GHG measurements have become a pioneer technology in the Andean Region, as it leads to more precise emissions data.

supplementation was conducted in Colombia. The trial with sheep was carried out in the Ovine Metabolic Unit, which is part of the School of Animal Husbandry of Universidad Nacional Agraria La Molina. Ten sheep of the Junin breed with a live weight of 27 to 39 kg at the beginning of the trial were used. The sheep were first subject to a period of adaptation to the conditions of confinement, as they came from a regime of extensive grazing, and then were subject to a cycle of four experimental periods, which took place in late March, April, May and June 2017. The treatment consisted of two feedings with different levels of non-structural carbohydrates (30% and 50%).

3.39 Methane emissions found in the trial, still non-definitive, were 41.5 g CH4/sheep/day (diet with 50% NSC) and 39.6 g CH4/sheep/day (diet with 30% NSC) (Chart 1), which are very similar, although emissions per kilogram of gained weight were lower in sheep fed with 50% NSC. This result is in line with NSC capacity to modify rumen fermentation in favor of propionate production, the increase of starch-fermenting bacteria, and the reduction of sources of hydrogen, which would explain the reduction of methane emissions (Wanapat et al., 2015).

3.40 The trials with cattle in traditional systems were conducted in the San Francisco de Chichausiri agricultural cooperative. Samples were collected from 12 creole cows with different levels of cross-breeding with Brown Swiss cows. Collection of samples was carried out during both the rainy season (April) and the dry season (August). The animals were subject to a period of adaptation to the use of the gas collection equipment for two weeks during the rainy season and one week during the dry season.

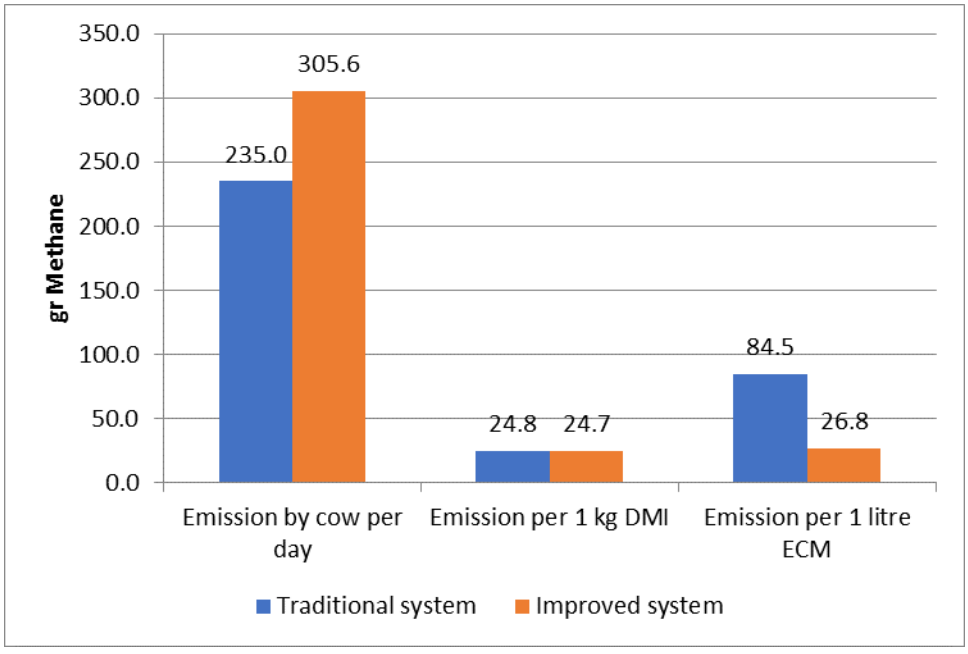
Figure 4. Enteric methane emissions in intensive sheep fattening with two levels of non-structural carbohydrates (50% vs. 30%)



