LOW CARBON DEVELOPMENT STRATEGY (LCDS) FOR THE NICARAGUAN LIVESTOCK SECTOR

Low Carbon Development Strategy (LCDS) for the Nicaraguan Livestock Sector

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LIST OF ACRONYMS

BAGSA................. Nicaraguan Agricultural Exchange
BCN..................... National Bank of Nicaragua
BID .... Inter-American Development Bank
CANICARNE......... Nicaraguan Chamber of Beef Exporters
CANISLAC............ Nicaraguan Chamber of the Dairy Sector
CATIE................... Tropical Agricultural Research and Higher Education Center
CDT .... Technology Development Centres
CETA.................... Centro de Enseñaza Técnicos Agropecuarios
CONAGAN........... Nicaragua National Livestock Commission
CRIA .... National Council of Agricultural Research and Innovation, Regional Councils of Agricultural Research and Innovation
CRS...................... Technoserve and Catholic Relief Services
DGPSA .... Animal Health Division of MAG
ECA .... Field School
EIAR .... Escuela Internacional de Agricultura de Rivas
ENABAS.............. Nicaraguan Basic Food Company
ENACC................. National Environmental and Climate Change Strategy
FAGANIG............. Federation of Nicaraguan Cattlemen Associations
FDL...................... Fondo de Desarrollo Local
FUNDESER .... Rural Socioeconomic Development Foundation
GHG .... Greenhouse Gases
INAFOR .... National Forestry Institute
INATEC .... National Technological Institute
INETER .... Nicaraguan Institute of Territorial Studies
INPESCA.............. Nicaraguan Institute of Fisheries and Aquaculture
INTA .... Nicaraguan Institute of Agricultural TechnologY
IPSA .... Institute of Agricultural Protection and Health
LCDS.................... Low Carbon Development Strategy
LULUCF .... Land-use, Land use-change and Forestry sector
MAG .... Ministry of Agriculture
MARENA............. Ministry of National Resources and the Environment
MEFCCA.............. Ministry of Family, Community, Cooperative and Associative Economy
MHCP.................. Ministry of Finance and Public Credit
MIFIC .... Ministry of Development, Industry and Commerce
NCF .... Nordic Climate Facility
NIT .... Nuclei of Research and Territorial Innovation
ONDL .... National Office of the Clean Development Mechanism
PNA..................... National Food Program
PNAIR .... National Rural Agroindustry Program
PNDH .... National Human Development Plan
PNF .... National Forest Program

POSAF .... Socio-Environmental and Forest Development Program
PRODUZCAMOS.. Production Promotion Bank
PRORURAL .... Inclusive Rural Development Sector Program
SDE .... Enterprise Development Services Component
SNIA .... Nicaraguan System of Agricultural Research and Innovation
SNPCC .... National System for Production, Consumption and Commerce
SSP .... Silvopastoral System
TAU .... Technical Assistance
UCC..................... Universidad de Ciencias Comerciales
UCTS .... Universidad Católica del Trópico Seco
UNA .... Universidad Nacional Agraria
UNAN.................. Universidad Nacional Autónoma de Nicaragua

1. Overview

1.1. Basic information

<table>
<tr><td colspan="3">Title of the LCDS: Low Carbon Development Strategy (LCDS) for the Nicaraguan Livestock Sector</td></tr>
<tr><td colspan="2">Country/ies: Nicaragua</td><td></td></tr>
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With the coordination of DICTA and MinAmbiente
Support for LCDS development has been provided by the Nordic Climate Facility (NCF)</td></tr>
<tr><td>Sector/Subsector:</td><td colspan="2">Agriculture and Land Use Change and Forestry
Bovine Livestock</td></tr>
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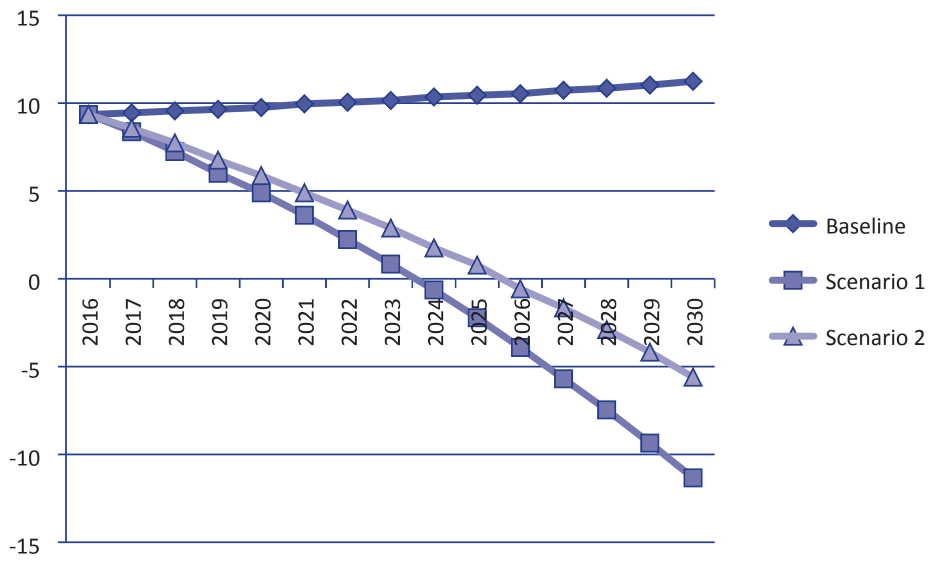
<tr><td>CO_2</td><td>X</td><td>CH_4</td><td>X</td></tr>
<tr><td>N_2O</td><td>X</td><td>HFCs</td><td></td></tr>
<tr><td>PFCs</td><td></td><td>SF_6</td><td></td></tr>
<tr><td>NF_3</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td colspan="3">Status of Endorsement by appropriate National Authority:
The Low Carbon Development Strategy (LCDS) has been developed in close coordination with the Nicaraguan Institute of Agricultural Technology (INTA), and in consultation with the Ministry of Environment and Natural Resources.</td></tr>
</table>

1 The approval authority is the designated national focal point/entity to the UNFCCC.

1.2. Overview of the key aspects of the LCDS

The table below presents a summary of the information described in SECTION 2.

Brief description of the objectives of the proposed LCDS and summary of measures to be included in the LCDS	Livestock is one of the most important land-use activities in respect of the emission of greenhouse gases (GHG) into the atmosphere, contributing 57% of total agricultural emissions. Deforestation, whose main drivers are small landowners, insecure land tenure, livestock and the expansion of the agricultural border, is another main source of GHG. However, there are several practices that can reduce these emissions, or even turn livestock systems into net GHG fixers. The objective of this low-carbon development strategy for the livestock sector (Livestock LCDS) is to promote the implementation of good livestock practices to improve production in the 2016-2030 period, while contributing to substantive mitigation of GHG emissions. The practices identified by local producers and national stakeholders include the following: 1) Rotation and division of paddocks in conjunction with silvopastoral systems with energetic fodder banks, live fences and scattered trees 2) Manure management through the installation of biodigesters (biogas) 3) Production and use of biofertilizers Two scenarios for the implementation of these practices were simulated: **Scenario 1:** Changing 30% of the native pasture area to establish good management practices and the adoption of improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 1%/y. **Scenario 2:** Changing 20% of the native pasture area to establish good management practices, and the adoption of improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 0.5%/y. Total GHG emissions from livestock were estimated at 14.4 $MtCO_2e$ in 2016, increasing in the Business As Usual (BAU) scenario to 21.7 $MtCO_2e$ in 2030. Taking net emissions into consideration, as well as the GHG emissions reductions caused by the carbon sinks in the Livestock sector, the BAU scenario shows net emissions of 9.4 $MtCO_2e$ in 2016, expected to increase to 11.2 $MtCO_2e$ in 2030, a net increase of 1.9 $MtCO_2e$. The simulation of the two scenarios for the Livestock LCDS also show increasing GHG emissions, reaching 26.9 for scenario 2 and 32.5 $MtCO_2e$ /year for scenario 1 (Figure 17). This increase in GHG emissions can be attributed to an increase in the national cattle herd due to improved cattle production facilitated by the Livestock LCDS's practices, congruent with national policies. The cattle stock is estimated to increase from 4,168,000 (CENAGRO 2011) to 7,935,000 in 2030, according to the projections of CATIE.

	Although, assuming carbon sequestration and the contribution of GHG sinks through implementation of the Livestock LCDS's practices, net GHG emissions in the baseline were estimated at 9.4 $MtCO_2e$/year in 2016. Following current trends in the sector without state intervention, total net emissions are expected to be 11.2 $MtCO_2e$/year in 2030, representing a net increase of 1.9 $MtCO_2e$/year, with cumulative emissions of 153 $MtCO_2e$ between 2016 and 2030 in the BAU scenario. Net emissions would decrease in the Livestock LCDS scenarios, allowing for increases in the number of cattle. Net cumulative emissions reductions would be 152 $MtCO_2e$ over the next fourteen years in scenario 1 and 115 $MtCO_2e$ under scenario 2. This indicates that the Nicaraguan livestock sector could become a net carbon sink in 2024 under scenario 1 and in 2026 under scenario 2. 
Relevance to national sustainable development plan(s) or national strategies and/or to the sectoral mitigation goals	Rural poverty, the progressive deterioration of natural resources and the vulnerability of the poor to climate change form a vicious circle of impoverishment, exacerbated by low levels of education, high population growth and over-exploitation of natural resources. Due to the increasing population, 6.3 million hectares of land covered by natural vegetation were incorporated into agricultural and livestock activities between 1960 and 1998, generating a substantial reduction in forest cover of 50%, and this trend is expected to continue if no efforts are made to halt deforestation. It is therefore of the utmost urgency and necessity to invest in adaptation actions which also contribute to climate change mitigation, as expressed in Nicaragua's Second National Communication, and as streamlined and reiterated in its national and sectoral policies.

Brief description of relevant existing mitigation initiatives and their synergies with the proposed LCDS	The Second National Communication to the UNFCCC refers to the implementation of good practices of adaptation to climate change through the Socio-Environmental and Forest Development Program (POSAF). The program introduced forest and agroforestry productive systems on private farms located both inside and outside protected areas by carrying out 88 projects aimed at establishing 87,951 hectares of degraded lands with agroforestry and forestry systems, making them economically profitable and environmentally sustainable, and thus benefiting 14,349 rural families. A total of 6,784 fuel-saving stoves have been installed in an equal number of families, producing an average saving of 2.99 kg of firewood per day, equivalent to 1,091.35 kg/year per family, and representing a decrease in consumption of 21%, which represents savings of $152 per year. 92,822 people from the participating families were sensitized regarding natural resource management and environmental conservation issues. Other livestock- and forestry-related initiatives are continuing through the Nicaraguan Institute of Agricultural Technology (INTA) and other national institutions and NGOs, especially through the establishment of Field Schools, which have proved to be a successful method of capacitating livestock producers in new practices and technologies. The Livestock LCDS will liaise with these relevant stakeholders and provide capacity and financing opportunities to livestock producers to implement the practices that have been identified and prioritized nationally.
Brief description of the transformational impact, including its sustainability	The LCDS is expected to have extensive sustainable development co-benefits, but it will also induce a transformative impact for the whole sector and the rural population. In terms of GHG emissions, the LCDS will transform the current development path of increasing emissions towards reversing this trend and actually convert the sector into a carbon sink, while bringing increased productivity for farmers, ensuring that they will not revert back to their former practices. By making the implementation of sustainable practices a nation-wide concerted effort, a rapid up-take of sustainable practices will be stimulated, making the transformational impact of the LCDS not only abrupt and irreversible in terms changes to the development path, but also swifter than could have been expected without the LCDS. The transformational impact of the LCDS can also be illustrated by the support that implementing practices will give to the achievement of the Sustainable Development Goals and their targets, described in more detail in the LCDS document.

2. Livestock LCDS DETAILS

2.1. Introduction

Nicaragua is located in the centre of the Central American isthmus, bordering on Honduras in the north, Costa Rica in the south, the Caribbean Sea in the east and the Pacific Ocean in the west. The country has an area of 130,374 km^2 and is divided into fifteen administrative departments, two autonomous regions and 153 municipalities. It is divided into three major climatic, edaphological and topographic natural regions, Pacific, Central, and Atlantic or Caribbean. The Nicaraguan population has quintupled since 1950, reaching 5,071,670 inhabitants in 2000. The current annual population growth rate is 2.7%, and the gross average density is 41 inhabitants/km^2.

Figure 1. Map of Nicaragua with administrative departments

Rural poverty, the progressive deterioration of natural resources, the vulnerability of the poor to climate change and natural disasters are variables that form a vicious circle of impoverishment, exacerbated by low levels of education, high population growth and over-exploitation of natural resources. Due to the increasing population, between 1960 and 1998, 6.3 million hectares of land covered by natural vegetation were incorporated into agricultural and livestock activity, generating a substantial reduction in forest cover by 50%, from about 8 million ha of forest to 4 million ha.

The adverse impacts of climate change, manifested by the increasing frequency and intensity of extreme events such as droughts, hurricanes and heavy rains, are a massive threat to human development in Nicaragua and are undermining the country’s efforts to reduce poverty and extreme poverty. 65% of Nicaraguan households are considered poor, as they earn less than two dollars a day. This situation of poverty is especially acute in rural areas that are most vulnerable to climate change. Because of its geographical position and poverty, Nicaragua is highly vulnerable to earthquakes, volcanic eruptions, floods, landslides, hurricanes, droughts and tsunamis. It is the second most affected country in the world by the passage of tropical storms. The proportion of the national population at risk from hurricanes and tropical storms is 25.4%, equivalent to 1.3 million people, while drought affects almost 45% of the population nationally. As an example, Hurricane Felix caused millions in losses in the North Atlantic Region in 2007 due to damage to infrastructure and the environment and the loss of human lives. More than 198,000 people were affected, 20,394 homes, 500 kilometres of roads (bridges and culverts) and 1,248,553 hectares of forest were destroyed, and more than a hundred people killed. Rehabilitation costs alone amounted to USD 300 million. These vents have high social costs, widening the poverty gap and inhibiting sustainable human development. Therefore, it is of utmost urgency to invest in adaptation actions which also contribute to climate change mitigation.

Source: Nicaragua Second National Communication to the UNFCCC

2.2. Alignment with national development policies

2.2.1. National Human Development Plan (PNDH) 2012-2016

The PNDH was drawn up with the central objective of improving the living conditions of all Nicaraguans, especially those living in poverty. The updated version of 2012 contains twelve guidelines. More specifically, Guideline 12 relates to the Livestock LCDS and advocates the protection of mother earth, adaptation to climate change and comprehensive disaster risk management as guaranteeing the National Productive Strategy. Agricultural potential and natural resources are identified as the main opportunities for economic growth and poverty reduction in the country. Private investment is highlighted as a means to stimulate the sector with the support of the appropriate public policies and international cooperation. In the medium term this effort is aimed at increasing food production, boosting the agro-industrial process, the rational exploitation of natural resources and productive investment. The livestock LCDS is clearly aligned with the PNDH's objectives and will contribute to its achievement.

2.2.2. The Inclusive Rural Development Sector Program (PRORURAL)

This program is conceived as an integral part of the National Human Development Plan (PNDH). It represents the overall national policy for the agricultural, forestry and rural sectors and has at its base a model of sustainable and equitable human development that can develop the economic dynamism of the nation, with a vision of gender equality and environmental sustainability. Implementation of PRORURAL is led by four institutions of the National Production Office (Ministry of Agriculture, Ministry of Family Economy, Cooperative and Associative Community, INTA and INAFOR) and related agencies. The aim of PRORURAL is to provide better conditions for the rural population with an emphasis on rural workers, small and medium producers, indigenous communities and peoples of African descent, while improving the efficiency and effectiveness of national resources, private resources and cooperation, and achieving a better performance in these sectors. Activities relevant to the Livestock LCDS include:

- formulation of agricultural and forestry policies
- access services to inputs and equipment
- technical assistance
- associativity
- production certification
- sustainable forest management
- product transformation and market access

Part of the PRORURAL program consists of technology transfer from INTA through field schools (ECAs), a method that has proved highly efficient in the dissemination of information, technologies and practices. Fulfilling PRORURAL required the definition and adjustment of the policy implementation instruments and led to the formulation of three national programs: the National Food Program (PNA), the National Rural Agroindustry Program (PNAIR) and the National Forest Program (PNF) (MAG, 2013).

2.3. National context related to climate change, and alignment with climate change mitigation specifically

Nicaragua emits only 0.03% of global emissions. With 2.58 tCO_2 emissions per capita, well below the world average of 4.0 and the mean of highly industrialized countries, which is above thirteen, it is the country with lowest per capita emissions in Mesoamerica and among the four countries with the lowest per capita emissions in Latin America. In 1994 the country was considered a sink for GHG, capturing more CO_2 than it emitted, and with a net balance of -12,055,710 tCO_2. This demonstrates the historical climate related environmental service provided by Nicaragua since 1750 and shows why Nicaragua's climate change focus is mostly directed towards adaptation. The national GHG inventory for 2000 shows that Nicaragua contributes with carbon sinks, fixing -94,489,000 tCO_2 while emitting 139,869,000 tCO_2, resulting in 49,220,190 tCO_2 and 59,477,390 tCO_2e in net emissions.

Table 1. GHG emissions by gas and sector

Sector	GHG emissions (kt)					Total CO_2eq 100 years	
	CO_2	CH_4	CO_2eq	N_2O	CO_2eq	Emissions	Absorption
Energy	3,534.34	14.65	307.65	0.26	80.6	3,922.59	
Processes	305.85					305.85	
Waste		27.65	580.65	0.23	71.3	651.95	
Agricul-ture		161.00	3,381.00	12.00	3,720.00	7,101.00	
UT CUTS	45,380.00	86.00	1,806.00	1.00	310.00	47,496.00	
Total	**49,220.19**	**289.30**	**6,075.30**	**13.49**	**4,181.90**	**59,447.39**	

Source: Nicaragua Second National Communication to the UNFCCC (2011)

Analysing emissions over time from 1994 to 2000 shows increases in emissions, mostly originating from the energy sector (32.5%), and caused by population growth and increases in energy demand. The other sector showing a sharp increase in emissions was the land-use, land use-change and forestry sector (LULUCF), which in 1994 was the main sink with a net absorption of -12,055,710 t. However, it has since increased its emissions fourfold to 45,380,000 tCO_2, becoming the main source of CO_2 emissions in 2000. These changes can also be attributed partly to changes in IPCC accounting methodologies.

As already mentioned, the Nicaraguan government is prioritizing adaptation to raise production and productivity and eradicate poverty, but nevertheless there are measures that have a synergic effect between adaptation and mitigation, as demonstrated in a number of CDM projects. The practices that will be introduced by the Livestock LCDS are aimed at exploiting these synergies and contributing to GHG emissions reductions, while enhancing the resilience and adaptive capacities of the rural livestock producers and helping raise productivity and poverty eradication, while ensuring sustainable use of the natural resource base. The following describes the central policy framework related to climate change in terms of strategies and institutional framework in more detail.

2.3.1. National Environmental and Climate Change Strategy (ENACC) and its Action Plan (2010-2015)

ENACC and its Action Plan are led by the Ministry of Environment and Natural Resources (MARENA). They represent the general framework for adaptation to climate change and consist of five strategic guidelines, described below:

1. Environmental Education for Life
2. Environmental Protection of Natural Resources
3. Conservation, Recovery and Harvesting of Water
4. Mitigation, Adaptation and Risk Management in the face of Climate Change
5. Sustainable Land Management

2.3.2. Plan for Adaptation to Variability and Climate Change in the Agricultural, Forestry and Fisheries Sector in Nicaragua, 2013

This plan has been developed by the Ministry of Agriculture (MAG) and contains the basic elements to promote the Action Plan 2010-2015 of the ENACC as an Adaptation Plan in the agricultural, forestry and fisheries sectors. The Plan proposes that producers carry out actions to defend and protect natural resources, conservation, and the recovery and harvesting of water sources, thus encouraging the adaptation of both production systems and their livelihoods, and favouring sustainable and competitive productive processes. The Livestock LCDS is clearly aligned with the national Strategy and Plan for Adaptation, and through its implementation will contribute to the fulfilment of their respective objectives.

2.3.3. National Policy on Agricultural Technology and Innovation

The policy aims at contributing to the transformation of the current agricultural production system by applying agricultural principles, practices, values and attitudes that can maintain the productivity and economic productivity of agro-ecosystems over time, while ensuring both a sustainable use and management of the environment and natural assets.

2.3.4. Agroecological development policy of Nicaragua

This policy aims at contributing to the transformation of current production systems into sustainable systems which, based on ecological principles, will improve the living conditions of producers and consumers, guarantee healthy and quality products to society, and recover and improve the capacities of the eco-systems. With the implementation of the Livestock LCDS, rural farmers and families will receive support to implement sustainable production systems and technologies that will contribute to the fulfilment of the National Policy on Agricultural Technology and Innovation, as well as to Nicaragua's Agroecological development policy.

2.3.5. Program to Improve the Competitiveness of the Livestock Sector (IICA 2012)

In 2014 the government of Nicaragua, through MAG, launched a major livestock development program called 'Program to Improve the Competitiveness of the Livestock Sector' (IICA 2012). The program sets out the government strategy for the livestock sector for the next decade and has four objectives:

(a) Increase the productivity of milk and beef per animal and per hectare through the establishment of improved grasses and legumes

(b) Mitigate environmental degradation by reducing the GHG emissions of the livestock herd and carbon sequestration through the promotion of silvopastoral systems

(c) Improve milk and beef quality and safety along the milk and beef value chain

(d) Reduce rural poverty by generating employment and providing services to the livestock sector along the milk and beef value chains.

To meet these four objectives, the program focuses on four components: support services, credit, animal health, and environment.