* DMI: dry matter intake, DWG: daily weight gain

3.41 Trials with cattle in improved systems was conducted in the Regional Institute for Development (IRD-Sierra). Samples were collected from 11 Brown Swiss cows. The collection of samples of emitted gas was carried out during the rainy season (March) and the dry season (August). The cows were under a grazing and also given concentrate supplementation. The results of the trials with cattle in traditional and improved systems in Peru (Chart 2) show that the preliminary emissions are within the ranges for the animal species, although the emissions of cows in natural systems are closer to those of beef cattle (Johnson & Johnson, 1995). The emissions per animal in the traditional system are lower as compared to the improved system. This is due to the less size and weight of the animals and their lower consumption of dry matter (9.5 vs. 12.5 kg DMI/cow/day). It is also observed that the emission per liter of milk in the traditional system was three times higher than that of the improved system. This confirms that the improvements in terms of the efficiency of productive systems may be an alternative for mitigation, as according to the results a single cow in the improved system could produce almost eight times more per day than a cow in the traditional system; therefore, in terms of milk production, replacing 8 cows of the traditional system for 1 cow of the improved system would result in a 70% reduction in the emissions, producing the same amount of milk. This involves a change not only in the food systems of the animals, but also in their genetics. However, in order to ensure the magnitude of these trends it is necessary to make corrections in the chromatographic readings that were discarded (Figure 5).

Figure 5. Enteric methane emissions in traditional milk production system vs. improved system in Peru's Andes region



* DMI: dry matter intake, ECM: energy corrected milk

3.42 The trial with cattle in Colombia was conducted in the Tibaitatá. Samples were collected from 10 Holstein cows under production grazing on kikuyo pasture. The animals were divided according the type of supplementation (traditional vs. strategic). The experiment was conducted from June to December and consisted of four periods with 15 days for adaptation to the diet and 5 days for collection of methane samples. The gas samples collected are still being processed in order to quantify the flow of methane emissions. However, there are results in terms of milk production and quality after the application of the supplementation (Table 7), which show its positive impact on the concentration of total solids in the milk.

Table 7. Milk production under supplementation (traditional and strategic)

Variable	Traditional	Strategic	SEM	p<
	Milk production (kg d^{-1})			
Total milk	13.0[a]	12.6[b]	0.10	+
Fat corrected milk	12.8	13.4	0.08	ns
	Milk composition (%)			
Fat	3.9[b]	4.4[a]	0.05	*
Protein	2.7	2.7	0.01	ns
Total solids	11.5[b]	11.8[a]	0.05	***

[a,b.] Different letters in a line, significant differences between. the treatments Ns: non-significant, +: p<0.1, * p<0.05, *** p<0.001.

3.43 The trial for measuring nitrous oxide in traditional systems was conducted in the San Francisco de Chichausiri agricultural cooperative. The experimental area was a typical scrubland (high grasses) with a history of cattle grazing and in regular to good condition. The collection of samples was carried out during the dry season (May-June and August-September). 16 chambers were installed one day before the beginning of the collection of samples. The treatment with urine was applied to 8 chambers both inside the chamber and in the portion of soil for sampling; the rest of the chambers were for control. In the first stage of the dry season, the field was divided in two portions and the treatment was applied to each portion of chambers; in the second stage, the application was at random. The trial in the improved system was conducted in the same way and during the same period of time as in the traditional system; the difference was the use of a plot of rye-grass with clover. The flows of emission have not yet been determined as the samples collected are in the analytical phase. However, there are results in terms of the complementary measures which will help to explain the dynamics of the emissions (Figure 6 and Figure 7).

Figure 6. Nitrate and ammonium concentration in a rangeland during the second period of the dry season

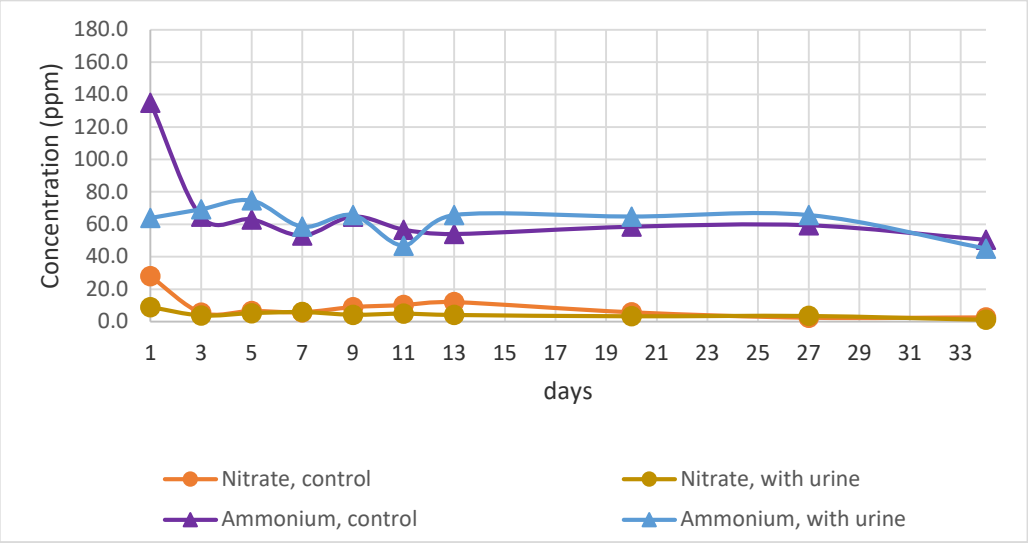
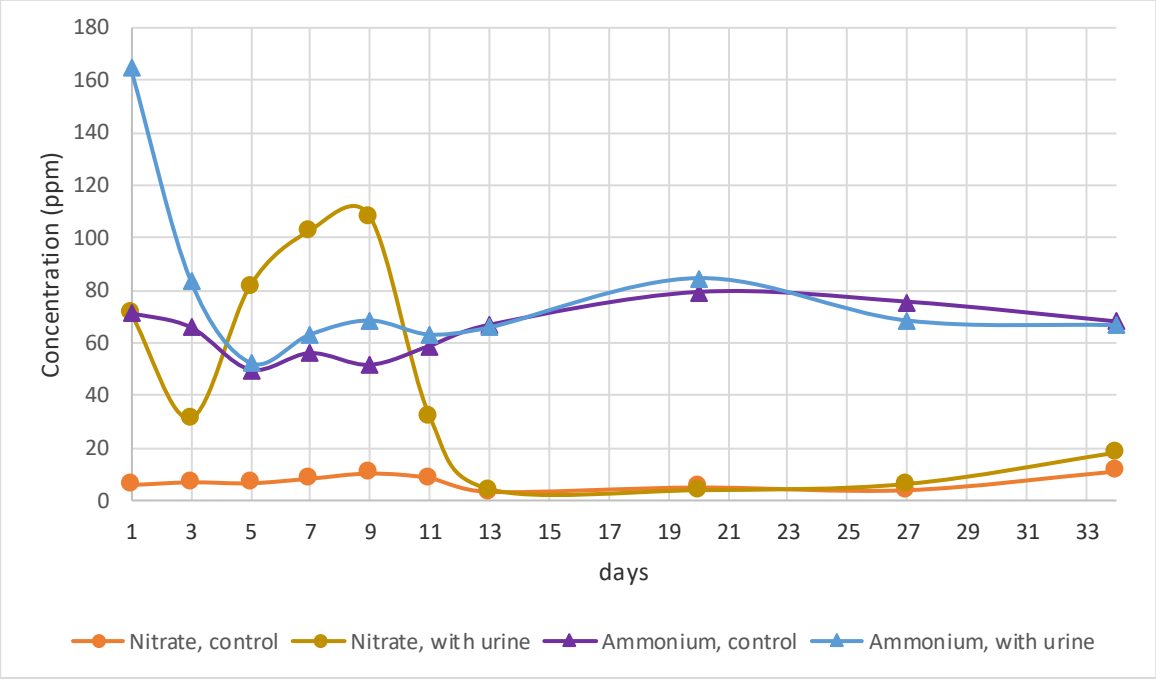


Figure 7. Nitrate and ammonium concentration in a rye-grass and clover pasture during the second period of the dry season



3.44 Component 3. Evaluation of feeding strategies and their effects on enteric methane and nitrous oxide emissions.

3.45 During 2016, the experiments on animals with two different diets (natural grasslands and alfalfa pastures) have been initiated. However, during 2017

animals in those trials were subject of the experimental conditions and the use of collars for methane measures.