The aim of the support services component is to strengthen the capacity of local farmers' organizations to provide technical assistance and training to small and medium farmers, especially in the fields of improvement to pasture, dry-season feeding, animal nutrition, mineral supplementation, silvopastoral systems, animal health management and genetic improvement strategies. It will also encourage collaboration among public institutions with other civil-society actors and international cooperation agencies working in the livestock sector.

The credit component aims at developing and proposing a line of credit with a value chain approach taking into account all actors, from production to processing. This component proposes financial products by production system, herd size and actors along the milk and beef value chains, with an emphasis on the expected returns of the proposed investments and appropriate real interest rates and payment conditions.

The animal health component aims at reorganizing and strengthening the technical and administrative structures of DGPSA, the Animal Health Division of MAG.

Finally, the environment component aims at identifying interventions that cause negative impacts on the environment in order to design mechanisms to mitigate these impacts. At the farm level, the component focuses on the mitigation of environmental degradation by reducing GHG emissions and increase carbon sequestration through the promotion of silvopastoral systems.

2.3.6. Relevant laws, decrees and projects

Law No. 7655/2011, the Law on the Promotion of Agroecological or Organic Production, provides the institutional framework to promote strategies for adaptation to climate change and to ensure the Common Good of Mother Earth and Humanity in the policies of the agricultural productive sector. It aims to increase the productive capacity of the country, being directed towards reducing the social, economic and ecological vulnerabilities of Nicaraguans.

Executive Decree No.69-20086, the National Policy for the Sustainable Development of the Forestry Sector of Nicaragua, is aimed at helping improve the quality of life of current and future generations of the Nicaraguan population by giving a priority to the families of small and medium agricultural and forestry producers, peasants, rural workers, indigenous peoples, African descendants and ethnic communities and by promoting the sustainable development of the forestry sector. The aims are to replenish forest resources, avoid deforestation, and introduce rational forest management and community forestry with a business vision (MAG, 2013: *Plan de Adaptación a la variabilidad y el Cambio Climático en el Sector Agropecuario, Forestal y Pesca en Nicaragua*).

Nicaragua has also initiated implementation of the Readiness Strategy for Reduction of Emissions by Deforestation and Forest Degradation (ENDE-REDD+ Strategy). ENDE-REDD+ is an initiative aimed at mitigating deforestation and forest degradation, and consequently the GHG emissions resulting from these phenomena, while helping improve the national economy and the livelihoods of rural communities. ENDE-REDD + has been created with the objective of benefiting families, farmers and indigenous communities, especially those highly vulnerable poor communities, by means of instruments like the forest development policy. It will also apply a restitution of rights approach in using and drawing benefits from natural resources in a rational and sustained way, with an emphasis on adapting to climate change, and taking into account the potential and existing natural resource capital in the territory. http://enderedd.sinia.net.ni/index.php/en/

2.4. National institutional context related to climate change

2.4.1. Ministry of Environment and Natural Resources (MARENA)

MARENA is the national focal point to the UNFCCC and is also the national entity that dictates policies and standards in the environmental sector. MARENA's Directorate General for Climate Change (DGCC) is the body that regulates and leads all processes related to climate change management, including adaptation, mitigation, risk management, aid management through official development assistance, and the negotiation of a new global regime on climate change through the UNFCCC. MARENA is therefore the final national approver of the Livestock LCDS, with the mandate to report the LCDS as one of the country's contributions to adaptation and mitigation to the UNFCCC.

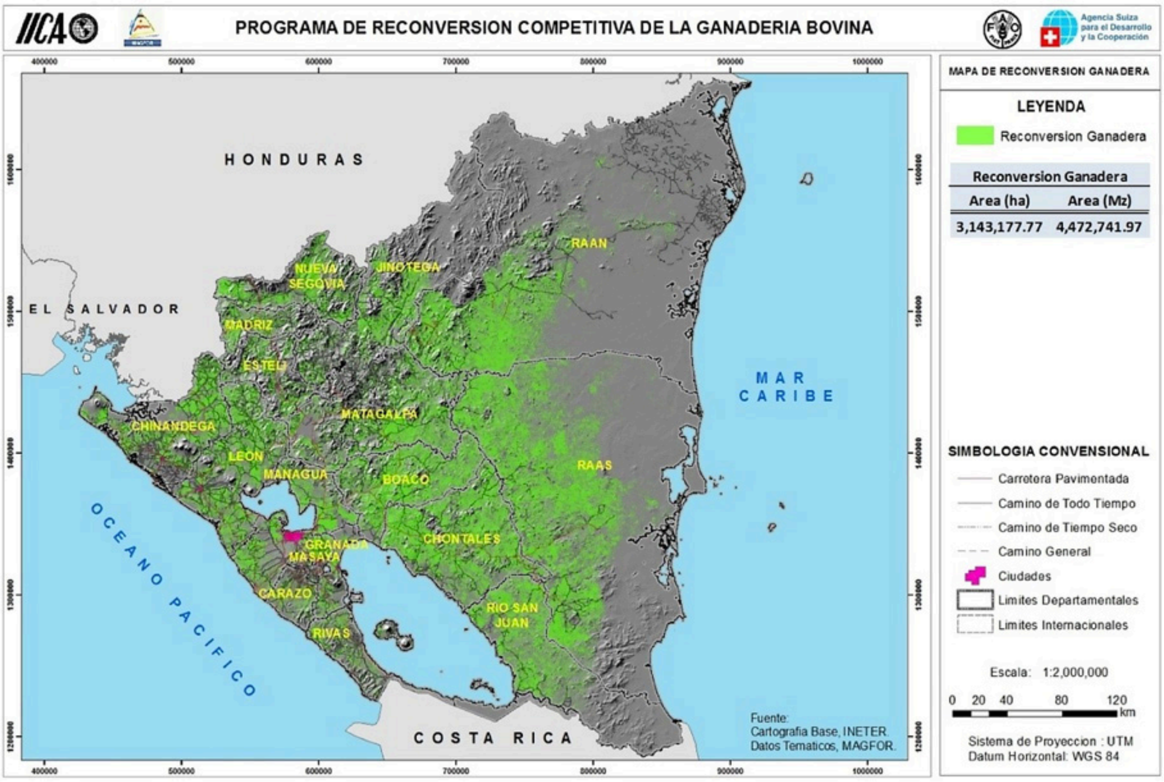
2.4.1.1. The National Office of the Clean Development Mechanism (ONDL)

The ONDL is a unit of the DGCC which promotes and advises on the formulation of mitigation and adaptation projects regarding climate change. As part of the UNFCCC and the Kyoto Protocol, Nicaragua can access benefits in the emissions reduction market through the CDM, as it has a National Operational Entity that is duly empowered for such purposes. It coordinates closely with interinstitutional and multi-sectoral entities related to climate change, mainly with MAG, the Ministry of Energy and Mines, the Ministry of Foreign Affairs, the Ministry of Finance and Public Credit, the Central Bank of Nicaragua and the National Council for Sustainable Development. ONDL will therefore coordinate with MAG in implementing and reporting on the Livestock LCDS to the UNFCCC.

2.5. Current situation in the livestock sector

The livestock sector has been gaining in importance in monetary terms through its exports of meat and milk derivatives, becoming one of the sectors of greater strength and potential for the country. Livestock contributes to 6.8% of GDP (2015), with an average production of 250 million kg/year (MAG, 2013), and it generates 490.8 million dollars in exports of beef and animals. The main markets are local, Central America and the United States. The priority given to meat for export is due to the fact that the country is free from diseases such as foot and mouth and bovine spongiform encephalopathy. The price per meat kilogram was USD 0.6, and 0.35 for live cattle. Approximately 150,000 small producers and their families rely on milk as a major source of income in rural areas. Livestock activities cover 2,310,440 ha of pastures with natural grass and 950,776 ha of improved pastures. The total livestock population is 4,136,422, divided into 136,687 farms dedicated to cattle management. Improvements in the competitiveness of meat and milk production are expected through the introduction of animals that are more resilient to climate variability.

Figure 2. Livestock production areas in Nicaragua



Source: MAG 2014

Livestock generates 20% of employment in the country's agricultural sector, directly involving 150,000 families. 90% of farms are small to medium dual-purpose, i.e. producing both milk and meat, and using low-rate technology. The country has 107 collection centers with a capacity of 598,000 kg/day. However, these centres are being under-utilized, collecting only about 330,000 kg/day in the dry season and 479,000 kg/day in the rainy season, with a remaining unutilized installed capacity of about 100,000 kg.

Table 2. Socioeconomic indicators of cattle livestock in Nicaragua

Indicators	Nicaragua
Productive ha	2,310,439.77 ha with natural pastures
	950,775.69 ha with improved pastures
Livestock GDP in 2015	6.8%
Animal production index	136.22%
Yield cattle heads per year Yield litres of milk per year	4,136,422 animal heads 3.12 kg/cows/day
Average farm area (ha)	30
Number of farms	136,687 farms
National meat consumption t	N/D
Export	USD 429,180 meat USD 32,801 cheese
Number of employed families/people	150,000 families

Source: Own elaboration with FAO (2014), SEPSA (2013), INE (2008) and FUNICA (2012) data.

Table 3. Main characteristics of livestock by department in Nicaragua

Nucleus	Municipalities	Total producers	N° animals	Milk Prod/ Kg thousands/ day	Milk Kg/cow/day
RAAS	Cruz de Rio Grande	1,961	127,436	21-145	1.88-2.75
	El Ayote	851	77,346	21-145	3.2-3.41
	El Rama	3,475	212,962	21-145	1.88-2.75
	Muelle de los Bueyes	1,743	102,816	21-145	2.96-3.2
	Nueva Guinea	4,502	207,079	21-145	3.2-3.41
	Paiwas	1,823	186,050	21-145	1.88-2.75
RAAN	Bonanza	352	6,882	1.33-3.21	3.41-4.59
	Rosita	966	32,521	21-145	3.41-4.59
	Siuna	4,840	170,281	21-145	3.41-4.59
	Mulukukú	1,689	136,851	21-145	3.41-4.59
	Waslala	2,766	77,527	21-145	3.41-4.59
Matagalpa	Matiguás	2,105	134,799	21-145	2.96-3.2
	Río Blanco	1,194	57,518	21-145	3.2-3.41
	Muy Muy	776	28,794	8.77-21	2.75-2.96
	Rancho Grande	1,093	28,193	8.77-21	3.41-4.59
	San Ramón	687	11,742	3.21-8.77	2.96-3.2
Chontales	San Pedro de Lovago	548	29,826	21-145	2.96-3.2
	Chontales	643	40,006	21-145	3.41-4.59
	Boaco	1,218	66,349	21-145	1.88-2.75
	Río San Juan	740	58,022	21-145	3.2-3.41
	Jinotega	453	36,856	21-145	3.2-3.41
Boaco	Camoapa	1,669	109,607	21-145	2.75-2.96
	Boaco	1,853	76,991	21-145	2.75-2.96
Río San Juan	El Almendro	1,137	91,167	21-145	3.2-3.41
	San Miguelito	1,536	70,864	21-145	3.41-4.59
	Morritos	634	40,187	8.77-21	2.75-2.96
Jinotega	Jinotega	1,746	22,722	8.77-21	3.41-4.59
	El Cúa	1,396	27,494	21-145	3.2-3.41
	San Rafael del Norte	668	9,930	3.21-8.77	3.2-3.41
	Wiwilí	2,842	44,538	8.77-21	2.75-2.96

Source: CENAGRO 2012, Economic situation report FUNIDES, CETREX 2014

2.5.1. Case study and socioeconomic characterization of livestock producers in the Matagalpa area

In the Livestock LCDS preparation phase, a case study was elaborated in the Matagalpa area, to gather more detailed data on livestock and stakeholder acceptance for the proposed practices. The following presents a selection of the data on the livestock sector.

Table 4. Characteristics of the herd, land use and greenhouse gas emissions of average farms, with three levels of intensification in Matagalpa, Nicaragua.

	Intensification level		
	Low (<1.4 AU/has)	**Medium (1.4-2.3 AU/has)**	**High (>2.3 AU/has)**
Herd size (AU)	53.8 ± 4.8 a	45.5 ± 3.6 a	49.2 ± 4.9 a
Animal stock (AU/has)	0.5 ± 0.01 c	0.9 ± 0.01 b	1.5 ± 0.1 a
Land use (has)			
Natural pastures	80.9 ± 8.6 a	36.9 ± 3.1 b	22.9 ± 2.2 b
Improved pastures	37.0 ± 6.3 a	17.0 ± 2.6 b	13.1 ± 3.0 b
Fodder banks	0.8 ± 0.3 a	1.1 ± 0.3 a	0.9 ± 0.2 a
Agricultural crops	2.0 ± 0.3 a	2.1 ± 0.3 a	2.0 ± 0.2 a
Forest plantations	1.7 ± 0.5 a	1.2 ± 0.4 a	1.7 ± 0.7 a
Forests	7.2 ± 2.4 a	3.4 ± 0.7 ab	2.2 ± 0.4 b
Live fences (km)	6.0 ± 1.0 a	4.1 ± 0.8 a	4.6 ± 0.8 a
Total	131.6 ± 12.7 a	62.8 ± 5.0 b	45.3 ± 4.3 b
Total emissions (tCO_2e/has/year)	1.5 ± 0.4 ab	2.3 ± 0.6 b	3.3 ± 0.3 a

Livestock farms in Matagalpa-Nicaragua (Vía Láctea) have low levels of livestock intensification, as expressed in terms of animal stock (1.3 ± 0.7 AU / ha), which explains the high proportion of native pastures (53% of total area). Despite this, Nicaraguan farms have begun to establish fodder banks, which are on average 0.9 ha/farm. The highly intensive farms presented an animal stock that exceeds 81% and 214% of median and low intensification (1.5 ± 0.1 vs 0.9 ± 0.0 vs 0.5 ± 0.0 AU / has) respectively. No clear trend in the use of live fences in relation to the level of intensification was found; however, Nicaraguan farms have a total length of these linear systems of 4.6 km/farm.

Climate change has direct effects on livestock production and indirect effects due to changes in the availability of forage and pasture. It determines the type of livestock and its adaptation to different agro-ecological zones and the number of animals that have the capacity to support rural communities, as well as influencing livestock composition in terms of species. For each day the start of the winter season, which is the fattening period, is delayed, there is a weight loss of 200-300 grams for each head of cattle. In the case of milking cows, the yield drops by between half and one litre per day. During periods of drought, losses of between fifteen and twenty percent have been observed, while during periods of excess precipitation, water floods the grassland grounds and grass is lost, with economic losses due amounting to ten percent. (MAG, 2013: *Plan de Adaptación a la variabilidad y el Cambio Climático en el Sector Agropecuario, Forestal y Pesca en Nicaragua*).

2.6. Alignment with sectoral strategies and development plans for livestock

2.6.1. Production, Consumption and Trade Plan 2017-2018 (MAG)

This plan establishes the main productive policies and goals agreed with the productive sectors. The main policies relevant for the Livestock LCDS that will be implemented during the present productive cycle are the following:

- Promote the productivity, quality, efficiency, innovation and competitiveness of goods and services
- Encourage the generation, adaptation and application of technology and new methods for the production of primary goods and their agro-industrial transformation
- Promote sustainable and environmentally friendly production, preserving and restoring forests, conserving and restoring water sources, making rational use of water, and using inputs, fertilizers and pesticides that reduce damage to land and protect biodiversity.

The policy also reiterates that the government will continue to promote credit options for small producers who currently do not have access to financing through existing programs and projects.

2.6.2. Production, Consumption and Commerce Plan 2017-2018

The Production, Consumption and Commerce Plan has been prepared by the National System for Production, Consumption and Commerce. It establishes the main policies and targets for the productive sectors through dialogue, alliances and consensus with the relevant stakeholders. The main policies relevant to the Livestock LCDS during the current production cycle are the following:

- Promote the productivity, quality, efficiency, innovation and competitiveness of goods and services.
- Encourage the generation, adaptation and application of technology and new methods for the production of primary goods.
- Promote sustainable and friendly production with nature, preserving and restoring forests, conserving and restoring water sources, making rational use of water, and using inputs, fertilizers and pesticides that reduce damage to the land and protect biodiversity.

The plan for 2017/2018 envisages an increased cattle head production of 23.7%, a 24% increase in meat production, a 10.5% increase in meat exports, increased national consumption of 6.1%, and increased milk production of 6.3%.

The Livestock LCDS will contribute to the achievement of the goals described in the Plan through its innovative approach, introduction of alternative production practices that will contribute to GHG mitigation, reforestation and alternative use of soil fertilization, leading to decreased soil degradation and improved water quality and availability.

2.6.3. Establishment of integrated farms with diversified management and silvopastoral arrangements for beef cattle and/or dual purpose, as defined in the Second National Communication to the UNFCCC

Livestock and milk production have developed in an uncontrolled manner in Nicaragua, with no extensive pasture management practices, rotation of pastures, animal load or adequate pastures, thus causing increased CH_4 and CO_2 emissions.

This line of action envisages the establishment of farms with diversified management and silvopastoral arrangements for fattening cattle and milk with the aim of utilizing the available area more efficiently, while increasing forest cover and improving family economies. The expected impacts are increased productivity, higher financial incomes, socioeconomic improvement of producers and reductions of CH_4 and CO_2 emissions by reducing grazing areas, increasing plant cover and water production in streams, and using renewable energy through biodigesters.

The project proposes establishing production modules of fifty hectares that will allow the remnants of the farm to develop natural regeneration of the forest and soil, increase vegetation cover, promote water infiltration, reduce the area of pastures through controlled and rotational grazing and the establishment of corrals with cement floors, allowing the collection of manure for inputs to bio digesters and supplementary feeding. Implementation is envisaged as proceeding through strategic alliances between organized cattle-ranchers and other guild groups in order to establish demonstration farms, thus allowing the validation of production models and the diffusion of technology among milk and dairy farmers.

Actions needed to facilitate these implementations include:

- Training and sensitization of the population on the problem of desertification of soils by traditional management, causing water scarcity
- Establishment of a demonstration farm for each ecosystem and development of a formal and non-formal technology dissemination program
- Establishment of a grazing program with reduced grazing to increase plant cover and natural regeneration by improving the local microclimate and thus contributing to climate change mitigation.

The cost of implementing the program is estimated at USD 21,757,658 over a period of ten years. Applying a discount rate of 15% per year, the net present value of investment is USD 16,068,167, indicating a high level of profitability. The resulting internal rate of return is 38.29%, 23% higher than the discount rate. The cost-benefit ratio (2.24) indicates that, for every dollar invested in this program, there will be a profit of USD 1.24. The period of recovery of the investment is equivalent to two years and three months.

Implementation of the Livestock LCDS will directly contribute to the implementation of this program as identified in the Second National Communication, with the social, environmental and economic benefits being closely aligned with those described above.

2.6.4. Subprogram of Reconversion of Bovine Cattle and Sheep Cattle (MAG), October 2008

The Subprogram has a sixteen-year horizon and aims to support the increase in incomes and the standards of living of small and medium-sized livestock producers and their workers as part of the fight against poverty and complementarity with the Zero Hunger Program. The program will introduce technological and business development services to boost the productivity of milk and meat production, thus contributing to food security and ensuring affordable prices for the population, while preventing the deterioration of natural resources and the environment, and encouraging the exploitation of livestock in conjunction with reforestation. It is planned to do this by through promoting the establishment of adequate and accessible financial services for small and medium-sized farmers, through the state-owned Production Promotion Bank (PRODUZCAMOS), and affiliated financial institutions.

Five components have been identified within the program, which has thirteen specific projects. The following are those that are aligned with the Livestock LCDS:

2.6.4.1. Enterprise Development Services Component (SDE)

Forage Project

The Forage Project will promote new feeding technology alternatives to be established in 16,000 farms with an estimated population of 650,000 head of cattle. The project aims at introducing rotating grazing on approximately 14,000 farms and over 600,000 head of cattle under mineral supplementation.

Technological Services Development Project

This project focuses on Technical Assistance, Training and Technology Transfer and aims to at train four hundred technicians from the institutions of the public agricultural sector, related academic institutions and the private sector to develop private technical service capabilities. Service providers and/or companies will be trained and certified to work on 16,000 farms. The target is to reach at least a thousand reference farms for the diffusion of technologies, draw up a practical livestock manual, train forty technicians and eight hundred producers in silvopastoral systems and establish a specialized school for livestock.

2.6.4.2. Conservation and Improvement of the Environment Component

Reforestation and silvopastoral project

Support will be given to guilds and associations with the aim of reconverting at least ten percent of farm areas into forests with silvopastoral systems. The silvopastoral project involves the conversion of extensive systems to intensive production systems combining agricultural, livestock and forestry activities that are sustainably productive. Implementation of this component focuses on the generation and transfer of technologies, training, the dissemination of information and institutional coordination. The target is to establish eight hundred demonstration areas on farms, 133 forest plantations with grazing, 268 silvopastoral systems in sustainable intensive livestock, 133 natural forests with grazing, 133 silvopastoral systems with an emphasis on protein banks, and 133 improved pastures associated with tree legumes.

2.6.4.3. Credit Component

The Credit Component includes long-term comprehensive credits and specific credit lines for small, medium and large cattle producers. The funds allocated to the Credit Component will be administered by PRODUZCAMOS, which is tasked with the management and control of funds in coordination with existing credit networks, and will be in charge of supervising the correct use and application of the funds. The target is to finance the largest number of cattle farms possible with a total amount of USD 40,000,000, bring business development services to all cattle farms financed under this subprogram, have at least two private banks participating in the subprogram, and articulate all financed farms with the Component of Conservation and Improvement of the Environment projects.