3.46 The evaluation of strategies for the mitigation of enteric methane was carried out with the co-executors (Bolivia, Colombia and Ecuador) through virtual and on-site meetings and included the adjustment of the LIFE-SIM tool for comparison of mitigation scenarios based on the context of the livestock production systems analyzed by the project. The procedure to have examples of strategies which could be tested in reality consisted in identifying the typical systems as base scenarios for each country (virtual), then identifying potential enteric methane mitigation strategies (virtual), and finally evaluating food strategies by using the LIFE-SIM simulation software (on-site). The results were consolidated in a workshop titled "Identification, simulation and evaluation of food strategies for mitigation of enteric methane emissions in livestock production in Andean countries", conducted in Lima (Peru), where specific mitigation strategies were selected for the development of scenarios that can further reduce the amount of methane per liter of milk produced in relation to the traditional food base in production systems (Table 8).

Table 8. Results of the simulation of the traditional base and food strategy for the reduction of emissions in Andean countries

	Bolivia		Colombia		Ecuador		Peru	
Parameters	Traditional base	Food strategy	Traditional base	Food strategy	Traditional base	Food strategy	Traditional base	Food strategy
Milk production kg/lactation	1,068	1,251	4,929	5,305	1,403	2,527	1,480	1,500
Milk production Average l/day	5.0	5.9	13.5	14.5	3.8	7.6	6.9	7.0
Gross margin USD/lactation	-25	249	477	966	478	493	197	120
Production cost USD/kg	0.45	0.23	0.23	0.15	0.02	0.26	0.12	0.17
Total methane emission, kg/year	64	48	157	168	103	65	112	107
Methane g/kg milk	36.9	23.6	31.8	31.7	73.4	25.8	41.1	41.8

3.47 In La Paz and Oruro (Bolivia) high-plateau region, grazing simulation in alfalfa with oat hay, oat silage and middling showed that there would be a 34% reduction in methane emissions. In Pichincha and Chimborazo (Ecuador) central highlands, there would be a 65% reduction through the use of improved pastures (i.e. forage mixtures, overseeding kikuyu grass) and by providing concentrate supplementation, as medium-scale producers usually do. In Cundinamarca and Boyacá (Colombia) high-plateau region, there was not a significant reduction after adjusting the grazing frequency to 42 days and

providing concentrate supplementation; however, for farmers the strategy was more profitable than the usual process. In Puno (Peru) high-plateau region, there would be a 5% reduction in the total annual methane emission through the introduction of grazing in alfalfa and rangelands complemented with alfalfa hay and oat silage.

3.48 Component 4. Development of scenarios to mitigate enteric methane and nitrous oxide emissions under various dairy production systems.

3.49 Based on the research made above, the results of the simulation of mitigation scenarios also provided productive and economic information which will be critically analyzed in order to suggest actions for the influence on policies that aim to reduce emissions and which can be used to expand the criteria for the selection of a strategy that can be effective not only in terms of the environment, since the strategies with more mitigation capacity are not always the most profitable for producers.

3.50 Component 5. Strengthening research capacity on measurement of GHG emissions and contribution to policy formulation for the promotion of sustainable dairy systems.

3.51 The project strengthened research capacities in different ways. The project web site was updated with information on the most relevant activities. During an experiment in Peru, a specialist conducted a technical visit for the exchange of information with UNALM and CORPOICA research teams. As a result, it was possible to compare the differences in the adaptation of gas collection systems. The implementation of the experiments allowed to have in place an installed physical capacity at UNALM and CORPOICA, both for the collection of gas samples and for the chromatographic analysis.

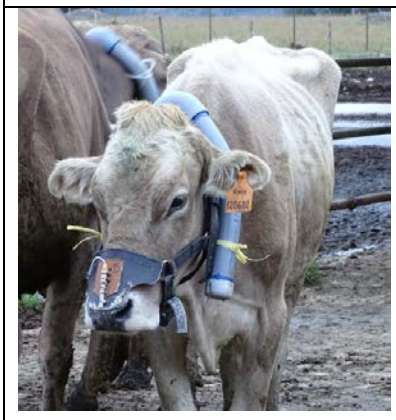
3.52 In the workshop titled 'Identification, simulation and evaluation of food strategies for the mitigation of enteric methane emissions in livestock production in Andean countries, carried out at IICA's office in Lima, Peru, 12 participants of the co-executor countries strengthened their capacities for the development of mitigation strategies and for comparing them by using the LIFE-SIM tool.