The Livestock LCDS will contribute to and be aligned with all the projects described above, and will take advantage of the support mechanisms provided by the Subprogram of Reconversion of Bovine Cattle and Sheep Cattle, including a contribution from the Credit Component, which will constitute part of the national contribution to the Livestock LCDS. Similarly, being already tasked with providing and coordinating financial packages to promote these activities, PRODUZCAMOS will also be involved in channelling the finance envisaged in the Livestock LCDS and will be a crucial stakeholder in its implementation.

2.7. Sectoral GHG emissions and potential reductions through alternative practices

In terms of its global warming potential, CH_4 is the gas that contributes the largest emissions in the sector (2000), with a total of 161 Gg, corresponding to 3.381 $MtCO_2e$ (21 GWP factor over 100y period), and 55.6 % of national CH_4 emissions, with 29.7 % of CH_4 emissions coming from the LULUCF sector. CH_4 emissions from enteric fermentation reached 143 Gg, corresponding to 87.7% of total emissions from the agriculture sector, and underlining the importance of the livestock sector in terms of the country's overall emissions.

Table 5. GHG Emissions in the Agriculture Sector

Category of GHG sources and sinks	CO_2 emissions (Gg)	CO_2 absorptions (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOC (Gg)	SO_2 (Gg)
4. Agriculture			**161**	**12**	**79**	**3**	**N/A**	**N/A**
A. Manure Fermantation			143					
B. Manure managen-ment			4	1			N/A	
C. Rice cultivation			10				N/A	
D. Agricultural soils			0	11			N/A	
E. Prescribed burning of savannas			1	0			N/A	
F. Agricultural waste burning			3	0			N/A	
G. Others			0				N/A	
5. Change in land use and forestry	**45,380**	**0**	**86**	**1**	**753**	**21**	**N/A**	**N/A**
A. Changes in forrest and other woddy biomass stocks	0							
B. Forest and grassland conversion	45,380	0	88	1	753	21	N/A	
C. Abandonment of crop-lands, pastures, plan-tation forests, or other managed lands		0						
D. CO_2 emissions and re-movals from soils	0	0						
E.Others	0	0	0		0	0		

Source: Nicaragua Second National Communication to the UNFCCC (2011)

The LULUCF sector has the greatest impact on Nicaragua's emissions, being the largest source of such emissions but also the largest CO_2 sink. Emissions in the LULUCF sector are estimated at 139,869 $MtCO_2$ (2000), while the absorptions reached 94,489 $MtCO_2e$, with net emissions at 45,38 $MtCO_2$. The LULUCF sector is also responsible for emitting other gases, namely 86,000 tCH_4, 753,000 t of carbon monoxide (CO), 21,000 t of nitrogen oxides (NOx), and 1,000 t of nitrous oxides (N_2O). The categories "Land conversion to forest land" and "Forest land remaining forest" are the main sinks in the LULUCF sector, accounting for 36.8% of total CO_2 absorbed or stored by above- and below-ground biomass. The categories "Land conversion to grassland" and "Agricultural land remaining agricultural" account for 38.9% of total CO_2 emissions and are the main sources of emissions, mainly due to the increases in burning, clearing and logging, the country's high annual deforestation rate and to a lesser extent tillage and pre-crop burning. Looking at emissions trends, as already described in section 2.3, the sector used to contribute to a net absorption of -12,055,710 t in 1994, while becoming a net source of emissions in 2000, a fourfold increase in six years.

The emissions and synergies between the LULUCF and agriculture sectors reflect the importance of trees outside forests as GHG sinks, clearly linked to agroforestry activities that allow the absorption of global emissions. There is a need to continue working in order to promote production under agro-ecological principles, aimed at reducing slash-and-burn agriculture and facilitating the conversion of livestock production to silvopastoral systems, and striving to achieve an agriculture, livestock and forestry sector that makes Nicaragua a net carbon sink again.

2.8. Institutional framework for the Livestock and Forestry sector and the management of the Livestock LCDS

The livestock sector is governed, managed and supported by the institutions described in what follows. The relevance of these institutions to climate change is also underlined in the Action Plan 2010-2015 of ENACC, which establishes responsibilities for these national institutions in relation to climate change, as described here.

2.8.1. Ministry of Agriculture (MAG)

MAG formulates policies, programs, plans and strategies for agricultural and forestry development, protects and guarantees the health and safety of processes along the production chain and facilitates certification processes, as well as being the enforcement authority for Law 765/2012, "Law for the promotion of agro-ecological or organic production". More specifically related to the Livestock LCDS, MAG has the following functions:

- Formulate policies, plans and strategies for agricultural and forestry development
- Identify and prioritize the demand for credit and technological assistance from agricultural and forestry activities
- Formulate and propose a policy for the distribution, ownership and use of the state's rural land
- Formulate proposals and programs for the protection of the ecological system, with an emphasis on the conservation of soils and water, and coordinate with the Ministry of the Environment and Natural Resources.
- Formulate and propose the delimitation of areas for agricultural, forestry, agroforestry, aquaculture and fisheries development, in coordination with the Ministry of Environment and Natural Resources.

MAG is therefore the national institution with the relevant mandates related to the Livestock LCDS and will be its overall coordinating entity, represented through the National System for Production, Consumption and Commerce (SNPCC).

2.8.1.1. National System for Production, Consumption and Commerce (SNPCC)

The SNPCC of MAG is an inter-institutional National System composed of the Ministry of Family, Community, Cooperative and Associative Economy (MEFCCA), the Nicaraguan Institute of Agricultural Technology (INTA), the Institute of Agricultural Protection and Health (IPSA), MARENA, the Nicaraguan Institute of Fisheries and Aquaculture (INPESCA), the Nicaraguan Institute of Territorial Studies (INETER), the National Forestry Institute (INAFOR), the Nicaraguan Basic Food Company (ENABAS), the Ministry of Development, Industry and Commerce (MIFIC), the National Bank of Nicaragua (BCN) and the Ministry of Finance and Public Credit (MHCP).

SNPCC functions as an official forum for coordination and consultation in the public agricultural sector and presents biannual plans for production, consumption and commerce. By means of the plan, the SNPCC draw up the main policies and productive goals for the country, agreed with the productive sectors. The SNPCC is therefore the entity with the appropriate mandates to function as the Livestock LCDS coordinating entity, and it manages the execution of the activities envisaged in the Livestock LCDS supported by international sources.

2.8.2. The Nicaraguan Institute of Agricultural Technology (INTA)

INTA is tasked with providing technical advice and executing state programs for the generation and transfer of agricultural technology as formulated and defined by MAG in coordination with the National System for Production, Consumption and Commerce (SNPCC). INTA also promotes scientific and technological research, as well as training and professional development, with an emphasis on private stakeholders, and it holds all types of contracts and carries out operations that directly or indirectly serve the fulfilment of its objectives. It is therefore the appropriate entity to provide technical capacity-building to producers in the sustainable practices identified and prioritized by the Livestock LCDS and to monitor its implementation.

Until 2013, INTA's mandate had been adapting the technology developed by other centres and transferring this knowledge to farmers. This transfer of technology was made through 150 technicians, each technician working with ten to twelve agricultural promoters, and each promoter with ten producers. Other NGOs, such as Technoserve and Catholic Relief Services (CRS), which are currently are conducting agricultural projects and field schools in the country, are using the same methodology to reach smallholders. INTA has also been in charge of technology transfers through the implementation of so-called "Field Schools for Farmers" (ECAs). ECAs have been established through various programs (by the FAO and national programs) ECAs connected to the PRORURAL program began in 2011 with the aim of strengthening the capacities of producers through learning by doing and producer-to-producer learning. 130 ECAs were developed to provide information and technologies related to environmental issues, agricultural efficiency improvements, soil preparation and conservation and livestock. From 2014, the Technical Education in the Field (ETC) component was implemented through 150 ECAs distributed in a hundred municipalities throughout the country, with an enrolment of around 17,000 participants, 12,000 of whom were assisted through the participation of 645 technicians and the institutions of the National System of Production, Consumption and Commerce (SNPCC), of which INTA is a member.

INTA's mandate changed in 2014, when the focus was directed towards the adaptation and innovation of agricultural technologies. Transfers of technology in the livestock sector are now the responsibility of the Livestock Department of the Ministry of Family Economy, Peasantry, and Agricultural Cooperatives (MEFCCA). It is expected that this institution will work in close cooperation with INTA and its technicians. INTA will still play a crucial role in the measurement, reporting and evaluation of progress with the Livestock LCDS.

2.8.2.1. Nicaraguan System of Agricultural Research and Innovation (SNIA)

SNIA is a recently formed system under the direction of and coordinated by INTA, and is composed of a National Council of Agricultural Research and Innovation, Regional Councils of Agricultural Research and Innovation (CRIA) and the Nuclei of Research and Territorial Innovation (NIT). It was established to help promote the improvement of agricultural productivity, food and nutritional security and the care of the environment in coordination with the National Plan for Human Development by creating consensus and dialogues on agricultural research and innovation. The CRIAs seek to coordinate, plan, implement, monitor and evaluate the country's agricultural research and innovation activities, while the NITs are the basic units of the SNIA that respond to the particular agro-ecological and productive characteristics of each territory, based on agricultural research and innovation processes.

SNIA has established twenty-two coordination teams by theme, those relevant for the LCDS being livestock, climate change, biotechnology, water for agricultural use and agricultural socio-economics. SNIA is also assisting in the establishment of eight Regional Councils of Agricultural Research and Innovation at the national level, and is planning to prepare a policy proposal for agricultural research and innovation, draw up a unique catalogue of agricultural technologies and good innovative social practices, create an Observatory of Technologies and introduce a prize for agricultural and agro-industrial innovation.

Through its role and mandate and its connection with regional territories through CRIAS, INTA will use SNIA to play an important role in the promotion of the LCDS's practices by means of policy proposals and the dissemination of catalogues of agricultural technologies and good innovative practices.

2.8.3. The National Forestry Institute (INAFOR)

INAFOR registers plantations and agroforestry systems; regulates, controls and provides technical assistance to producers regarding forest management in production systems, thus monitoring the sustainable use of the nation's forest resources; generates statistical information; and enforces the appropriate measures, corrections and sanctions in accordance with the relevant laws and regulations. INAFOR is in charge of implementing Nicaragua's forestry development policy, approves Permits of Exploitation, and evaluates and supervises forest management plans. INAFOR collaborates with MAG in proposing technical standards and approval processes for diversified forest management in accordance with national laws, signs agreements with municipal governments or public and private bodies, delegates monitoring and control functions, and promotes and transfers the necessary resources for their fulfilment. It also manages the National Forest Registry and the national inventory of forest resources, and promotes and implements forest development programs with local governments and civil society, especially those aimed at the reforestation of degraded areas. INAFOR will therefore play a central role in implementation of the Measuring, Reporting and Verification system of the Livestock LCDS (MAG, 2013).

2.8.4. Livestock Department of MEFCCA

The Livestock Department of MEFCCA has taken over INTA's responsibility to provide technical assistance to livestock producers and promote the use of environmentally friendly technologies, the use of renewable energy in the sector and skills management. The Livestock Department of MEFCCA will therefore be the entity in charge of the provision of capacity-building activities to producers and their coordination.

2.8.5. The National Technological Institute (INATEC)

INATEC is the governing institution for training and technical and technological education in Nicaragua, providing young people and adults with qualifications and contributing to their insertion in the labour market for the economic and social development of the country. A government institution partially funded by contributing private companies (2%), it provides free quality technical and technological education and training to Nicaraguan families, institutions and contributing companies. INATEC has 43 centres throughout the country, with equipped teaching classrooms, laboratories and workshops. INATEC promotes the development of skills, the dignity of workers' trades and recognition of the skills acquired in the different fields of work among both the rural and urban populations.

More specifically, INATEC has the following functions:

- Train women protagonists of the productive programs, Zero Hunger and Zero Usury
- Certify workers from different sectors with work experience but without title
- Provide training to workers in the contributing companies
- Offer training and habilitation courses for the disabled
- Train micro-entrepreneurs.

Through its mandate and role, INATEC will be one of the institutions involved in providing capacity-building to farmers and technicians under the Livestock LCDS.

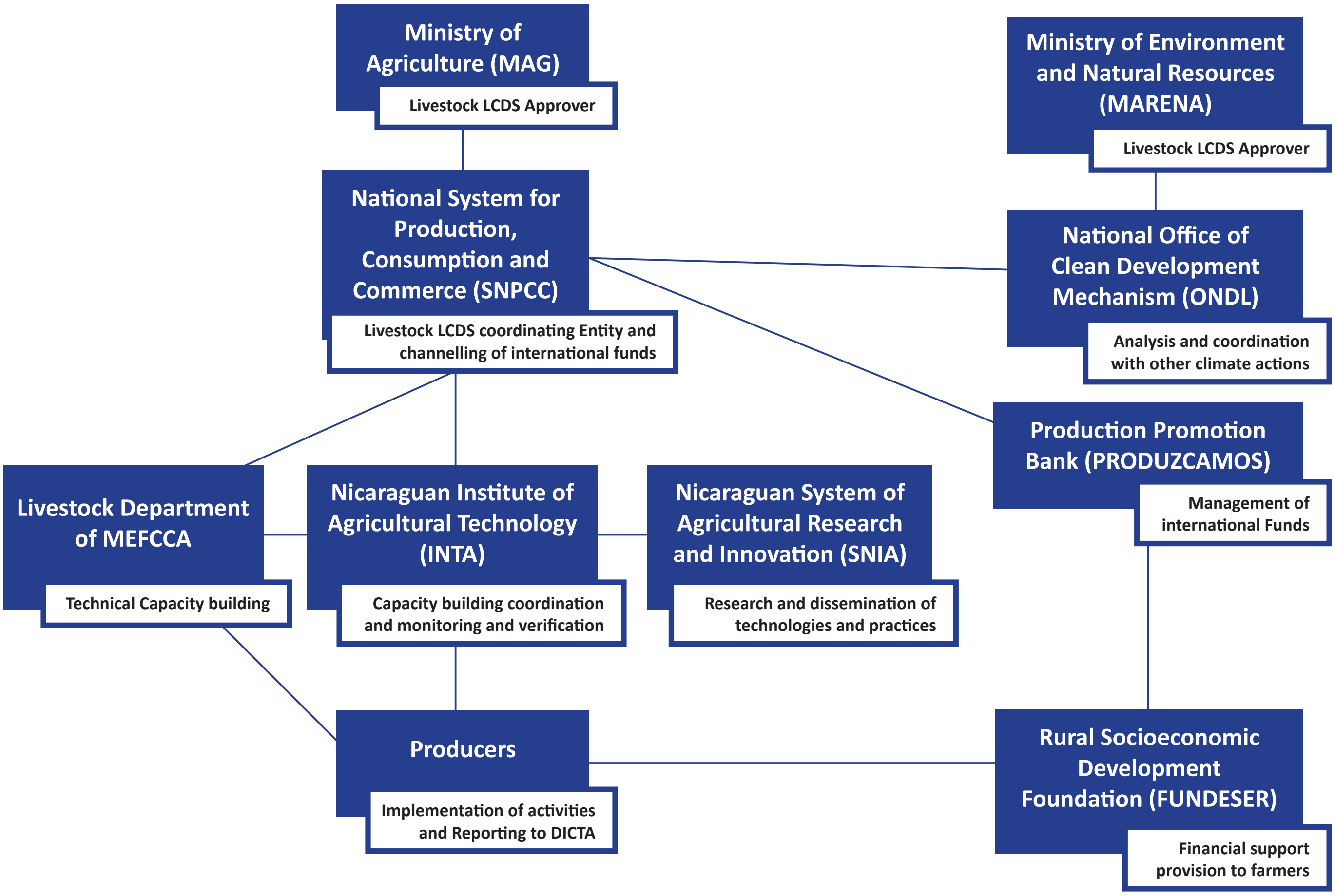
2.8.6. Production Promotion Bank (PRODUZCAMOS)

PRODUZCAMOS is the entity in charge of channelling funds to finance Nicaragua's livestock productivity, and it is already involved in a number of projects to coordinate and manage funds from national and international sources. As an example, PRODUZCAMOS is currently managing USD twenty million sourced from the Inter-American Development Bank (BID) to support the rural productive chains in the dairy sector and of cocoa, sturdy coffee and vegetables. Related to livestock activities, this initiative will support 875 small producers in the dairy sector, organized through cooperatives, who will benefit from financial and technical assistance, thus allowing them to increase significantly the productivity of their farms. Likewise, through BID support, a loan of two million USD has been channelled to finance three hundred small and medium-sized cattle producers in five municipalities. Although PRODUZCAMOS has no direct relationship with small producers, it has engaged the Rural Socioeconomic Development Foundation (FUNDESER) to execute the loan, as FUNDESER is a more appropriate organization to approach small producers and the private sector. As a complementary element to the loan, the program provides for the provision of technical assistance to final beneficiary producers and financial intermediaries in order to improve the service they provide to their partners.

Credit agreements and technical assistance have also been established with major cooperatives in the dairy sector. The investment plans that are subject to the financing are diverse, ranging from the establishment of pastures and protein banks for food and the acquisition of equipment and facilities for the management of grass-cutting to making improvements in milking pens and galleys. Implementation of the Livestock LCDS will streamline the provision of technical support and credit nationally, thus contributing to the uptake of the Livestock LCDS's practices through existing arrangements and facilitating its implementation through the already established institutional frameworks.

The following figure shows the institutional framework for the implementation of the Livestock LCDS, the institutions involved and their respective roles:

Figure 3. Institutional framework for the implementation of the Livestock LCDS



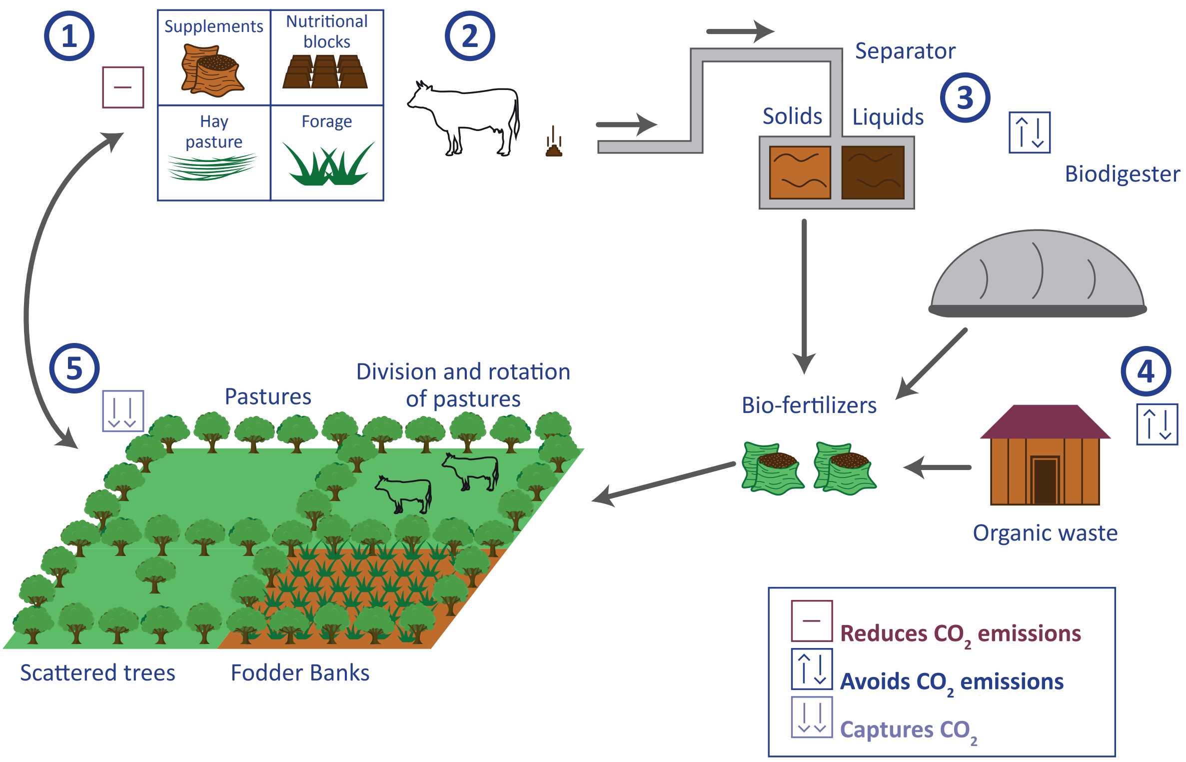
3. Description of sustainable livestock practices in implementing Livestock LCDS

The establishment of land-use systems that will improve the livestock sector and the use of organic fertilizers on native pastures are having a high impact on the carbon footprint of cattle livestock in Nicaragua. These practices are consistent with national proposals for policies to improve cattle livestock (CONAGAN, 2015). The sustainable mitigation and adaptation livestock practices listed below were identified and prioritized as a result of broad stakeholder consultations with local producers and national institutions with the relevant mandates on climate change and agriculture, in addition to national and local institutions engaged in capacity-building in the livestock sector.

1. Implementation of silvopastoral systems, including rotation of pastures
2. Silage of protein forage
3. Application of biodigesters
4. Production and application of organic fertilizers

These practices can be implemented separately, but most positive synergies can be achieved if they are implemented in holistic systems, where the implementation of one practice facilitates the implementation of the others in a symbiotic way. This is illustrated by the figure below:

Figure 4. Synergies and symbiotic relationship between sustainable practices



3.1. Silvopastoral systems

A silvopastoral system is a livestock production management practice for pastures in which perennial woody plants, trees and/or shrubs interact with animals and herbaceous forage plants as part of an integrated management system (Pezo and Ibrahim 1998). The incorporation of perennial plants is a strategy that contributes to increasing above- and below-soil carbon, reducing soil degradation, favouring adaptation and mitigation to climate change, diversifying production systems, reducing dependence on external inputs and intensifying land use. Their implementation also improves the quality and availability of food for domestic animals throughout the year by means of the fruit and forage produced by trees and shrubs and allows livestock production to be diversified, thus increasing the incomes and welfare of producers and their families. Good silvopastoral system designs therefore also contribute with economic, social and environmental co-benefits. Reductions of GHG emissions are achieved through the following mechanisms:

- Carbon capture by the trees that are introduced to the system and the soils, which will increase their organic matter
- Reduction of methane emissions by improving animal feed through the use of better quality pastures and forages
- Reductions in the use of nitrogen fertilizers, pesticides and other inputs
- Reduction of pressure on forests to provide firewood and wooden posts because they occur in areas of wooded pastureland

Silvopastoral systems are envisaged as having the following sub-practices:

- Division of pastures
- Use of forage banks
- Establishment of live fences
- Planting of scattered trees and/or shrubs in the paddocks

The various silvopastoral designs offer a lot of benefits depending on the type of SSP, the species of tree to be used and the management of the system. However, all SSPs guarantee universal benefits, regardless of design, species or management. SSPs are a strategy to achieve sustainability of the farm. That is why we must try to obtain economic, social and environmental benefits.

Table 6 lists the economic, social and environmental benefits that, according to Montenegro and Abarca (2002), are achieved with an SSP:

Table 6. Most common benefits reported in silvopastoral systems

Economic benefits	Social benefits	Environmental benefits
Higher incomes due to increased animal productivity	Better quality of life for the family and the community	Reduction of atmospheric carbon dioxide and mitigation of global warming
Reduced costs by reducing the need to purchase external inputs	Increase in employment in the rural community	Increased tree cover on the farm
Higher income from diversification of production		Increase in biodiversity conservation and generation of ecosystem services
Improved quality of milk and beef from the farm		Protection of riparian forest and forest.
		Reduction in the use of chemicals

3.1.1. Division of pastures

On most farms, grazing land is not used efficiently, and pasture production is low. Two or three large paddocks are generally used for a small number of animals. Pasture division and grazing rotation allow greater grazing efficiency. To calculate the area of each pasture, it is necessary to determine the approximate level of grass production by unit of surface and the number of animals to be grazed. The division of tillage to be made, according to the number of days of grazing and rest and the number of animals to be grazed, determines the level of investment in fences.

Table 7. Estimated costs of fencing one hectare of pasture

Activity	Manpower (d/h)	Cost (Cordobas)	Cost (USD)
Cleaning the ground	1	240	7.9
Cutting of piles	6	1,440	47.2
Wire roll	-	3,500	114.8
Staples	-	500	16.4
Planting of posts and stakes	8	2,720	89.2
Fixing wiring	10	2,400	78.7
Total Cost		10,800	354.1

Exchange rate: October 2016: 1 U$ = 30.5 Cordobas. 1 working day, one person for 8 hours = 200 Cordobas

Figure 5. Division of pastures

3.1.2. Forage Banks and use of silage

Forage banks are also known as energy-protein banks. The forage bank is an area on the farm where trees or shrubs are planted in compact blocks of high density in order to maximize the production of high-quality foliage for animal feed supplements in dry periods or when the availability of grass is reduced (Holguín and Ibrahim 2005). The production of a food source on the farm significantly reduces the need to buy nutritional supplements such as concentrated feed. The forage bank contributes to improving soil use, thus reducing the area devoted to livestock grazing while converting areas into forests.

Figure 6. Forage banks and silage

Energy forage can be used for silage, a method of storing green fodder, either grass or legumes, compacted in a deposit or construction and protected from air and moisture in order to preserve the highest quantity and quality of nutrients and avoid their degradation (Reyes et al. 2009). The process allows food to be stored at harvest times, thus preserving quality and palatability, which makes it possible to increase the animal load per area. The anaerobic fermentation of soluble carbohydrates in fodder allows the production of lactic acid. The quality of the silage is affected by the chemical composition of the material to be ensiled, the climate and the microorganisms used, among others. The silage is stored in silos that allow the anaerobic condition to be maintained. There are several different types of silage, and the choice of the appropriate one depends on the type of livestock exploitation, the economic resources available and the topography of the terrain among other factors.

Using silage contributes to the reduction of purchases of external inputs to maintain animal feed during the critical season, allowing a stable number of animals and their sustained production throughout the year to be maintained. Pressure on the pastures is reduced, allowing their rest and recovery in periods of lower precipitation and thus avoiding overgrazing.

Table 8. Average costs for the establishment and maintenance of one hectare of energy forage bank and the production of silage feed of one ton.

Activity	Man-days *	Cost (U$)
Manual land clearing	6	39.18
Preparation of the ground	-	69.65
Bedding	-	34.82
Cutting, hauling and sowing of grass	-	165.43
Earth up	-	54.42
Fertilization	-	145.84
Cleaning after sowing	6	39.18
Sub-total	49	548.54
Manual weed control	5	32.65
Cutting, hauling, chopping and offering	52	339.57
Subtotal	59	385.28
Silage	8	30/ton
TOTAL	116	963.82

** 1 man-day consists of 8 working hours. The average value of a man-day is estimated at 194.5 córdobas ** Values include product prices. Source: Based on workshop results*

3.1.3. Establishment of live fences

One of the most common silvopastoral methods on farms in Nicaragua is to establish trees and/or shrubs of different species on the boundaries of the farm or to demarcate divisions of pastures or crops (Figure 9). These live fences are widely used because they lower the costs of establishing and maintaining the enclosure. Live fences are also a direct and/or short grazing and hauling food source for animals. They also provide economic benefits such as the provision of live poles to set up new fences. In addition to the economic benefits, they are also very valuable from an ecological point of view, as the rows of trees help connect patches of fragmented forest. In this function they are known as biological corridors, since migratory birds and mammals use the trees to rest, get food or nest (Villanueva et al., 2008).

Figure 7. Living fences as a biological corridor

Table 9. Cost of establishing a hundred linear metres of simple and compound living fences

Activity	Cost per activity
	Dollars
Cleaning the ground with machete	6.53
Cutting and hauling pickets	19.59
Cutting and hauling dead poles	26.12
Digging of holes, planting of cuttings, dead poles and laying of wire	39.18
Cost of one roll of wire and one pound of staples	54.41
Total	145.84
Activity	
	Dollars
Implementation of a hundred linear metres of simple live fencing	145.84
Fruit and wood plants	26.12
Total	171.96

Figure 8. Live fences

3.1.4. Planting of scattered trees and/or shrubs in paddocks

In traditional schemes, the livestock farmer seldom sows trees in his paddocks. However, dispersing trees and/or shrubs in the paddocks increases tree cover and provides benefits in the context of animal productivity (Figure 9). Trees and shrubs provide greater comfort for the animals because the shade of the trees improves the microclimate of the pasture. Animals are therefore more comfortable and spend more time consuming food. In addition, the organic matter improves soil fertility, and wood resources are provided for family use, such as firewood, wood, etc. In the dry season the trees and shrubs become a source of foliage and fruit for the animals. They also contribute to the removal of carbon of between 12-55 tCO_2e/ha, depending on the density of trees per hectare. The cost of implementing this system is USD 778 per hectare, and its annual maintenance is USD 150 per hectare.

Figure 9. Trees scattered in pastures

3.2. Biodigesters

Biodigesters are closed containers designed to capture the biogas that is produced from the fermentation of organic matter under anaerobic conditions. The use of manure from cattle is ideal for the production of biogas. The gas produced in the biodigester can be used to cook, heat water, light a house or even generate electricity. For traditional farmers small applications are envisaged, leading to energy saving and replacing fuelwood of approximately 90 kg firewood per week, thus reducing deforestation. Biogas is composed of CH_4 (approx. 60%), CO_2 (approx. 40%), and other gases and water vapour in lesser proportions. Another product that can be obtained from the biodigester is waste sludge, a liquid rich in nutrients and an excellent organic fertilizer that can be used to fertilize the grass or crops or be sold in the community. GHG reductions of 6-10 tCO_2e/year can be expected, achieved through the following processes:

- Reduction of CH_4 and N_2O emissions derived from the management of livestock manure
- Reduction of fuelwood consumption for cooking, and therefore reduction of deforestation

Figure 10. Low-cost and medium-cost family biodigesters

Even though this technology has a high GHG mitigation potential, with many desirable co-benefits, there is little real information on the location and geographical density of livestock, and current techniques of operation do not favour the collection of manure.

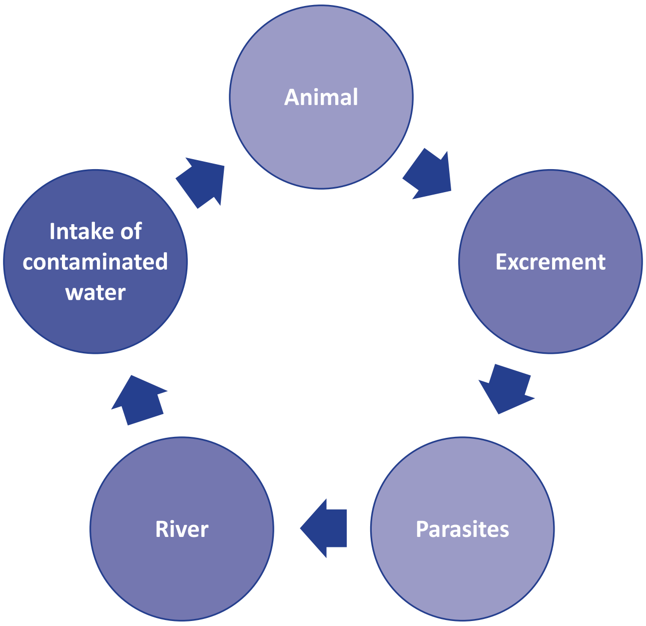
Family-size biodigesters are generally constructed using plastic polyethylene sleeves or tubes. These materials are inexpensive and easy to install, and the materials are locally available. The cost of a plastic biodigester with a capacity of 12 m^3 can range from USD 300 to USD 500 (Figure 10), depending on the material used. A 4 m^3 biodigester for a carrying capacity of 64 kg of dry biomass is estimated at USD 500. A three-year investment recovery period is expected.

Figure 11. Waste sludge from a biodigester to be used as fertilizer

3.3. Organic fertilizers (composting and biofertilizers)

The mismanagement of excreta (excrement and urine) from livestock contributes to the contamination of water sources. This is a serious problem because some parasites that affect human and animal health contaminate the waters supplied to the cattle and the human population (Figure 12). Good management of excreta can instead lead to positive effects by providing the source material for the production of organic fertilizers for pastures and crops. The application of organic fertilizers reduces the need for chemical fertilizers, thus reducing N_2O and CH_4 emissions.

Figure 12. Processes of the contamination of water and of animals and humans by parasites



One of the most appropriate forms of excreta management is ensuring the decomposition or degradation of organic waste materials in a warm, humid and aerated environment where the microorganisms (microbes) contribute to the decomposition of organic matter, becoming an excellent organic fertilizer. This fertilizer is a source of nutrients that can be utilized gradually according to the needs of the plants or pastures. In addition, organic fertilizers improve degraded soil by adding or returning carbon and other structural matter and nutrients, thus improving water retention and preventing erosion (Restrepo, 2001). Due to the diversity of organic waste that is found on a ranch, it is possible to prepare a wide variety of organic fertilizers. The Livestock LCDS refers only to those that are made mainly from livestock manure.

3.3.1. Composting

Compost is the organic material that is obtained as a product of controlled microbial action on organic waste. The end result of this process is a product that can be applied to the soil to improve its characteristics without causing risks to the environment.

Figure 13. Concrete flooring around feeding area to facilitate the collection of manure for biofertilizer production

Compost is formed by the microbial degradation of materials accommodated in layers and subjected to a process of decomposition; the microorganisms that carry out the decomposition or mineralization of the materials occur naturally in the environment. Producing this type of fertilizer is economical and easy to implement. Costs are estimated at USD 20/t and typically require one to two days a month for maintenance, with a repayment period for the initial investment of approximately one year.

Expected emissions reductions using this method are 5 to 100 tCO_2e/ha/ year, depending on the application of fertilizers used by the producer (Figure 14).

Figure 14. Processing of organic manure using livestock manure (Photo Jiménez-Trujillo, 2011)

3.3.2. Liquid Biofertilizers

Liquid biofertilizers are fermented fluids obtained by anaerobic (airless) fermentation in a liquid medium of fresh animal manure and enriched with microorganisms, milk, molasses and minerals for 35-90 days. The biofermentation process produces vitamins, enzymes, amino acids, organic acids, antibiotics and a great microbial richness that contribute to dynamically balancing the soil and the plants. Microorganisms can also be added to improve the quality of the fertilizer. These microorganisms are the same as those that occur naturally in agricultural soils, but they have been selected to improve the physical condition of the soil. In preparing biofertilizers based on bovine manure, a biofermenter with hermetic lid is required in which the raw materials are placed. Biofertilizers also have the peculiarity of producing gases during the fermentation process, similar to what takes place in a biodigester. The gases produced in this anaerobic process should be burnt or utilized. Production costs are estimated at USD 26.00 per litre of biofertilizer, with no operating costs.

Figure 15. Production of liquid biofertilizers

4. Identification of barriers and implementation options

4.1. Barrier Analysis

The identification of barriers to implementing these practices followed a bottom-up process. Three approaches were employed in conducting the barrier analysis: a literature study, consultation with local livestock producers through workshops, and validation workshops with farmers and relevant national institutions. This was supplemented by site visits and interviews with producers and national stakeholders. The national stakeholders consulted consist particularly of experts from national ministries and regional offices, such as such as the Nicaraguan Institute of Agricultural Technology (INTA), Nicaragua National Livestock Commission (CONAGAN), Federation of Nicaraguan Cattlemen Associations (FAGANIG), the Nicaraguan Chamber of the Dairy Sector (CANISLAC), academia and NGOs. During the preparation of the Livestock LCDS, workshops were held in the presence of key government and civil-society members and private individuals in July 2016 and June 2017. The stakeholders consulted identified barriers within in two main categories, as listed here:

Human capacity:

- Low level of knowledge and technical capacity
- Lack of administrative management of farms and financial knowledge

Financial:

- Lack of access to credit

4.1.1. Low level of knowledge and technical capacity

The 2011 Agricultural Census indicated that 17.5% of farms were receiving agricultural and forestry technical assistance and/or training. Most of these activities (60.39%) had been developed by government institutions (Ministry of Agriculture and Forestry, INTA, IDR, INAFOR). Cooperatives and NGOs were responsible for 37.45% of the total activities (Ortega et al. 2013). Even though Nicaragua has a range of capacity-building activities targeting the livestock sector, producers still stated that they lack the technical capacity to implement the identified practices and that they need longer term technical support and training. In addition, from a gender perspective, data from the 2011 Census revealed that only 22.4% of producers having received technical assistance and training were women. According to a Nitlapán (UCA) study, technicians from public and private entities are not aware of the role of women who exercise more farm-level administrative functions, assuming that they do not have enough knowledge about livestock (Flores et al. 2011)[2]. It is therefore necessary for the Livestock Departments of MEFCCA, INTA and IPSA to design long-term capacity-building programs that take gender issues into consideration and capitalize on existing programs and initiatives.

4.1.2. Lack of administrative management of farms and financial knowledge

The success of innovative value-chain financing depends to a large extent on the decisions of interested financial producers and suppliers. These decisions will depend on the financial and livestock knowledge of these actors, the information and communication opportunities at their disposal and their technical capacity. At present, due in part to ignorance of financial illiteracy, the demand for producer financing is often very low. Producers hesitate to borrow, and banks hesitate to lend. It should also be pointed out that many producers do not keep records of their activity, it being a primary requirement of the bank that the producer can show accounts to demonstrate his or her ability to pay back the loan.

2 "Dual-purpose milk and beef value chain development in Nicaragua: past trends, current status and likely future directions", CGIAR.

4.1.3. Lack of access to credit

The lack of access to capital and financing is one of the most important barriers to achieving the productive restructuring of small and medium-sized producers. The lack of access to credit depends mainly on:

- A lack of guarantees;
- over-indebtedness to suppliers and inability to repay the loan;
- high interest rates making investments unfeasible.

The major private actors providing credit to agricultural and livestock producers at present are three private financial institutions: Fondo de Desarrollo Local (FDL), ProCredit, and Bancentro. Prior to 2008, there were more players involved in the provision of credit, but in 2009, farmers in financial difficulties who had obtained loans were advised not to repay them. This campaign started at the same time as the world financial crisis was at its peak, affecting the local prices of agricultural products. This event caused a major disruption in the banking system that was providing agricultural credit. As an example, FDL had allocated more than USD 28 million in credit to the agricultural sector in 2009 but between 2009 and 2010 lost USD 10 million in loans that producers did not pay back. As a result, the provision of credit to agricultural producers has been reduced significantly since 2009 by 55–60%.

The number of livestock producers in Nicaragua who obtain credit is very small: of the estimated 136,687 producers who owned cattle in 2011, only 4,777 (3.5%) had livestock-related loans. In contrast, about 27.3% of producers received credit for crop-related activities, almost eight times more than for livestock-related activities (CENAGRO 2012). This difference is mostly due to the fact that credit for crop-related activities is short-term (i.e. for the duration of the crop, usually four to six months). Credit allocated to livestock producers varies from eighteen months for steer fattening to more than two years for cow–calf operations, and banks prefer to lend money for short-term investments. In addition, the livestock farms that received credit in 2011 varied by farm size. The number of farms below 13.7 ha received proportionately less credit than those with more than 13.7 ha, and this proportion increased as farm size got larger. Thus, there was a higher probability of obtaining credit if the farms were larger.

The lack of credit is one of the biggest problems faced by the Nicaraguan livestock sector, especially for women dedicated to this area of production (Agurto and Guido 2005). Data presented by the International Foundation for Economic Global Challenge (FIDEG) show a great gender gap in terms of credit, where 98% of the total amount of credit for the livestock sector was received by men. Furthermore, women, who represent 23% of farmers, only received 15% of agricultural and livestock credit, whereas men received 84% (CENAGRO 2012).

The nominal interest rate for agricultural loans is 24% per year. With an inflation rate of 7% in 2013, the real interest rate is about 17%, which is very high, and unsustainable for investing in a wide range of activities that require long-term investments to show results in increased outputs and enable loan repayments. FDL is currently the largest lender of livestock money to smallholders in Nicaragua, with around 2,500 clients (about 52% of the credit is allocated to the livestock sector). Most of the loans made to smallholder livestock farms by FDL vary between USD 2,000 and USD 5,000, and the most frequent client is a farmer who owns about twenty to thirty head of cattle. The risk of default or of falling behind on payments in this group is about 4%, and this remains unchanged for larger farms. However, the risk factor increases to about 8% for small livestock farmers who own between eight and twenty head of cattle, partially due to the increased risk of low productivity during prolonged dry seasons. The subsistence livestock farmers (i.e. those who own six to eight head) have the largest risk factor, about 25%, with an average loan amount of USD 930, because they depend mostly on cash crops for their survival.

4.2. Identification of possible options to address the barriers

4.2.1. Improving the level of knowledge and technical capacity of farmers

In order to meet the technical capacity demands and to support the rural sector, INTA formulated a University Communal Plan through alliances with the universities with the aim of promoting social innovation to expand coverage, induce generational change insert young people into the field and improve the connection with the higher education sector. Knowledge about new livestock production technologies and management innovations are generated by several actors in Nicaragua: (a) the Nicaraguan Institute of Agricultural Technology (INTA); (b) five universities: Universidad Nacional Agraria (UNA) in Managua, Escuela Internacional de Agricultura de Rivas (EIAR), Universidad Católica del Trópico Seco (UCTS) in Estelí, Universidad Nacional Autónoma de Nicaragua (UNAN) in Leon and Universidad de Ciencias Comerciales (UCC) in Managua; and (c) INATEC through technical schools called CETAs (Agricultural Technical Teaching Centers), which are distributed among the sixteen districts into which the country is divided. INTA has collaborative agreements with most of them, and this cooperation is usually secured through internships and bachelor's theses from students in animal science and veterinary faculties.

These education and research institutions play an important role in building the capacities of different actors in the sector. They participate through formal and informal education, the development of skills, the management of technological innovations, validation and transfers of knowledge to the productive sector, and improving methods and methodologies. In addition, technical institutes play an important role in building the capacity of young and future technicians and capacity-building providers. It is therefore important to disseminate the information on the Livestock LCDS's practices and methods for implementation to the different relevant educational and research institutions to ensure that these practices are included in their portfolios of capacity provided.

The existing capacity-building model in Nicaragua uses different modalities of capacity-building and/or technical assistance services, whose use depends on the different characteristics of the different groups of rural producers. The Basic Public Technical Assistance Services use mass media and free demonstrations to reach producers. INTA implements technology generation and transfer services through the so-called technology innovation and research farms using innovative producers, community seed banks, technology development centres (CDT) and experimental stations, which are physical units with infrastructure and equipment for the aforementioned services. The service covers provision of information, the organization of events (such as fairs) and training. Together with the producers, the technician makes a diagnosis of the farm, identifying existing problems and providing solutions to increase production. In conjunction with the producer, a production plan and training program is designed. A small unit at INTA, called research and technological innovation offices, coordinates this service. INTA is also in charge of the transfer of technology through the implementation of national and departmental fairs, national and regional conferences, field days, exchange tours, radio and television programs and the development and distribution of teaching materials. Finally, it is also in charge of technology transfers through the implementation of Field Schools for Farmers (ECAs). ECAs are field schools, generally enlisting approximately thirty participants per cycle. Through the existing ECAs, 17,000 participants have been enlisted and 12,000 assisted by means of the participation of 645 technicians and the institutions of the National System of Production, Consumption and Commerce (SNPCC), of which INTA is a member.