3.53 In November 2017, other 12 practitioners of the co-executor institutions participated in the workshop on "Measuring enteric methane and nitrous oxide in livestock production systems", which facilitated the exchange of knowledge on how gas was measured by the experiments conducted in Peru and Colombia. The participants were trained on the basics of GHG measuring techniques, design of experiments, experimentation costs, and the practical construction of prototypes for the collection of gas samples. Two members of the technical team were trained at the University of Hohenheim (Germany) on in-vitro digestibility

techniques, fiber evaluation and titanium-marker based consumption. The project was presented to the technical team of the University of Hohenheim, Serida (Spain) and the Workgroup on Food Security and Climate Change of the Ministry of Agriculture (Peru) as a strategy for dissemination and to get feedback. Two technical bulletins were produced: a technical bulletin on "Application of the methodology for collection of enteric methane and nitrous oxide in livestock production systems", which describes the experimental initiative conducted in Colombia and Peru; and a technical bulletin on "Mitigation of greenhouse gases derived from livestock production systems in the Andean region."

3.54 The results of the project will be disseminated in knowledge-sharing events in the four countries that are part of the project, with participation of key actors from ministries, international organizations, non-governmental organizations, private enterprises and producers with interest in livestock production and climate change; as well as a panel of specialists who will discuss —based on the contribution of the project— about the opportunities and limitations for the implementation of public policies for mitigation in the livestock production sector.

Alfalfa pastures and laboratory at the Regioanl Development Institute (IDR Sierra), San Juan de Yanamuclo, Jauja, Junion (3200 masl)



Natural pastures at The Agrarian Cooperative Chichausiri, Junion (4100 masl)

CH4 Protptypes

Canisters construction

C. NETWORKING AND CAPACITY BUILDING: FONTAGRO (FTG/RF-14654-RG)

1. OBJECTIVE

3.55 Create a network on livestock and climate change to exchange information, standardize methodologies, provide mutual technical support and promote collaboration

2. PROJECT ACTIVITIES

3.56 This project is executed by FONTAGRO/TAS and contemplates the financing of networking and capacity building activities for Latin America and the Caribbean. These activities and their expected outputs and results are presented in Table 7 and advances in execution described in the subsequent paragraphs.

Table 9: Project Components and Activities

Component	Activities	Expected results	Current Status
1. Coordination Committee and network meetings.	Main purpose will be to coordinate, review progress and plan initiatives. A plenary meeting of members will be organized every 18 months to share research results, and coordinate activities, to achieve efficiencies; they may be linked to other meetings and workshops.	Activities coordinated among institutions of Latin America and the Caribbean for pastures and livestock production and the measurement of GHG emissions. Mutual support in the region obtained for the conduction of initiatives on livestock and climate change.	On track
2. Web-page.	A web page will be created in addition to the web page stablished by Universidad Nacional Agraria La Molina (UNALM), an effort will be made to link web pages of all member institutions to share information and knowledge on livestock and climate change.	Information exchanged among institutions in Latin America and the Caribbean and LEARN for pastures and livestock production and the measurement of GHG emissions.	On Track
Capacity Building[9]	The main objective is to build research capacity on measurement of GHG emissions and on livestock systems research and modeling. The main activities are: **Workshops:** Two workshops will be	**Workshops**: Capacity established in at least eight institutions of Latin America and the Caribbean for the measurement of GHG	On track

[9] Complementary funding will be sought from LEARN and the MPI, especially for training on measurement of GHG emissions, exchange visits to New Zealand and Post Graduate training. This complementary funding is estimated at NZ$200,000 and is not being administered by FONTAGRO.