In terms of the direct technical capacity-building of producers, the Livestock Department of MEFCCA should intensify its efforts and provide technical assistance to the Livestock LCDS's practices, in coordination with those institutions related to consumption and trade production systems that have similar roles (INTA, IPSA, INATEC and MARENA), and in collaboration with the institutions present in the territories (NGOs). It will be crucial for the success of the Livestock LCDS to coordinate existing initiatives and to ensure that these initiatives contribute to the implementation of the LCDS's practices by providing information and training in their implementation and application.

4.2.2. Improving the administrative management of farms and the financial knowledge of farmers

Increased financial literacy is needed to increase the demand for and acceptance of funding. In addition, increased business and entrepreneurial capacities and knowledge of available financing opportunities at the cooperative level could improve farmers' confidence in the credit opportunities available. Producers' financial knowledge should also be stimulated through the design and provision of informational material for prospective borrowers, as well as through the provision of technical assistance and guidance on commercial management. The Livestock Department of MEFCCA should also, upon delivering technical assistance, refer farmers to the benefits of a credit diagnosis and of the monitoring of farms through BANCO PRODUZCAMOS. This could support producers in assessing investments and using credits through the elaboration of a farm plan, an investment plan and a system of monitoring.

While commercial and financial education is needed for both producers and cooperatives, it is also true that private-sector financial institutions need educating about sustainable livestock production. At present, the price of funding the livestock trade is high because of the lack of understanding of the processes on the ground. Lending institutions should invest in agricultural specialists to provide knowledge about these investments and to coordinate and establish a dialogue with MAG about farmer's activities and conditions, thus creating trust and understanding in the sector.

4.2.3. Improving access to credit

As implementing these practices will require investments from farmers, it is critical to improve access to credit at preferential rates for local producers. Funds, guarantees or other financing instruments to provide preferential credit lines may come from agreements with international financial institutions, national banks and the government.

It is necessary to make alliances with financial institutions, i.e. private banks and national rural banks, and capacitate them in the financial and long-term aspects of investing in the LCDS's practices. Guidelines should be provided for the design of forms of credit for investment in the farms in order to improve the criteria for preferential rates, as well as to define an incentive for investments in good practices.

Agricultural insurance and guarantees should also be strengthened to reduce the risks of the financial system and the livestock farmers, for example, by allowing land tenure, the farm's capital, wood, harvests, livestock and agricultural insurance to be used as collateral. This should be supported by an economic analysis of farms to identify financial resource needs and preferential interest rates, in addition to developing farm plans that integrate silvopastoral systems and other good practices, and their economic analysis to establish their profitability (cash flow behaviour and income with investment credits) and different interest rates.

5. Description of the Action Plan for the Livestock LCDS

5.1. Description of detailed activities to implement the mitigation measures included in the Livestock LCDS

As described earlier, a number of activities have already been implemented in the preparation of the Livestock LCDS, as well as a range of planned activities to overcome the barriers to implementing the practices and to ensure that the LCDS objectives are achieved. In the field of competitiveness and productive efficiency, technology plays an important role in accelerating and improving processes to raise the level of productivity in the form of the efficiency ratio of the product obtained (meat and milk). However, there is a shortage of technical personnel to motivate, facilitate and follow the producer in implementing these actions. The country needs improvements in the dissemination of knowledge about the proposed technological practices, and access to finance should also be improved. To achieve this, efficient technology transfer and technical assistance need to be expanded through field schools or Escuelas de campo (ECAs), which have already been used as a means to train and implement technologies in the field, as well as livestock-related interest groups.

As described above, a significant barrier to implementing these practices is the lack of access to long-term capacity-building services. The measure proposed to overcome this barrier is to strengthen the technical capacity-building system through a coordinated effort on the part of the Livestock Department of MEFCCA. However, it is important to build upon the existing systems to provide technical capacity such as the initiatives by INTA and other NGOs directed at small and medium livestock producers in order to take advantage of their established networks.

INTA would develop the necessary curriculum to train farmers to implement the practices. This would be based on the "best practice manual" developed through the support received by the Nordic Climate Facility (NCF). The informational material should be shared with technicians in the Livestock Department of MEFCCA and other active NGOs, and their technical staff should receive training in the new materials, ensuring that they can extend their knowledge to their members. It is important to mention that the material should not only focus on the implementation and operation of the practices, but include also financing opportunities, use of the MRV system and general knowledge regarding the good management of farms.

However, it is not sufficient to have well-trained staff; field schools are necessary too. Field schools and other strategies such as technological development centres (CDT), technological research and innovation farms are efficient transfer spaces that serve several purposes. They are places where both farmers and technical staff can be given access to information and practical training in implementing, operating and maintaining the different practices. They can also provide concrete examples of the practices to show how they actually work. Lastly, they can also serve as an assembly point for local farmers, thus indirectly addressing the general challenge of the low level of organization among farmers. Depending on the scale of the demand and the available national funds, a free or nominal fee could be charged, although international support could provide funds to secure free access for farmers, thus expanding the reach of the program.

It is important to highlight that the experiences of other countries, primarily Costa Rica and Honduras, show that, even though producers may be familiar with the practice and how to carry it out, this is not sufficient for them to implement it. The technical assistant often needs to visit the farm and work out a plan together with the farmer. This is naturally a time-intensive activity requiring substantial resources.

In terms of the financial aspects, the current nominal interest rate for agricultural loans of 24% (real interest rate of 17%) is too high for farmers. Implementing the proposed practices at rates of about 3–4% a year in real terms, when combined with the assistance of international finance or climate finance, could provide the necessary momentum for large-scale implementation of the LCDS. Due to the negative experience with defaulting loans and the high risk of non-repayment, especially from small and medium producers, risk guarantees could also be an appropriate vehicle to reduce the risk perception of banks and thus their interest rates.

After the large number of loan defaults in 2009, private banks that continue to provide credit to farmers have modified their conditions for receiving credit, the two most important modifications being:

- Frequency of payments. Before 2009, a producer who received a loan for steer fattening could repay the loan at the end of the cycle (i.e. after eighteen months). Now, banks oblige debtors to pay interest every six months to reduce the risk of default. In the case of cow–calf operations, which are usually covered by a two-year loan, banks are making producers pay interest monthly by using the income the latter receive from milk sales.
- On the brighter side, financial institutions have started to create their own units of technical assistance (TAU) to reduce the risk of default. Now, credit applications are accompanied by a visit to the farm by an animal scientist or veterinarian and a credit officer to assess the purpose of the loan with the producer and to estimate his or her capacity to repay it. If necessary, the vet can recommend an adjustment in the credit application to include a technological component that will help the producer to increase production or productivity and thus reduce the risk of default. In addition, periodic visits are now made by TAU staff to make sure that the credit is being used in accordance with the initial agreement and that production targets are being met. This increases transaction costs but at the same time creates trust between the borrower and the lending institution.

These conditions should also apply to investments in LCDS practices to create more trust on the part of the financiers, while also taking into account the desirability of longer repayment periods. Through MAG, the LCDS will therefore liaise with these credit institutions to present the expected economic benefits of the introduction of these practices.

To achieve the objective set out in Scenario 1, a total investment of USD 516,861,072 is needed for the initial investments by farmers. In Scenario 2, the sum falls to USD 394,691,206. Nevertheless, farmers and local and national credit institutions will be those providing most of the financing needed to implement the LCDS, but sourcing additional funding or guarantees to reduce interest rates will be crucial for the success of the LCDS.

Table 10. Breakdown of activities, timeline and responsible institutions

Activity	Timeframe	Responsible institutions	Funding	Status
Identification of Livestock LCDS priority practices in the livestock sector	2015-2016	UNEP DTU Partnership, Tropical Agronomy Centre (CATIE), INTA	Nordic Environment Finance Cooperation	Implemented
Analysis of GHG, sustainable development and economic impacts of the LCDS	2016-2017	UNEP DTU Partnership, Tropical Agronomy Centre (CATIE), INTA	Nordic Environment Finance Cooperation	Implemented
Development of educational material on the implementation of LCDS Practices	2017	CATIE	Nordic Environment Finance Cooperation	Implemented
Pilot capacity-building on LCDS practices to farmers	2016	CATIE	Nordic Environment Finance Cooperation	Implemented
Coordination with the National Office of Clean Development Mechanism (ONDL) with other mitigation and adaptation activities	2015-ongoing	SNPCC, ONDL	National Funds	Ongoing
Coordination with INTA and other NGOs for the alignment of current livestock programs with the Livestock LCDS	2017-2018	Support program for the livestock value chain of MEFCCA, INTA	FIRSA, national Funds	Planned
Integration of LCDS practices into Livestock Department of MEFCCA's Program of Agricultural Technology Transfer	2017-2018	INTA, MEFCCA	National Funds	Planned
Capacity-building of at least thirty technicians of the Livestock Department of MEFCCA technicians to enable training of staff to provide technical assistance to producers in field schools, based on educational material on the implementation of LCDS practices	2017-2020	INTA, MEFCCA	International funds	Planned

Capacity-building of 12,000 producers on Livestock LCDS practices, through the established 150 ECAs, based on educational material on the implementation of practices	2017- 2018	Support program for the livestock value chain of MEFCCA, CATIE	National and international funds	Partially implemented
Information dissemination to educational and research institutions based on LCDS documents and educational material on the implementation of LCDS Practices	2018	INTA	National Funds	Planned
Capacity-building to producers on financing needs and financing opportunities for the implementation of practices through field schools	2018-ongoing	Support program for the livestock value chain of MEFCCA	National and international funds	Planned
Liaising with the banking sector about farmer's activities and conditions to establish trust and understanding in the sector to stimulate access to credit	2018	MAG, PRODUZCAMOS	National Funds	Planned
Source international climate finance to expand the capacity-building component of the Livestock LCDS, thus expediting the process of implementation to achieve the optimistic LCDS scenario.	2018	SNPCC	International capacity-building support institutions	Planned
Source international climate finance to provide preferential loans to farmers through loan finance, risk guarantees or other financing mechanism, thus expediting the process of implementation to achieve the optimistic LCDS scenario.	2018-ongoing	SNPCC, MARENA	International Capacity Building support institutions	Planned

6. Estimate of national GHG impacts and sustainable development benefits

6.1. Baseline scenario in the absence of planned LCDS measures

A future increase in the number of dry months is expected according to current climate scenarios, and projections show that changes in the intra-annual patterns of dry months will be noticeable. This pattern will be disadvantageous for agricultural practices, which could reduce the availability of water in areas that are already degraded, such as León, the Sebaco Valley, Matagalpa and Jinotega (Cifuentes-Jara 2009). Given these vulnerability scenarios and the importance of productivity, good practices that promote adaptation and mitigation to climate change must be implemented urgently. Silvopastoral systems and good livestock practices envisaged by the Livestock LCDS are therefore highly relevant to the Ncaraguan livestock sector.

6.1.1.1. Estimating GHG emissions in a Business as Usual scenario

The BAU scenario elaborated by CATIE corresponds to the probable scenario in the projection of GHG emissions for the short and medium terms (2020 and 2030 respectively) assuming no interventions. In the livestock sector, the BAU scenario implies the absence of promotional instruments that are specifically designed to mitigate GHG emissions. This situation does not take into consideration a significant increase in the amount of cattle, thus limiting the economic development opportunities for farmers. This approach provides a reference with which to compare emissions assuming changes are made to improve the livestock sector's carbon intensity. It is important to note that, when emissions are compared between the baseline and alternative scenarios, the latter also assume a greater increase in the cattle herd, which is why the carbon intensity per head of cattle will be lower, even though emissions might be higher under the alternative scenarios. The BAU scenario therefore enables the potential impacts of national or regional policies to be reviewed a priori.

To estimate the impacts of the changes in livestock practices, the Livestock LCDS analyses each practice's contribution to emissions and its capacity to fix atmospheric carbon in biomass and soil as carbon sinks. The net emissions of livestock activities and practices are first estimated for the current situation, and projections for the future are made assuming a business as usual (BAU) scenario by analysing current trends. After establishing the BAU scenario, two alternative Livestock LCDS scenarios are constructed assuming changes in land use and improved livestock management practices. The methodology used consists of the following phases:

1. Estimates of greenhouse gas emissions (GHGs) by cattle farms.
2. Construction of the BAU scenario of GHG emissions according to the historical trends in land use and herd management.
3. Projected GHG emissions by simulating probable scenarios with LCDS implementation with reference to different levels of the impact of state policies and support provided.

The BAU scenario assumes a land-use change rate of 2.4 %/year, and a unitary emission of 1.8 tCO_2e/ha/year for Nicaragua was estimated based on the surveys conducted in the case studies. The simulation estimated total GHG emissions of 14.4 $MtCO_2e$ in 2016, increased in the BAU scenario to 21.7 $MtCO_2e$ in 2030. Taking net emissions and the GHG emission reductions caused by the carbon sinks in the livestock sector into account, the BAU scenario shows net emissions of 9.4 $MtCO_2e$ in 2016, expected to increase to 11.2 $MtCO_2e$ in 2030, a net increase of 1.9 $MtCO_2e$. These scenarios are aligned with the country trends described in the GHG inventory reports and the Second National Communication to the UNFCCC, showing an expected increase in emissions with BAU.

6.1.1.2. Methodology for BAU generation

The procedure that it was used to estimate the base line of the livestock sector is summarized in the following activities:

- Review and analysis of national statistics in the production and growth of the livestock sector.
- Review and analysis of instruments for the promotion of livestock development in each country.
- Review and analysis of statistics on land use and forest cover in each country.
- Review and analysis of agricultural censuses.
- Review of GHG emissions inventories according to the first and second communications on climate change for Nicaragua and its update for agriculture, land use and land-use change.

Future land use and her characteristics in the baseline situation were projected taking into account the history of land use and herds in the country. Current and future land use (2016 and 2017-2030) was estimated based on national studies to assess the annual rate of pasture change. This rate was applied to predict the area of pasture in 2016 and 2030. Land use per year was assessed using the area of use of the previous year and the exchange rate, estimated based on the reported data in the literature (Eq. 1).

$$A_{t+1} = A_t * \left(1 + \frac{Tc}{100}\right) \qquad \text{Eq. 1}$$

Where;

A_{t+1} : Land use area in year t+1 (has)
A_t : Land use area in year t (has)
T_c : Land use change rate (%/year)

Current GHG emissions were estimated based on surveys[3] made with producers. The estimate included the annual GHG emissions per unit area (tCO_2e/ha/year). GHG emissions for the country were calculated as a weighted average by multiplying the emissions of each farm's pasture with its area. Each farm's emissions were added and divided into the sum of the pasture area of all the farms surveyed (Eq. 2). GHG emissions in each year of the baseline were estimated as the product of the estimated pasture and the average emissions estimated on the interviewed farms (Eq. 3).

$$E_u = \frac{\sum(A_p * E_f)}{\sum A_p} \qquad \text{Eq. 2}$$

Where;

E_u : Emissions unit (tCO_2e/has/year)
A_p : Pasture area (has)
E_f : GHG emissions from the farm (tCO_2e/has/year)

3 A representative selection of two hundred meat, dairy and double-purpose producers were consulted for detailed data collection. In these surveys, the characteristics of the farm, herd and management that determine the actual carbon footprint were identified. GHG emissions were estimated by including all activities that generate GHG gases. In these activities, the characteristics of the herd, the type of food provided, and the use of fossil fuels, lime and electricity were included. Furthermore, the production of milk per cow and the number of animals in the herd were taken into account.

$$E_t = A_p * E_u$$ Eq. 3

Where;

E_t : Emissions unit (tCO_2e/year)

A_p : Pasture area (has)

E_f : GHG emissions from the farm (tCO_2e/has/year)

A land-use change rate of 2.4%/year was assumed for Nicaragua. In the same way, a unitary emission rate of 2.9 tCO_2e /ha/year was estimated from the surveys conducted in the case studies.

The BAU calculations were carried out using a literature review and data collected from surveys administered to livestock producers. The variables taken into account regarding GHG emissions were the following:

1. **Application of nitrogen fertilizers and carbonates.** The amounts of nitrogen and carbonates applied to pastures and other forage systems were estimated. An emissions factor of nitrogen application of N_2O 0.01 kg / kg and 0.12 N and 0.122 kg C / kg and magnesium calcium carbonate respectively was considered (IPCC, 2006). N concentrations and CaO in each fertilizer employed and in the soil were used.
2. **Use of fossil fuels.** Fossil fuels used in the management of livestock farms, such as the use of motor pumps, scythes, chain saws and tractors, were estimated. The emissions factors used were 0.00283 and 0.00233 tCO_2e /l of diesel and petrol respectively (IPCC, 2006).
3. **Use of electricity.** The total amount of electricity used on farms was investigated, being later converted into GHG emissions using the grid emissions factor for each country according to national conditions of power generation.
4. **Emissions from livestock management.** GHG emissions were estimated in terms of the enteric fermentation of livestock and manure management. Producers or directors were consulted for the details of livestock manure management, and the emissions factors suggested by the IPCC (2006) were used. Estimates were made using level 2 (Tier 2). In this case, the emissions per productive and dry cow, calf, heifer and bull unit were estimated. The land-use systems where animals or forage is produced to provide animals with food were also taken into account.

The latest national GHG inventories and herd inventory data were consulted. Based on these data, GHG emissions per animal unit were estimated for a one-year period. Nicaragua had a cattle herd of 5.2 million heads (BCN and MAG, 2015). In 2000, it was estimated that cattle were responsible for 7.1 $MtCO_2e$, of which about 4.8 $MtCO_2e$ were attributed to cattle enteric fermentation and manure management (assuming that 50% of N_2O emissions from agriculture correspond to livestock) (MARENA, 2008).

No statistical difference ($p> 0.05$) was found in herd size at different levels of intensification in Nicaragua (49.5 AU / estate; Table 17). Farm size affects the level of intensification, so that small farms are more intensive than medium or large farms (1.5 ± 0.1 vs 0.9 ± 0.0 vs 0.5 ± 0.0 AU / has, respectively (Table 11).

Table 11. Characteristics of herds, land use and greenhouse gas emissions of average farms, with three levels of intensification in Matagalpa, Nicaragua

	Intensification level		
	Low (<1.4 AU/has)	**Medium (1.4-2.3 AU/has)**	**High (>2.3 AU/has)**
Herd size (AU)	53.8 ± 4.8 a	45.5 ± 3.6 a	49.2 ± 4.9 a
Animal stock (AU/has)	0.5 ± 0.01 c	0.9 ± 0.01 b	1.5 ± 0.1 a
Land use (has)			
Natural pastures	80.9 ± 8.6 a	36.9 ± 3.1 b	22.9 ± 2.2 b
Improved pastures	37.0 ± 6.3 a	17.0 ± 2.6 b	13.1 ± 3.0 b
Fodder banks	0.8 ± 0.3 a	1.1 ± 0.3 a	0.9 ± 0.2 a
Agricultural crops	2.0 ± 0.3 a	2.1 ± 0.3 a	2.0 ± 0.2 a
Forest plantations	1.7 ± 0.5 a	1.2 ± 0.4 a	1.7 ± 0.7 a
Forests	7.2 ± 2.4 a	3.4 ± 0.7 ab	2.2 ± 0.4 b
Live fences (km)	6.0 ± 1.0 a	4.1 ± 0.8 a	4.6 ± 0.8 a
Total	131.6 ± 12.7 a	62.8 ± 5.0 b	45.3 ± 4.3 b
Total emissions (tCO_2e/has/year)	1.5 ± 0.4 ab	2.3 ± 0.6 b	3.3 ± 0.3 a

Nicaraguan livestock farms were found to have low levels of livestock intensification, expressed in terms of animal stock (1.0 ± 0.0 AU/ha), which explains the high proportion of areas of native pastures (53% of total). Despite this, Nicaraguan farms have begun to establish fodder banks, which are on average 0.9 ha/farm. The highly intensive farms presented an animal stock exceeding 81% and 214% of median and low intensification (1.5 ± 0.1 vs 0.9 ± 0.0 vs 0.5 ± 0.0 AU / has, respectively). No clear relation was found between the use of live fences and the level of intensification, though Nicaraguan farms have a total average length of these linear systems of 4.6 km/farm. Archetypal livestock farms in Nicaragua presented a carbon footprint average of 2.4 tCO_2e/ha/year. A tendency to increase emissions by increasing the intensification of farms was also observed. However, GHG emissions per animal unit were statistically different ($p < 0.05$) on farms with different levels of intensification in Nicaragua (3.0 vs 2.6 vs 2.2 tCO_2e/AU/year for farms with low, medium and high intensification respectively). A reduction in net emissions per animal was detected, by increasing intensification.

6.2. Livestock LCDS GHG emissions reduction scenarios

The Livestock LCDS, by introducing the identified and prioritized practices, and through its alignment with national policies, sectoral strategies and action plans, will function as a synergetic effort between agricultural policies and policies that reduce deforestation, reduce emissions, increase the number of carbon sinks, protect biodiversity and water resources, and contribute to improving the lives of farmers. The Livestock LCDS presents two scenarios, depending on the efficiency of national policies and the availability of international support.

Scenario 1. Changing 30% of the native pasture area to establish good management practices and adopting improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 1%/y.

Scenario 2: Changing 20% of the native pasture area to establish good management practices and adopting improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 0.5%/y.

6.2.1. Estimates of GHG emissions reductions in the LCDS scenario

To establish net GHG emissions and other impacts under the LCDS scenarios, CATIE applied the following parameters:

a) Description of the herd: number and breed of animals.

b) Productivity: levels of average daily milk production per animal and per farm and its fat and protein contents.

c) Land uses: the area in productive use and land-use systems that produce fodder, especially pastures, which are handled on the farm. Grazing management system, such as rest and occupation periods and stocking.

d) Productivity of silvopastoral systems: the production of fodder banks and other silvopastoral systems established on farms, as well as cutting and recovery periods.

e) Description of the diet: digestibility (IVDMD) and crude protein (CP) of food were determined, including fodder in diets.

f) Description of inputs: priority was given to nitrogenous fertilizers, consumption of fossil fuels and energy sources, depending on the energy matrix of each country.

g) Herd management: principally the herd's nutritional management, which affects GHG emissions because of increased animal movement in times of forage scarcity. This situation directly affects GHG levels, increasing overgrazing and pasture degradation processes.