	conducted before starting project implementation: (i) Livestock Production Systems Research and Modeling. It will be organized by CATIE-UNALM and FONTAGRO and coordinated by Dr. Carlos Leon-Velarde. Participants will include leaders of the member institutions of the two consortia, resource persons and at least two persons per institution. In addition to technical aspects, issues of coordination and implementation will be discussed. (ii) Techniques to measure GHG emissions. It will be organized by CATIE-LEARN-New Zealand-FONTAGRO and it would involve three modules: CH4, N2O and Gas Chromatography analysis. Instructors will include members of the consortia, New Zealand and INIA-Uruguay. Participants will include at least two members of each institution participating in the consortia. Towards the end of years 2 and 3 workshops will be organized by CATIE and UNALM to review and synthesize results. **Exchanges:** During the three years, at least two professionals per institution will receive short-term training on pastures, livestock production systems, and measurement of GHG emissions. **Post graduate training**: Funding will be sought under the Livestock Emissions Abatement Research Network (LEARN) initiative and others to offer scholarships for post graduate training to candidates from the various institutions participating in the consortia.	emissions and the modeling of costs and benefits. **Exchanges:** Capacity strengthened in at least eight institutions of Latin America and the Caribbean for pastures and livestock production and the measurement of GHG emissions. **Post graduate training:** Capacity strengthened in at least eight institutions of Latin America and the Caribbean for pastures and livestock production and the measurement of GHG emissions. **Post graduate training:** The project will offer opportunities for the conduction of MSc Thesis for at least 8 candidates.	

3. ADVANCES IN PROJECT IMPLEMENTATION AND RESULTS TO DATE

3.57 During 2017, significant progress in the outreach, communication and organization of capacity building events have been achieved. The following paragraphs describe advances and accomplishments of these activities by project component.

3.58 Component 1. Coordination Committee and network meetings

3.59 During 2017, and in connection with FONTAGRO's Annual Technical Meeting in Honduras, team members of each project have shared their preliminary results with others scientists and peers. This meeting helped members to share their experiences and establish mutual understanding over project goals.

3.60 Component 3. Capacity Building.

3.61 During the year, the project team members from Central America and the Andean Region organized short term exchanges for training purposes. In those exchanges, graduate students and other professionals learned about GHG measurements, experimental design, sampling process, data collection and analysis. Because of the participation of graduate students in research activities, more than six theses were finalized, and preliminary results were presented in several congresses, seminars and workshops. Similarly, regional and international publications were completed, and technicians were trained.

3.62 FONTAGRO, is coordinating with CATIE (Costa Rica) and the Global Research Alliance (GRA) a new initiative "**Latin American and the Caribbean Platform for Sustainable Intensification of Livestock Production**". The objective of this platform is to promote sustainable intensification of livestock production systems and value chains in LAC within the wider strategic context for adaptation and mitigation of climate change. The Platform's specific objectives are:

a) To develop and facilitate a coordinated regional agenda for research and development of livestock production technologies and practices for adaptation to climate change, while minimizing GHG emissions;

b) To facilitate knowledge sharing within the LAC region by documenting and disseminating success stories on sustainable intensification of livestock production systems for climate change adaptation and mitigation;

c) To strengthen the capacities of key stakeholders (public and private) in the livestock sector to address adaptation to and mitigation of climate change impacts in the livestock sector;

d) To contribute to the formulation and dissemination of policies on sustainable intensification of livestock production systems in LAC, and

e) To jointly seek and mobilize resources to support the above activities.

3.63 The platform started last during 2017 and it is expected to reach researchers and lecturers working on sustainable livestock production; extension staff and technical assistance providers; graduate and undergraduate students majoring in animal production, veterinary, environmental and soil sciences; farmers' organizations; the private sector, and policy makers. In addition, it is expected that the platform will indirectly benefit 4000 livestock farmers and workers in different nodes of the livestock value chains; and other private and public organizations involved in livestock systems, marketing and processing of ASF products, and other related topics.

IV. CONCLUDING REMARKS

4.1 The Agreement between the IDB, as legal administrator of FONTAGRO, and the Ministry for Primary Industries from New Zealand has allowed for the financing of important applied research projects on sustainable livestock production systems. These projects are enabling pioneer actions in the Andean and Central American Region, given that no experiments and measurements have been conducted in this area prior. This joint initiative is fully aligned with the Bank's and FONTAGRO's mission for Latin America and the Caribbean.