Table 12 illustrates the emissions, carbon fixation and net emissions of livestock land-use systems used in the simulations. Changes in the carbon footprint as an effect of land-use systems include other good practices, such as good manure management. In this scenario, changes in land use depend on the size of farms, and small farms are expected to establish smaller areas of improved systems than larger farms.

Table 12. Animal stocking and carbon footprint characteristics in livestock land uses in Nicaragua

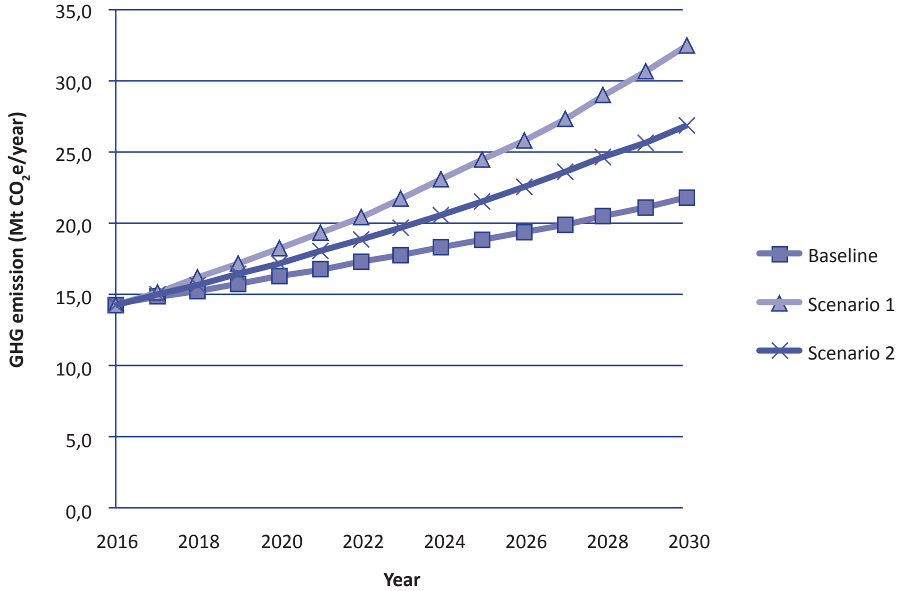
Land-use system	**Animal stock (animal unit/ha)**	**Carbon fixation rate**	**GHG emissions**	**Carbon footprint**
		$tCO_2e/ha/y$		
Native pastures	0.9	0.0	1.8	-1.8
Native pastures with trees	1.2	7.8	1.6	6.2
Improved pastures	1.5	0.0	2.9	-2.9
Fodder Banks	3.0	10.0	5.0	5.0
Intensive silvopastoral systems	3.0	31.4	4.5	26.9
Live fences	N/A	15.0	4.0	11.0

Elaborated by CATIE. Source: Andrade and Tobar (unpublished data); Messa (2009)

In addition to these production systems, there are other management practices that modify this balance. Biogas production changes this balance, assuming that a cow can produce 1.73 m^3 biogas/day, which corresponds to 9.0 tCO_2e/year (Casas-Prieto et al. 2009). Likewise, organic fertilization and use of legumes can reduce GHG emissions by 0.7 Mg CO_2e/ha/year, which contributes to improving the carbon footprint of land-use systems (Snyder et al. 2008).

The simulation of the two scenarios of land-use change and implementation of good practices also show increasing GHG emissions, reaching 26.9 $MtCO_2e$/year for scenario 2 and 32.5 $MtCO_2e$/year for scenario 1 (Figure 16). This increase in GHG emissions can be attributed to a higher stocking rate in improved cattle production systems, with improved pastures, fodder banks and intensive silvopastoral systems. The increases in cattle were estimated assuming an intensification of cattle production facilitated by the improved cattle production systems, thus aligning environmentally sustainable practices with an increase in production and allowing farmers sustainable economic development. The proposed practices are congruent with national policies and are applied to the improvement of the national livestock sectors. The cattle stock is estimated to increase from 4,168,000 to 7,935,000.

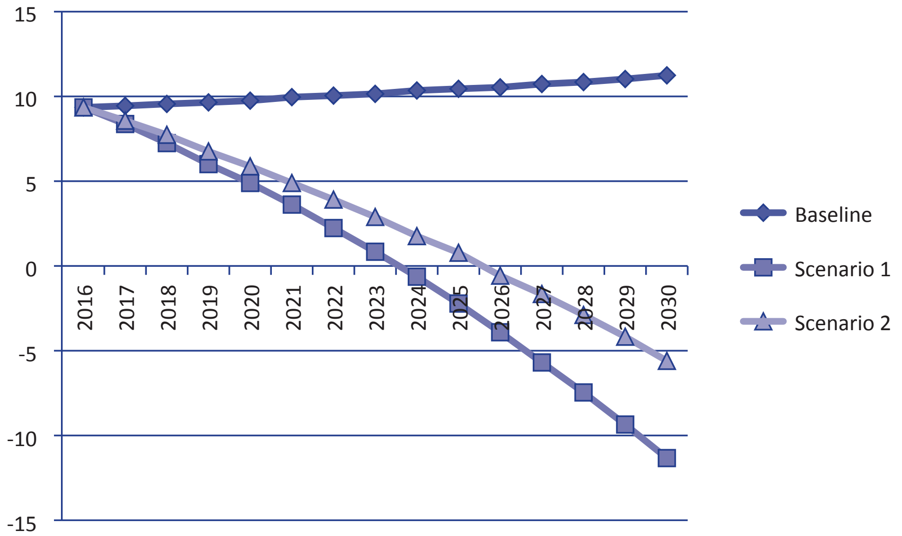
Figure 16. Livestock sector GHG emissions in the BAU and two LCDS scenarios



Elaborated by CATIE. Source: Tobar, Andrade, Suri and Rivera, 2016 (unpublished data)

Taking carbon fixation into the equation, and illustrating the net GHG emissions, 9.4 $MtCO_2e$/year of net emissions were calculated for the baseline in 2016. Following current trends in the sector assuming no state intervention, total net emissions are expected to be 11.2 $MtCO_2e$/year in 2030, representing a net increase of 1.9 $MtCO_2e$/year, with cumulative emissions of 153 $MtCO_2e$ between 2016 and 2030 in the BAU scenario. Net emissions would decrease in the Livestock LCDS scenarios with state policies promoting improvements to livestock practices in the country, assuming increases in the number of cattle. Net cumulative emission reductions would be 152 $MtCO_2e$ over the next fourteen years under scenario 1, and 115 $MtCO_2e$ under scenario 2. This indicates that the livestock sector in Nicaragua could become a net carbon sink in 2024 under scenario 1 and in 2026 under scenario 2.

Figure 17. Net emissions for the livestock sector, taking into account the LCDS mitigation scenarios



Elaborated by CATIE. Source: Tobar, Andrade, Suri and Rivera, 2016 (unpublished data)

6.2.1.1. Methodology for establishing emissions from LCDS scenarios

In the development of both sustainability scenarios (scenarios 1 and 2), a projection of management changes in livestock farms was made, including changes in land use, which causes changes in the farm's carbon footprint. Organic fertilization practices were associated with native pastures, while biodigesters were associated with manure production from a determined number of animals in each herd. Sustainability scenarios are described below.

Pasture area and GHG emissions in the baseline were estimated first, based on the unitary emissions results from the survey administered to producers (Eq. 2). This represents the situation presented for 2016. Total emissions in a year are given in the form of the product of the pasture area (ha) and unitary emissions (tCO_2e /ha /year; Eq. 3). Changes in the BAU were estimated according to current development drivers and trends in the sector and policy guidelines.

The proposed alternative scenarios required estimating the area of pasture and other forage production systems, as well as unitary GHG emissions. The area of converted land use was estimated by assuming a reduction in the area of native pasture, according to the established baseline scenario, and a replacement with improved pastures, scattered trees in pastures, fodder banks and intensive silvopastoral systems. Unitary GHG emissions were estimated similarly to area estimates for each year. Thus, estimates with the 2016 emissions were made first, being calculated for the following year according to the change rates in them. The total change value was divided by the simulation time (fourteen years) to estimate athen annual change rate in unitary emissions.

Net carbon emissions reductions caused by the introduction of alternative practices were calculated as the difference between the two assumed mitigation scenarios and the baseline of each typical farm at the country level, including intensification of the herds (Eq. 4). Total GHG emissions were estimated during the simulation period (2016–2030) for each scenario and in the baseline, and the carbon footprint of each scenario was calculated as the subtraction of overall emissions between the scenario and the baseline. In these mitigation scenarios, public policies that affect livestock were also taken into account. Calculation of each scenario's impact on GHG emissions for this sector can be summarized by means of the following equation:

$$A_c = \sum E_{tbi} - \sum E_{tpi} \qquad \text{Eq. 4}$$

Where:

A_c : Net emissions (tCO_2e)
E_{tbi} : Total baseline net emissions for year i (tCO_2e/farm/year)
E_{tpi} : Total net emissions in the project's situation for year i (tCO_2e/farm/year)

6.3. Description of the benefits in terms of sustainable development

Livestock is one of the main productive sectors in Nicaragua, and is also one of main sources of employment in rural areas. As described in Chapter 3, implementation of the prioritized practices will contribute to improving drought resistance, adapting to the changing climate and making the sector more resilient in accordance with the expectation of prolonged drought seasons and increasingly intense precipitation, while allowing for an increase in cattle production and productivity.

Surface run-off is expected to be reduced by adopting silvopastoral systems (Rios et al., 2006). Likewise, the protection of riparian forests and watersheds in livestock farms allows improvements to be made in the biological, physical and chemical conditions of water (Chara et al., 2007), thus improving both animal and farm families' welfare. Silvopastoral systems also allow product revenue to be improved as a result of increased productivity and the development of new products such as wood (Andrade et al. 2008a). The benefits of the incorporation and retention of trees and shrubs in pastures are reflected in the production of wooden goods such as timber, poles and firewood, which can generate revenue increases in livestock farms of between 15% and 35% (Holmann and Estrada, 1997; Botero et al., 1999). Tree shade in pastures is also associated with increases in milk production and cattle weight gain of between 13% and 28% (Souza de Abreu, 2002, Betancourt et al, 2003; Restrepo-Saenz et al, 2004), which is attributed to the reduction of heat stress and the increase in voluntary animal consumption (Souza de Abreu 2002). The use of live fences, established to reduce the costs of traditional dead fencing (Holmann et al., 1992), also provides high-quality forage for animals (Ibrahim et al., 1999). Implementation of biodigesters contributes to savings in energy use for cooking, while providing an excellent fertilizer that can be used to optimize the farm's outputs. The following presents the sustainable development benefits of the LCDS's practices in terms of their social, environmental and economic aspects.

6.3.1. Social benefits: human benefits

Implementation of the capacity-building component of the LCDS will in general provide training for technicians from public and private institutions and stimulate producer-to-producer learning through the exchange of experiences, generally enhancing the skills and capacities of the members of local communities. Providing capacity-building to farmers will give families improved skills and better control and security over their welfare. The following lists the additional benefits related to each specific practice.

Implementation of silvopastoral systems and good management practices can improve the profitability and productivity of the farms and at the same time reduce both emissions and the vulnerability of this activity to climate change. Silvopastoral systems, combined with crop rotation and forage banks and silage, allow the diversification of feed for livestock production, thus increasing the income and welfare of producers and their families by improving the quality and availability of food for domestic animals throughout the year through the fruit and forage obtained from trees and shrubs.

By its very nature, the gas produced by the biodigester does not produce odours or unpleasant smoke like firewood cooking. Family members will experience improved health in the form of reducing respiratory and eye diseases – especially the women in charge of cooking with firewood and the small children who are always in the care of the mother – through the reduction of air pollutants when cooking with firewood is replaced with biogas. Manure management will also have positive health implications by improving sanitary conditions in the area, thus reducing the spread of parasites and bacteria.

The production of organic fertilizers will create savings, since producers will not be dependent on chemical fertilizers, while also providing additional labour for the family, output of which will be directly invested in their farm. In case of overproduction, the organic fertilizer will also provide income diversification through the sale of compost and liquid fertilizer to the community.

6.3.2. Environmental benefits

The management of silvopastoral systems favours improved adaptation and mitigation practices regarding climate change, diversifies production systems, intensifies land use and counteracts the environmental impacts generated by traditional livestock production systems. Increased tree cover and live fences provide corridors for wildlife, promoting bioconservation and improving biodiversity.

Introducing biodigesters reduces the pressure on forests by decreasing the consumption of firewood by more than 50% for each farm implementing the technology. This promotes the conservation of the fauna and flora and helps protect the water sources, as well as helping maintain the quality of the farm's water and recycling nutrients by using the sludge as fertilizer.

Biofertilizers allow manure to be used, thus maximizing the use of organic waste materials from livestock and agriculture. This fertilizer is a source of nutrients that are released gradually according to the needs of the plants, or in this case, the pastures. In addition, manure improves organic matter content, soil characteristics and water retention and prevents erosion. The use of organic fertilizers improves the physical, chemical and biological properties of the soil.

6.3.3. Economic benefits

The economic benefits of introducing sustainable practices are evident. Supplementation with woody tree forage has had a great impact on dual-purpose systems during dry seasons. Experience shows that using, for example, sugar cane with Cratylia can increase production by 100% compared to the traditional diet, which consists of Hyperrhenia rufa grazing. In trials, use of C. argentea banks has shown that they can contribute to increasing farmers' net incomes by 47% (milk price at USD 0.3/kg) compared to when only H. rufa pastures are used. With respect to meat production, similar increases range from 27% to 87% compared to traditional diets consisting only of grazing (base diet) (Roa et al. 2000; Burle et al. 2003). The following lists the economic benefits of the respective practices.

Management of silvopastoral systems diversifies production systems, reduces dependence on external inputs, intensifies land use, counteracts the degradation impacts generated by traditional livestock production systems and contributes to reducing investment costs in crops or pastures as the purchasing of fertilizers decreases.

Introducing biodigesters saves time in cutting, chopping and gathering firewood, time that can be used for another activity. Alternatively the money earmarked for the purchase of firewood can be used for other family needs. If liquefied gas or propane is used, it can easily be replaced by the biogas produced. The liquid sludge is an excellent fertilizer that will reduce fertilizer costs for the farm.

The production and use of organic fertilizers increase the amounts of nutrients that can be assimilated by plants, thus improving yields and having a positive impact on cattle growth and milk production, while improving the general condition of the soil. The availability of fertilizers saves money, as farmers will not need to buy chemical fertilizers. In case of overproduction, sales can generate additional income. The availability of organic fertilizers also facilitates the production of organic products that can be sold at higher prices.

6.3.3.1. Economic and financial analysis in a case study of Via Lactea, Nicaragua

To establish more exactly the economic impact of implementing the Livestock LCDS, a feasibility study was conducted by CATIE for the region of Vía Lactea to determine the financial attractiveness and risks associated with the LCDS. In the first stage, fluctuations in cash flow over a one-year period were analysed, noting the differences in income between the dry and rainy seasons. Additionally, a literature review was conducted to allow different scenarios for implementation of the Livestock LCDS to be drawn up because of the difficulty in obtaining financial information for small farmers and the consequent information deficit in conducting a complex financial analysis. The impact of the LCDS will be more closely monitored and its expected benefits adjusted as it is implemented and initial real impact data are gathered.

A simulation of prospective cash flows for the ten-year period from 2016 to 2025 was conducted to evaluate the financial viability of silvopastoral and good management practices in the region. Keeping in mind the variations in the investment capacities and motivations of farmers, three different scenarios were used to compare the economic viability of three different situations for every farmer.

Producers were grouped on the basis of the size of farms, land use and animal stock. Table 13 illustrates the classification of the groups used in this model.

Table 13. Grouping of producers on the basis of level of intensification

Intensification	Area	Category
Low intensification	Less than 50 hectares	Group 1
Medium intensification	Between 50 and 100 hectares	Group 2
High intensification	More than 100 hectares	Group 3

The analysis was based on the scenarios for the LCDS impact on GHGs explained in section 6.2 and the practices presented in Chapter 3, following the assumptions described here:

a) The rate for discounting yearly cash flows to calculate NPV is 10%.

b) The inflation rate used for Nicaragua is 3.99%/y, coherent with World Bank (2015) data.

c) The rate of interest on yearly savings is 7.5%, coherent with the rate of interest offered by national banks.

d) Price of milk per litre in Nicaragua is USD 0.58 as per national prices.

e) Prices of silvopastoral and good management practices are approximated from workshops conducted with producers, from which the actual rate of inputs were also averaged.

f) All activities are assumed to be established at the beginning of every year.

g) The total number of animals is assumed to be constant for the period.

h) Producers will continue raising livestock on their farms in the future, and they will not switch to other agricultural practices or land uses.

Biodigesters represent a large capital investment, given the financial capacity of Nicaraguan farmers, but at the same time they are of great benefit to the environment and to farmers. It was assumed that farmers will establish biodigesters on their farms by 2018, so to reduce the impact of a big cash outflow of USD 1,139, it was further assumed that farmers will set aside USD 200 in the first two years (2016 and 2017) in a savings account that would earn an interest rate of 7.5% per annum, consequently reducing the investment needed in 2018. The maintenance costs of a biodigester were estimated at USD 100 /y starting in 2019.

The rotation and division of pastures and associated silvopastoral practices posed a big investment for some farmer, but a negligible investment for other farmers, whether in relation to either an abundance or a lack of natural pastures. It was assumed that farmers would start converting one tenth of the required pastures every year from 2016, thereby spreading the weight of the investment equally between ten years. The cost of converting one hectare of pasture was assessed at USD 230.32 and the cost of maintenance of one hectare at USD 60 every three years. The maintenance costs of already improved pastures were also USD 60 every three years. Consequently, there would be a big cash outflow every third year (2018, 2021, 2024). The area for establishing live fences depended on the size of farms, with small-scale farmers establishing 4 km, medium-scale farmers 8 km and large-scale farmers 12 km of live fences over a span of ten years. It was assumed that farmers would start establishing live fences from 2016 and that the cost of establishing 1 km of live fencing was approximately USD 1,332. It was further assumed that farmers would establish one tenth of the required live fences every year. The maintenance costs of live fences were approximately USD 50 per annum.

As a result of further improved nourishment from the silvopastoral and good management practices prioritized in 2017, an increment of two kilograms of milk production per cow per day was assumed. In scenario 1 there would be an increment of four kilograms of milk production per cow per day in 2018 and three kilograms of milk production per cow per day in scenario 2. Since many prioritized practices would have been established by 2018 leading to improved farm production, it is assumed that milk production will be maintained at a constant incremented level of four and three kilograms of milk per cow per day in scenarios 1 and 2 respectively throughout the period of simulation. Hence, the cash inflows in this economic model represent farmers' incomes from milk production and include the yearly increments.

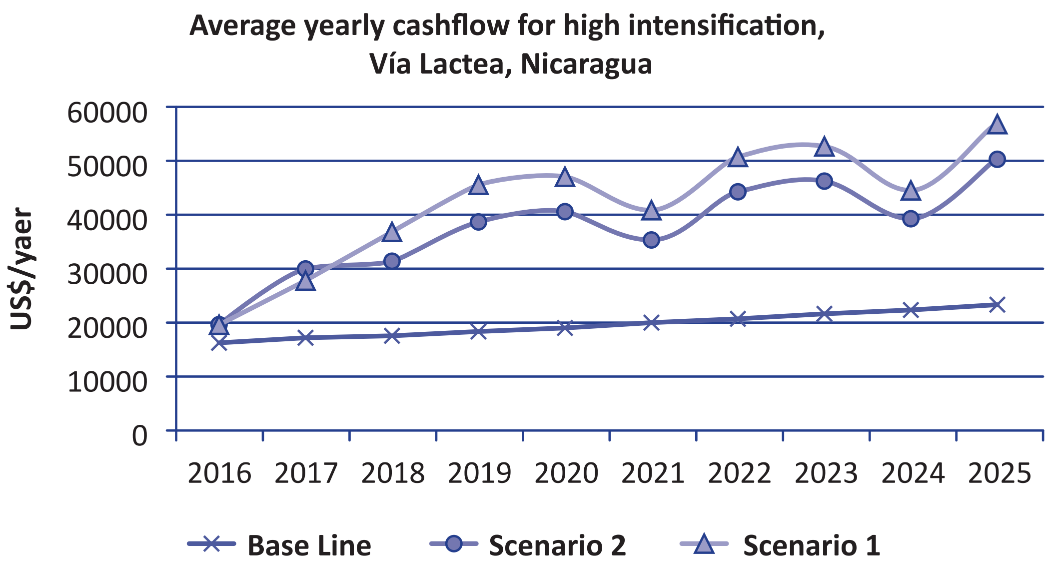
To mirror the effects of the increment in organic fertilizers, a reduction in the use of chemical fertilizers by 30% in the first year (2016), 60% in the second year (2017), and their complete elimination by 2018 was assumed, as well as their maintenance from 2018 onwards. Consequently, this reduced the costs of farm inputs every year.

The adaptation of silvopastoral systems and good management practices in low-, medium- and high-intensity farms in Nicaragua will also lead to job creation at the micro-level. Due to increased cash inflows and the better economic status of farming households, farmers will be able to recruit additional labour (both permanent and temporary) for specific jobs on the farm such as milking the cows, maintaining pastures, maintaining cleanliness and hygiene, etc. This new labour demand will lead to job creation in the local economy.