4.2 The projects have made significant advances. The project with CATIE in Central America has expanded the participating entities' ability to measure GHGs emissions under various scenarios, generating data that helps as evidence for policy design. The project has contributed to Costa Rica, Honduras, Nicaragua and Panama on the development of a local technology to estimate, in two methods (direct and indirect) the emissions of GHG under local conditions. Furthermore, the project allowed to understand how different levels of farming intensification and better agronomic practices on feeding and herd management can decrease the level of GHGs emissions and identified at the farm level that enteric fermentation is the main source of emissions compared with others.

4.3 In the case of the dairy systems in the Andean Region, the applied research and training activities have yielded promising data from the measurement of enteric methane and nitrous oxide on traditional and improved dairy production systems. The analysis of the data generated so far will be used in 2017 for the development of strategies to increase livestock productivity and reduce GHG emissions. The results of enteric methane quantification suggest that, as it was anticipated, improved systems emit less methane per unit of animal product than traditional systems. The project promoted the joint work and the exchange of knowledge among the participating countries, reducing the gaps between Ecuador and Bolivia, Colombia and Peru, in terms of quantification and mitigation of greenhouse gases. The project developed capacities to carry out studies on emissions and develop mitigation strategies and laid the foundations for identification of emission factors in the countries, which will help to estimate emissions with more precision and to carry out projects such as NAMA. The project promoted collaboration and exchange of knowledge, building links between the participating institutions. This will provide an opportunity for future collaboration in initiatives whose impact will be ensured.

4.4 In both cases, preliminary results indicate that local and regional GHG measurements and inventories can be constructed based on the obtained research results. To that effect, the interventions also facilitate the participating countries' data requirements for the IPCC. The development of Nationally Appropriate Mitigation Actions (NAMAs) in Honduras and Costa Rica is an indication thereof. Furthermore, the creation of the *Latin American and the*

Caribbean Platform for Sustainable Intensification of Livestock Production demonstrates the Region's commitment to sustainable agricultural practices and their desire to expand their ability to respond to climate change.

4.5 The Bank and FONTAGRO would like to take this opportunity to express their sincere appreciation and gratitude for New Zealand's contributions and active engagement in the Region.

ANNEX I. Project Financial Status Summary Table

Approval Number	Project Name	Approval Date	Approved Amount	Disbursed Amount	% of Disbursement	Committed Amount	Available Balance
FTG/RF-14652-RG	Silvopastoral systems in Central America	June-09-2014	300,000	300,000	100%	-	
FTG/RF-14653-RG	Dairy systems in the Andean Region	June-09-2014	368,000	368,000	100%	-	
FTG/RF-14654-RG	Networking and Capacity Building	June-09-2014	139,318	91,318	66%		47,999
Total			**807,318**	**759,318.30**	**94%**		**47,999**

ANNEX II. Unaudited Financial Statement as of December 31, 2017

INTER-AMERICAN DEVELOPMENT BANK
Unaudited Financial Statement — ***RFA - 1620***

Regional Agricultural Fund
December 31, 2017
(Expressed in United States Dollar)

DRAFT

Statement of Assets	
Cash	459,217.00
Investments	98,616,733.00
Accrued interest on investments	277,549.00
Total Assets (1)	**99,353,499**

	Prior Years Accumulated	Current Year	Total
Administrator's Accountability:			
Funds contributed	83,004,978	44,657	83,049,634
Allocation of inflation income	14,293,527	-	14,293,527
Intangible Capital	97,298,505	44,657	97,343,161
Grant contributions received	471,076	-	471,076
Income from investments	20,303,949	1,356,266	21,660,215
Income (Expense) from cash accounts	450,142	(1,023)	449,119
Technical cooperation expense	(16,184,322)	(2,347,210)	(18,531,532)
Direct and indirect expenses	(6,006,291)	(563,244)	(6,569,535)
Contribution released from restrictions	533,414	-	533,414
	(432,033)	(1,555,211)	(1,987,243)
Total Fund Balance	**96,866,472**	**(1,510,554)**	**95,355,918**
Interfund accounts payable (receivable)			163658
Undisbursed grants			3792282
Other liabilities			41641
Total Liabilities and Fund Balance (1)			**99,353,499**

(1) Data are rounded; detail may not add up to subtotals and totals because of rounding