For the region of Via Lactea, the model concluded that the practices are economically viable and that investment in such practices is profitable for farmers in both the short and long terms. High-intensification farms in general generate higher cash flows compared to medium and low intensification operations, and cash flows from scenarios 1 and 2 are higher than the base-line cash flow. An important result worth noting is that medium- and low-level intensification generates more stable yearly cash flows in Nicaragua than high-intensity operations.

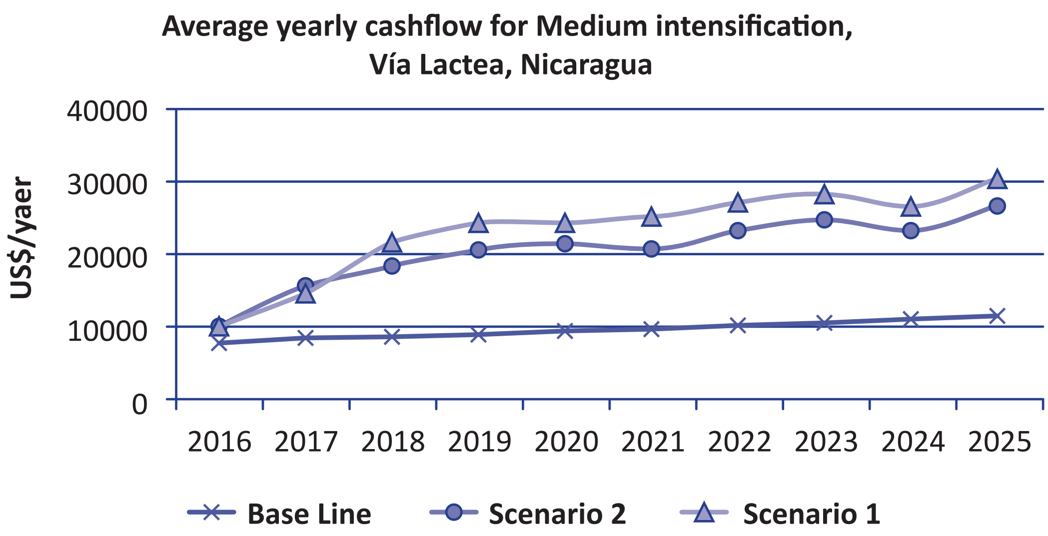
The depression seen in Figure 18, Figure 19 and Figure 20 for 2021 and 2024 represents the additional costs of maintaining improved pastures. Overall, the yearly cash flow analysis concludes that investment in silvopastoral and good management practices generates more benefits than it incurs costs and supports the application of such practices across the country. In particular the analysis advises farmers in Nicaragua to invest in accordance with scenario 1, as this results in greater cash inflows than in scenario 2.

Figure 18. Average yearly cash flows for base line, scenarios 1 and 2, for the high intensification group in Via Lactea, Nicaragua



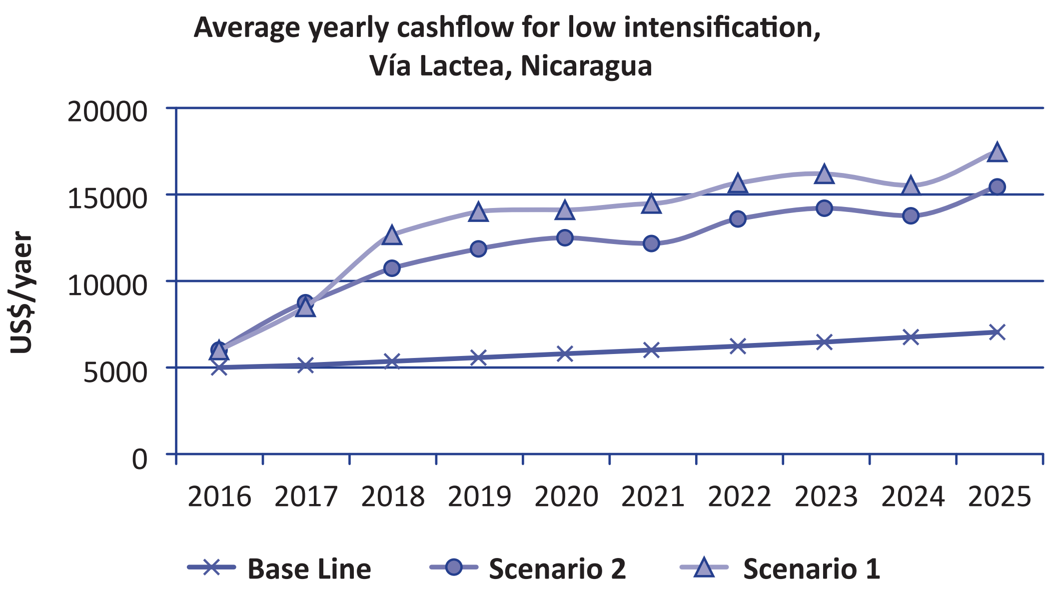
The x axis represents the time (years of the project), and the y axis represents cash flows in US$/year.

Figure 19. Average yearly cash flows for base line, scenario 1 and scenario 2 for the medium intensification group.



The x axis represents the time (years of the project), and the y axis represents cash flows in US$/year.

Figure 20 Average yearly cash flows for base line, scenario 1 and scenario 2 for the low intensification group.



The x axis represents the time (years of the project), and the y axis represents cash flows in US$/year.

The analysis of the benefit/cost (B/C) ratio (Table 14) shows that scenario 1 offers a more lucrative investment for farmers at all levels of intensity in Nicaragua. This signifies that scenario 1 provides more proportional benefits than it incurs costs compared to scenario 2. There is also a logical increase in the B/C ratio from lower to higher intensity operations in the base line and scenario 2. One possible reason for this is the operation of economies of scale, since costs are reduced with increases in production. In scenario 1, the medium level of intensification has the highest B/C ratio, though only slightly higher than the B/C ratio of the high intensification group. As it can be seen in Table 14, the B/C ratio is higher for the base line scenario. A longer term study will show an increase in the B/C ratio of investments since farmers will no longer need to invest more money in the prioritized practices, reducing costs as a result.

Table 14. Average B/C ratio for all groups of intensification for base line, scenario 1 and scenario 2 in Nicaragua

Average B/C ratio	Base line	Scenario 1	Scenario 2
High intensification	8.51	4.17	4.15
Medium intensification	7.17	4.18	4.06
Low intensification	5.48	4.12	3.90

For any level of intensification in scenarios 1 and 2, the net present value (NPV) is substantially greater than the NPV of the base line. This finding is important in evaluating the economic viability of silvopastoral and good management practices, as it clearly supports the adaptation of such practices from an economic point of view. As can be seen in Table 15, scenario 1 clearly offers a better investment for farmers, since they will earn more due to the increase in milk production compared to scenario 2. For the low intensification group, scenarios 1 and 2 show NPV values of 118% and 95% respectively greater than present values in the base line. For the medium intensification group the proportions are 135% and 108% respectively greater than the base line's present values, and for the high intensification group 106% and 86%. This substantial difference in present values suggests that for economic reasons these practices should be adopted by farms in Nicaragua at all levels of intensity. It also suggests that present values increase almost twofold going from low to medium and medium to high levels of intensification. The reason for this exponential growth is the increasing efficiency of the operation and management of farms with increasing intensity. Both the B/C and the NPV analysis support the economic benefits of the investment in silvopastoral and good management practices in Nicaragua. The economic analysis specifically concludes that scenario 1 offers a better investment for farmers since there are greater cash inflows and higher benefits due to increased milk production compared to scenario 2.

Table 15. Average NPV of all groups of intensification for base line, scenario 1 and scenario 2 in Nicaragua

Average NPV	Base line	Scenario 1	Scenario 2
High intensification	117,780 USD	242,815 USD	218,740 USD
Medium intensification	56,274 USD	132,327 USD	117,543 USD
Low intensification	35,358 USD	77,317 USD	68,949 USD

6.4. Description of the transformational impact of LCDS, including its sustainability

As described in the above sections, the LCDS is expected to make a large contribution to sustainable development, but its long-term contribution will go beyond providing specific co-benefits to be transformative in nature for the whole sector and parts of society. In terms of GHG emissions, over time the LCDS will contribute to drastically changing the current development path of increasing emissions within this sector, reversing this trend and transforming the sector into a carbon sink. This abrupt transformation is expected to bring increased productivity for farmers and ensure the long-term sustainable management of farm production systems, thus ensuring that farmers will not revert back to their former practices once the benefits from implementation of the practices start to materialize. This reorientation of development trends in the sector illustrates the wide transformational impact that the introduction of the LCDS's sustainable practices will have in the long term.

Some farmers have already started to implement some of the practices described in the LCDS, partially thanks to their own entrepreneurial interests, but also to public- and donor-implementation initiatives. However, these initiatives remain scattered and uncoordinated efforts, which have not had a transformational impact so far. Thanks to the activities envisaged in the LCDS Action Plan, which are aimed at overcoming the identified barriers to producers implementing these practices, the implementation of sustainable practices will require a concerted nation-wide effort. This will ensure a rapid up-take of sustainable practices that would not have materialized in the absence of the LCDS, thus making the latter's transformational impact not only abrupt and irreversible in terms changes to the development path, but also swifter than could have been expected without the LCDS.

The transformational impact of the LCDS is also illustrated by the contribution the implementation of its practices will have on supporting the achievement of the Sustainable Development Goals and targets. Specifically relevant are the following goals and targets whose MRV and indicators are described in more detail in the next chapter:

Goal	Target
Goal 1. End poverty in all its forms everywhere.	Target 1.2. By 2030, reduce by at least half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
	Target 1.a. Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions.
Goal 2.: End hunger, achieve food security and improved nutrition and promote sustain-able agriculture.	Target 2.1. By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
	Target 2.3. By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
	Target 2.4. By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and progressively improve land and soil quality
	Target: 2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technological development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.
Goal 3. Ensure healthy lives and promote well-being for all at all ages.	Target 3.9. By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.

Goal 6. Ensure availability and sustainable management of water and sanitation for all.	Target 6.3. By 2030, improve water quality by reducing pollution, eliminating dumping, minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.
	Target 6.4. By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of fresh water to address water scarcity and substantially reduce the number of people suffering from water scarcity.
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.	Target 7.1. By 2030, ensure universal access to affordable, reliable and modern energy services.
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.	Target 8.4. Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation in accordance with the ten-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.
Goal 10. Reduce inequality within and among countries.	Target 10.1. By 2030, progressively achieve and sustain income growth of the bottom forty percent of the population at a rate higher than the national average.
Goal 12. Ensure sustainable consumption and production patterns.	Target 12.2. By 2030, achieve the sustainable management and efficient use of natural resources.
Goal 13. Take urgent action to combat climate change and its impacts.	Target 13.2. Integrate climate change measures into national policies, strategies and planning.
	Target 13.3. Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.	Target 15.1. By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.
	Target 15.2. By 2020, promote the implementation of the sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.
	Target 15.3. By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.

7. Measuring, Reporting and Verification

7.1. Description of key parameters to assess progress with implementation of the Livestock LCDS

The following parameters will be monitored by INTA upon the delivery of support to farmers by the Livestock Department of MEFCCA, and will be reported by farmers annually.

The following parameters will be used to measure the progress of LCDS implementation in terms of GHG emissions reductions from the implementation of silvopastoral management practices, organic fertilizers and nutritional blocks:

Classification of farms upon receiving support, including:

- total area (ha),
- number of cattle
- current production system and practices
- use and application of fertilizers
- state of soil and above- and below-soil carbon, degraded, slightly degraded, non-degraded

Number of farms implementing the different practices and their extent:

- division of pastures, according to technical assistance
- use of forage banks, species and has cultivated
- establishment of live fences, species and has cultivated
- planting of scattered trees and/or shrubs in the paddocks, species and has cultivated
- production of biofertilizer in kg/liters, and source of fertilizer (biodigester sludge, other inputs other than manure)
- production of nutritional blocks in kg and classification of inputs

For emissions reductions caused by the introduction of biodigesters in farms, the following parameters will be monitored:

- number of farms implementing the technology
- number of cattle on the farm and type of cattle (dairy or other)
- use of fossil fuel for cooking/lighting prior to biodigester implementation

To assess the carbon intensity of the production, emissions in the baseline and after the implementation of practices will be compared to the productivity of the farms, meaning that the emissions will also be compared to the production of milk and meat by the farmers. To enable this, the following parameters will also be monitored:

- number of cattle on the farm and type of cattle (dairy or other)
- litres of milk and/or kg of meat produced

To assess the quantitatively measurable co-benefits, the following parameters will also be monitored:

- litres of milk and/or kg of meat sold
- alternative new products produced
- investments in the applications of new practices
- market price of the products and income generated
- number of people who received training
- jobs created
- state of soil and nearby aquifers

7.2. Description of key parameters to assess the national sustainable development benefits

The following lists the indicators that will be monitored in order to track their respective targets under the Sustainable Development Goals. Some indicators will have to be monitored nationally, which will create some difficulties in defining the LCDS's direct contribution to achieving the respective targets, while others will be measurable at the producer level, which will provide data enabling the contribution of sustainable development to the LCDS to be assessed with a high degree of confidence.

Table 16: Indicators for Sustainable Development Goals

Goal	Target	Indicators	Monitoring arrangement
Goal 1. End poverty in all its forms everywhere	Target 1.2: By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Indicator: 1.2.1 Proportion of population living below the national poverty line, by sex and age	Income of producers monitored by MARENA, MEFCCA, municipal governments and other participating institutions, through representative surveys, data aggregated at national level by INIDE.
		Indicator: 1.2.2 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Income of producers monitored by MARENA, MEFCCA, municipal governments and other participating institutions, through representative surveys, data aggregated at national level by INIDE.
	Target: 1.a Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions	Indicator: 1.a.1 Proportion of resources allocated directly to poverty reduction programmes by the government	Number of producers below the poverty line receiving funds from the LCDS (partially with public support) monitored by MARENA, MEFCCA, municipal governments and other participating institutions, through representative surveys, reported to INIDE.

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Target: 2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	Indicator: 2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)	Productivity increase in the farms monitored by INTA and other participating institutions, through representative surveys and verification. Impact analysed at national level by INIDE.
	Target: 2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	Indicator: 2.3.1 Volume of production per labour unit by categories of farming/ pastoral/forestry enterprise size	Productivity in the farms per labour unit monitored by MARENA, MEFCCA, municipal governments and other participating institutions through representative surveys and verification. Data aggregated at national level by INIDE.
		Indicator: 2.3.2 Average income of small-scale food producers, by sex and indigenous status	Monitored by MARENA, MEFCCA, municipal governments and other participating institutions through representative surveys and verification. Data aggregated at national level by INIDE.
	Target: 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, help maintain ecosystems, strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and progressively improve land and soil quality	Indicator: 2.4.1 Proportion of agricultural area under productive and sustainable agriculture	Monitored by MARENA, MEFCCA, municipal governments and other participating institutions through representative surveys and verification. Data aggregated at national level by SINIA.
	Target: 2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries	Indicator: 2.a.1 The agriculture orientation index for government expenditures	Volume of government expenditures monitored by INIDE.
		Indicator: 2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector	Volume of government expenditures monitored by INIDE.

Goal 3. Ensure healthy lives and promote well-being for all at all ages	Target: 3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Indicator: 3.9.1 Mortality rate attributed to household and ambient air pollution	Monitored at the national level by INIDE.
		Indicator: 3.9.2 Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene (exposure to unsafe Water, Sanitation and Hygiene for All (WASH) services)	Monitored at the national level by INIDE.
Goal 6. Ensure availability and sustainable management of water and sanitation for all	Target: 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Indicator: 6.3.2 Proportion of bodies of water with good ambient water quality	Monitored at the national level by by the institutions of the consumption and trade production system (INTA, MEFCCA, IPSA) MARENA, livestock and local organizations within the framework of the SNIA.
	Target: 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	Indicator: 6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	Monitored at the national level by the institutions of the consumption and trade production system (INTA, MEFCCA, IPSA) MARENA, livestock and local organizations within the framework of the SNIA.
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	Target: 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	Indicator: 7.1.2 Proportion of population with primary reliance on clean fuels and technology	Introduction of biodigesters with energy use monitored by INTA, MEFCCA aggregated at national level by INIDE.
		Indicator: 7.2.1 Renewable energy share of total final energy consumption	Introduction of biodigesters with energy use monitored by INTA, MEFCCA. Aggregation at national level by INIDE.

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Target: 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the ten-year framework of programmes on sustainable consumption and production, with developed countries taking the lead	Indicator: 8.4.1 Material footprint, material footprint per capita, and material footprint per GDP	Monitored at the national level by the institutions of the consumption and trade production system (INTA, MEFCCA, IPSA) MARENA, livestock and local organizations within the framework of the SNIA.
Goal 10. Reduce inequality within and among countries	Target: 10.1 By 2030, progressively achieve and sustain income growth of the bottom forty percent of the population at a rate higher than the national average	Indicator: 10.1.1 Growth rates of household expenditure or income per capita among the bottom forty percent of the population and the total population	Monitored by INTA through representative surveys and verification, and aggregated at the national level by INIDE.
Goal 12. Ensure sustainable consumption and production patterns	Target: 12.2 By 2030, achieve the sustainable management and efficient use of natural resources	Indicator: 12.2.1 Material footprint, material footprint per capita, and material footprint per GDP	Monitored by INTA, MARENA, MEFCCA, municipal governments and other participating institutions through representative surveys and verification, and aggregated at the national level by INIDE.

Goal 13. Take urgent action to combat climate change and its impacts	Target: 13.2 Integrate climate change measures into national policies, strategies and planning	Indicator: 13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/ strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other)	The LCDS contributes directly to this global goal. ONDL will report on the LCDS advancements to MARENA, and MARENA will communicate to the UNFCCC.
	Target: 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	Indicator: 13.3.2 Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions	The LCDS contributes directly to this global goal. ONDL will report on the LCDS advancements to MARENA, and MARENA will communicate to the UNFCCC.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Target: 15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	Indicator: 15.1.1 Forest area as a proportion of total land area	Monitored by MARENA, INAFOR, INETER through geographic information systems and field verification, and aggregated nationwide by SNIA.
	Target: 15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally	Indicator: 15.2.1 Progress towards sustainable forest management	Monitored by MARENA, INAFOR and INETER through geographical information systems and field verification, and aggregated nationwide by SNIA.
	Target: 15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world	Indicator: 15.3.1 Proportion of land that is degraded over total land area	Monitored by MARENA, INAFOR and INETER through geographical information systems and field verification, and aggregated nationwide by SNIA.

7.3. Parameters and indicators that will be used to measure the GHG emissions impacts of LCDS implementation.

For emissions reductions caused by changes in land-use practices, the has converted from the baseline in the farms to other practices utilizing the emission factors are described in Table 12. Animal stocking and carbon footprint characteristics in livestock land uses in Nicaragua.

Land-use system	Animal stock (animal unit/ ha)	Carbon fixation rate	GHG emissions	Carbon footprint
		tCO$_2$e/ha/y		
Native pastures	0.9	0.0	1.8	-1.8
Native pastures with trees	1.2	7.8	1.6	6.2
Improved pastures	1.5	0.0	2.9	-2.9
Fodder Banks	3.0	10.0	5.0	5.0
Intensive silvopastoral systems	3.0	31.4	4.5	26.9
Live fences	N/A	15.0	4.0	11.0

Elaborated by CATIE. Source: Andrade and Tobar (unpublished data); Messa (2009)

These emissions factors are estimated based on literature and case studies, but will be updated as LCDS implementation proceeds and new data are generated on the actual contribution of the implementation of practices to GHG emissions reductions.

To calculate emissions reductions from the implementation of biodigesters, the following CDM methodologies will be applied: AMS-III.R Methane recovery in agricultural activities at household/ small farm level --- Version 3.0, and AMS-I.I.: Biogas/biomass thermal applications for households/ small users --- Version 4.0

The AMS-III.R CDM methodology describes how to calculate emissions reductions from changing the management practice of a biogenic waste or raw material in order to achieve controlled anaerobic digestion equipped with a methane recovery and combustion system applicable to methane recovery systems that achieve annual emissions reductions of less than or equal to five tonnes of CO$_2$e per system, and where the sludge from the biodigester is handled aerobically and applied directly to the soil. The AMS-I.I. CDM methodology describes how to calculate emissions reductions from the generation of renewable thermal energy using biogas for use in residential, commercial and institutional applications, such as biogas cooking stoves and other thermal applications displacing fossil fuels for a total installed/ rated thermal energy generation capacity equal to or less than 45 MW thermal, and a rated capacity equal to or less than 150 kW.

The emissions reductions achieved by collecting manure and feeding it into farm biodigesters are calculated by:

$$ER_y = BE_y - PE_y$$

Where:
ER_y = emissions reductions achieved by the project activity for year y (tCO$_2$e)
BE_y = baseline emissions for year y (tCO$_2$e)
PE_y = project emissions for year y (tCO$_2$e)

The baseline is established using the IPCC Tier 1 approach described in 'Emissions from Livestock and Manure Management' in the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, where:

Emissions from manure management of cattle KG CH_4 $HEAD^{-1}$ YR^{-1} are estimated at:

Livestock Species	Temperature 15-25 °C	Temperature 26- ≥ 28 °C
Dairy Cows	1	2
Other cattle	1	1

The emissions reductions achieved by utilizing the biogas and replacing fossil fuel for cooking and lighting are calculated by:

$$ER_y = BE_y - PE_y$$

Where:
ER_y = emissions reductions during year y (tCO_2)
BE_y = baseline emissions during year y (tCO_2)
PE_y = project emissions during year y (tCO_2)

The amount of baseline emissions BEy is calculated by:

$$BE_y = \sum_k \sum_j N_{k0} * n_{k,y} * FC_{BL,k,j} * NCV_j * EF_{FF,j}$$

Where:
BE_y = baseline emissions during year y (tCO_2)
K = index for the type of thermal applications introduced by the project activity (e.g. cooking stove, lights)
J = index for the type of baseline fossil fuel consumed
$N_{k,0}$ = number of thermal applications k commissioned
$n_{k,y}$ = proportion of Nk,y that remain operating in year y (fraction)
$FC_{BL,k,j}$ = annual consumption of baseline fossil fuel j (mass or volume unit)
NCV_j = net calorific value of fossil fuel j (GJ/mass or volume unit)
$EF_{FF,j}$ = CO_2 emissions factor of fossil fuel j (tCO_2/GJ)

Project emissions from any continued use of fossil fuel j, are calculated by:

$$PE_y = \sum_m \sum_j N_{m,y} * FC_{m,j} * NCV_j * EF_{FF,j}$$

Where:
PE_y = project emissions during year y (tCO_2)
M = index for thermal applications (e.g. cook stove, lights) not decommissioned by the project activity
$N_{m,y}$ = number of thermal applications m remaining in use in year y
$FC_{m,j}$ = annual consumption of fossil fuel type j (physical units, mass/volume) by application m

Monitoring will consist of the following:

1. At the time of installation, all biodigesters will be inspected by INTA and undergo acceptance testing (commissioning) for proper operation in compliance with specifications. The following parameters will be recorded and subsequently monitored for the avoided emissions from manure management:

    a. Installation date and continuing operation of each system

    b. Annual consumption and NCV of fossil fuel FCBL,k,j from a representative sample survey of targeted households prior to and biannually after installation

    c. Annual average animal population

d. Amount of waste/animal manure generated by the farm

e. Amount of waste/animal manure fed into the system, e.g. biogas digester

f. Proper soil application (not resulting in methane emissions) of the final sludge

The following parameters will be recorded and subsequently monitored for the avoided emissions from displacing fossil fuels for thermal application:

2. Farmers will self-monitor and report annually to INTA and to the participating institutions with which they are in direct contact on the continuing use of biodigesters.

3. Verification will be done by INTA and the participating institutions biannually using survey methods, selecting a statistically valid sample of the residences where the systems have been installed, taking account in the sampling design of occupancy and demographic differences to determine the percentage of systems in operation as per the relevant requirements for sampling in the "Standard for sampling and surveys for CDM project activities and programme of activities".

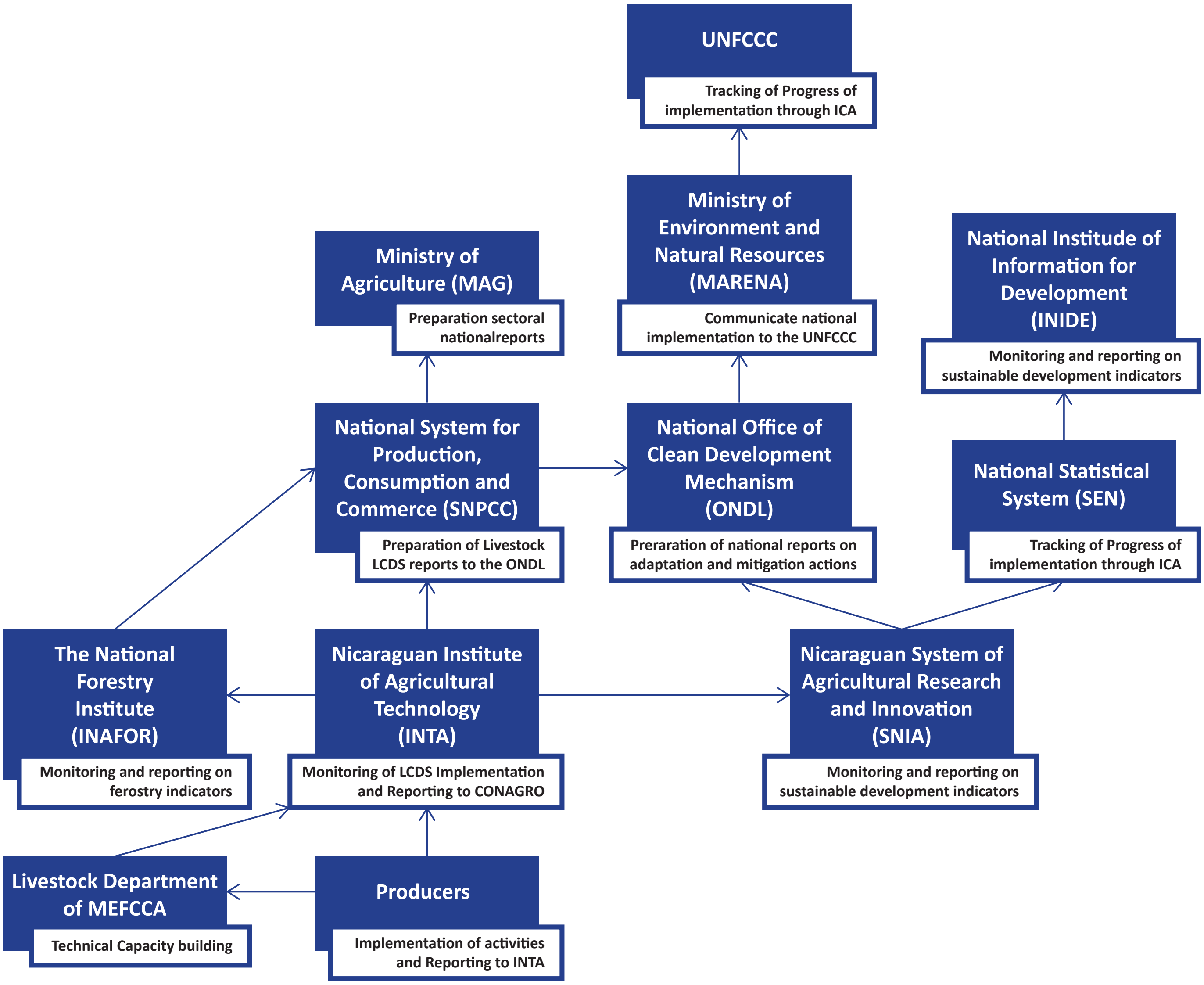
7.4. Institutional framework for MRV

Producers implementing the LCDS's practices will provide the primary source of data to be monitored through surveys[4] that will be managed by INTA in coordination with the participating institutions. Producers willl conduct measurements for most of the activities and will report to INTA and the other institutions on progress with implementation through biannual surveys. Likewise, the institutions (INTA, MEFCCA, MARENA, IPSA, municipal governments, NGOs) will maintain a flow of information that will be processed and administered by INTA and other institutions tasked with the provision of technical support, allowing for the cross-referencing of data. This institutional set-up, led by INTA will share data with the other participating institutions and decision-makers in order to feed information into the National Statistical System, which will allow INIDE to track contributions to sustainable development nationally.

The Production Promotion Bank (PRODUZCAMOS) will report to INTA on the financial support it has provided to producers, and this information will be cross-checked with farmer's reporting. INTA will report on the LCDS's progress to SNIA, SNPCC, INAFOR and representatives of unions (CONAGAN, FAGANIC, CANISLAC). SNPCC will itself report to the ONDL on LCDS implementation and its contribution to sustainable development and GHG emissions reductions. ONDL will report to MARENA, which will be in charge of preparing national reports to the UNFCCC. INAFOR will report on reforestation efforts to SNPCC, thus ensuring thatr information is cross-referenced. SNPCC will also report to MAG on progress with implementation in respect of productivity, thus enabling MAG to monitor progress in achieving the sectoral goals. Assessments of progress with sustainable development and poverty reduction, provided by INTA, will be tracked by INIDE through the National Statistical System (SEN), which will aggregate the reporting information to track the achievements of the goals described in the National Human Development Plan (PNDH). The institutional framework for MRV of the LCDS is illustrated in Figure 21.

4 The reporting survey is provided in Annex I.

Figure 21. Institutional arrangements for MRV of the Livestock LCDS



7.5. Description of verification process

Verification at the international level will take place through the UNFCCC's International Consultation and Analysis. More relevant for the LCDS, verification nationally will take place on two tracks. Periodic progress in meeting the goals and indicators of the PNDH will be subject to an independent verification mechanism, headed by INIDE and supported by the National Statistical System (SEN), which is in charge of establishing the system of monitoring and of reporting progress with PHDH implementation. The transparent use of the public resources allocated to fulfilling the LCDS will be monitored by SNPCC. Verification of actual implementation and the continuing functioning of the practices will be done biannually by INTA for a representative selection of farms.

8. Financial resources

8.1. Full cost of implementing the Livestock LCDS

8.1.1. Cost of implementation of practices for producers

The following tables illustrate the cumulative costs in USD for the introduction of the LCDS's practices for small, medium and large-scale producers (a total of 120,000 producers) in scenarios 1 and 2 for the period 2018 to 2029, as elaborated by CATIE.

Scenario 1 envisages a change of 30% in the native pasture area to establish good management practices, the adoption of improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 1%/y.

Table 17. Investment and O&M costs for the implementation of LCDS practices under scenario 1

Investment costs [USD]	For each farm		For all farms		
	Investment cost for farms investing in both SSP and organic fertilizers	Mainte-nance costs	SSP systems	Organic fertilizers	**Total**
Small farmers	5,224	9,960	438,816,000	4,573,800	**443,389,800**
Medium farmers	8,176	19,110	264,902,400	2,316,600	**267,219,000**
Larger farmers	37,248	131,150	134,092,800	574,200	**134,667,000**
Total			**837,811,200**	**7,464,600**	**845,275,800**

Scenario 2 envisages a change of 20% of the native pasture area to establish good management practices, the adoption of improved pastures and silvopastoral systems with pasture rotation, live fences and fodder banks, combined with the gradual and incremental establishment of organic fertilization systems and biodigesters by 0.5%/y.

Table 18: Investment and O&M costs for the implementation of LCDS practices under scenario 2

Investment costs [USD]	For each farm		For all farms		
	Investment cost for farms investing in both SSP and organic fertilizers	Mainte-nance costs	SSP systems	Organic fertilizers	**Total**
Small farmers	4,315	9,360	362,476,800	2,286,900	**364,763,700**
Medium farmers	5,904	16,845	191,289,600	1,158,300	**192,447,900**
Larger farmers	23,019	119,010	82,869,120	287,100	**83,156,220**
Total			**636,635,520**	**3,732,300**	**640,367,820**

The initial investments and O&E expenses will be carried by the producers, but the provision of financial support envisages preferential loans. The national and international financing needed to provide this support is not included in the above calculations.

8.1.2. Cost of capacity-building component

The following table presents the total costs to set up the field schools to provide capacity-building in LCDS practices.

Table 19: Cost of the capacity-building component of the LCDS

Training	USD$	Duration	Target
Establishment of field schools and work force	20,000,000	5 years	Establishment of 150 field schools
Training workshops with technical specialists for INTA and other partner institutions on implementation of Livestock LCDS practices through field schools	15,000	1 year	Minimum 30 technicians
Field-school workshops and support to the experimentation activities of ECAs (planting materials, tools and inputs); initially thirty in the first year, reaching 145 in years 1-5. Unit Cost: 10,000/field school	1,500,000	5 years	6,000 producers
Local workshops in target areas for dissemination of project plans, results and lessons learnt (years 1-5)	20,000	1 - 5yr	Technicians and facilitators
Total	21,535,000		

8.2. Funding from domestic sources

MEFCCA, INTA and other national institutions are already providing technical assistance services and technology transfers with national funds, and their alignment and continuation with the livestock LCDS will provide part of the national contribution. INTA and other consumption and trade production institutions led by INATEC have been in charge of the development of the national program for technical education in the field and technology transfers by setting up field schools for Farmers (ECAs). ECAs have been established with an enrolment of around 17,000 participants, of whom 12,000 were assisted through the participation of 645 technicians (Informe de Evaluación Final del PRORURAL Incluyente 2010-2014). With implementation of the Livestock LCDS these technologies and practices will be incorporated into the Livestock Departments of MEFCCA's and INTA's technical assistance to livestock producers. This will also be a part of the national contribution, where some of the current budget will be used for the targeted capacity-building of livestock producers regarding the LCDS's activities.

Other existing programs financed through PRODUZCAMOS and operationalized by FUNDESER will also be streamlined with the livestock LCDS, meaning that current activities financed through BID, combined with national resources, will also contribute to the success of the Livestock LCDS.

In addition, The National Livestock Commission of Nicaragua (CONAGAN) and BID have recently signed an agreement for USD 1,650,000 to be used to implement the Certified Natural Sustainable Livestock Project, an initiative to implement a Segregated Bovine Production System (SSPB). The project will incentivise farmers (women and men) to adapt new technologies and innovations for sustainable production through certification, which will also help them access new markets. The project will also support the certification of the products of farmers who are implementing the LCDS's practices, with a national contribution of USD 820,000 from CONAGAN, the Nicaraguan Chamber of Beef Exporters (CANICARNE), the Nicaraguan Agricultural Exchange (BAGSA) and cooperatives of producers located in the area of intervention. The goal is to reach a minimum of seven hundred producers and to certify at least three hundred farms over the course of four years.

Finally, Nicaragua has already invested USD 16.2 million, plus USD 5.2 million, in labour inputs from the producers and in the implementation of sustainable livestock practices by introducing live barriers, live fences, cover crops, fruit trees and trees for energy and timber purposes, thus illustrating both the national contribution already provided and the national commitment to transform the sector and contribute to GHG mitigation.

8.3. Financial support from international funding

The following lists the activities planned to finance implementation of the Livestock LCDS's activities from international sources:

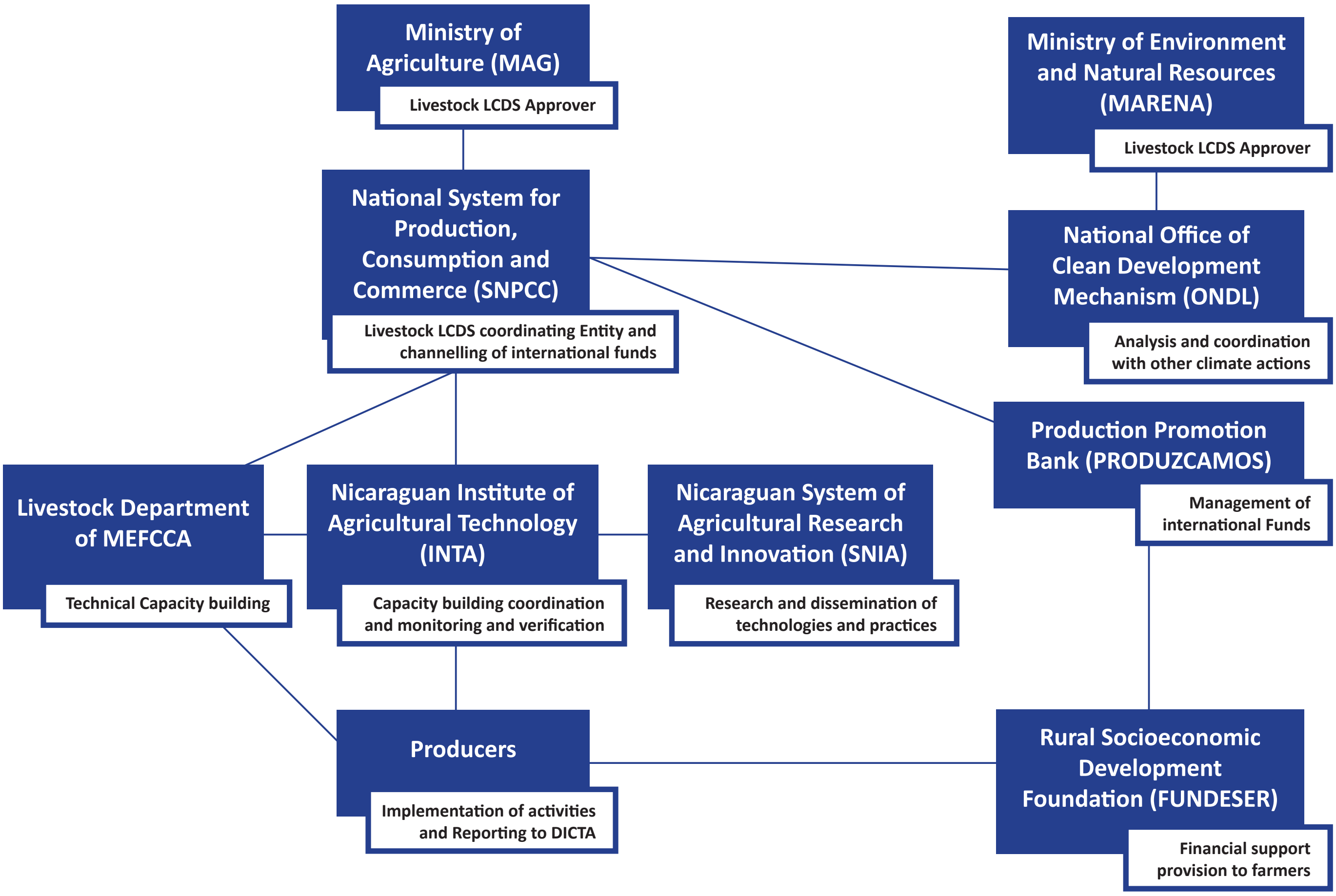
Expansion of PRODUZCAMOS financing, providing loans at preferential rates, at 4-7%/y to farmers, to cover initial investment costs, able to reach a minimum of 6,000 producers during the first five years. Estimating the average initial investment needed for small, medium and large producers over the first five years indicates that a total investment of USD 235,518,000 wil be needed to implement practices under scenario 1 for 6,000 producers (USD 516,861,072 by 2029 for 120,000 producers). The initial investment in favour of 6,000 producers is intended to boost interest in the practices and to create confidence in the local financial institutions in the profitability and security of investing in them. Nicaragua would need initial international assistance to provide preferential loans to farmers in the first five years, but financing implementation of the practices is envisaged as becoming self-sufficient as confidence grows. To this end, the Livestock LCDS envisages supporting 30% of preferential loans or guarantees to a total of USD 70,655,400 million, allowing for the provision of loans at preferential rates to farmers on a large scale.

Of the 21,485,000 USD needed for capacity-building activities, USD 20,000,000 will come from national sources through the existing programmes investing in the country, but USD 1,535,000 will be sought through international climate finance support, as additional capacity will be needed for the training of technicians and farmers and for inputs into the field schools to allow for capacity-building in the LCDS's practices.

8.4. Description of arrangements to finance the implementation of the LCDS, including domestic finances and international funding

International financing is planned to take place through the GCF, BID and/or other sources. SNPCC will channel the international funds for capacity-building into the Livestock Department of MEFCCA, INTA and other institutions involved, having the necessary capacity and mandate to implement capacity-building projects and programs. PRODUZCAMOS has the experience and capacity to administer loans to producers, and will manage the funds channelled through SNPCC.

Figure 22. Implementation arrangements for LCDS financing



9. Non-financial support required

Establishing silvopastoral systems and other planned practices requires intensive training of producers and detailed technical knowledge regarding appropriate implementation of the practices. The most appropriate type of silvopastoral system depends on the farm's characteristics and the needs of the producer. Identification of the trees and/or shrubs needs to be taken into consideration according to the needs of the farm and producers, and appropriate pasture division depends on the topography and the type of soil. When dividing paddocks, producers should consider the arrangement of tall trees and leafy trees in order to provide sufficient shade in grazing without affecting the growth of the grass, for which purpose the sun's movements must be taken into account. It is also necessary to consider the establishment of fast-growing trees along the periphery of the paddocks, which helps provide shade and contributes to improving the environment. These are only some of the examples of the capacity needed to establish the LCDS's practices.

As already described throughout the LCDS document, institutions already exist for the provision of capacity-building activities, although the Livestock Department of MEFCCA and other institutions will need assistance in training more technicians in the practices in order to empower farmers nationwide and achieve the envisaged impact. MEFCCA's Livestock Department will need further capacity-building from INTA and CATIE in order to train technicians and provide implementation support to farmers in field schools. The target is to provide training for a minimum of thirty technicians, the aim then being that they will train other staff in order to reach a minimum of 6,000 producers over a period of five years. In addition, capacity-building should be provided to local private companies in the necessary technical knowledge to construct biodigesters and in the appropriate building materials to be used to ensure the quality and continuing service of the technology.

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Annex 1. MRV survey to monitor GHG emissions and co-benefits on livestock farms

I General information

Date (dd/mm/yr)		Name of interviewee	
Region		Start time	
Department		End time	
Municipality		Geographical coordinates	
Community		Latitude (N)	
Producer name		Longitude (O)	
Sex (1=male, 2=female)		Altitude (masl)	
Are you		Name of the farm	
a) Owner		Cellular phone	
b) Administrator			
c) Other			
Do you live on the farm? (1: yes 2: no)			

II Human Resources

1. Members of family nucleus

Relationship	Age	Sex	Year of education	Occupation
Farmer				
Wife				
Son 1				
Son 2				

2. Do you hire labour: yes __ no ____

Labour	No. wage/ yr	Activity in which labour was employed	Cost per wage US$
Familiar			
Contracted			
Permanent			
Temporary			

III Natural capital

5. What is the total area of the farm? _______ ha

Land use	Area (ha)	Observations
Natural pasture		
Improve pasture		
Forage bank		
Cultivate		
Forest plantation		
Forest fallow		
Riparian forest		
Forest		
Other		

IV Production system

6. What is the operating system on the farm like?

Operating system	Dry season	Rainy season
Rotational grazing		
Continuous grazing		
Stable		

7. Describe by category the number of animals

Category	No. animals
Cows in production	
Cows born (but not in milk production)	
No cows in production	
Heifers > 2 years	
Heifers 1-2 years	
Calves female	
Bull	
Steers > 2 years	
Steers 1-2 year	
Calves male	
Horses	
Oxen	
Total	

8. Which races or crosses do you have on the farm?

9. Do you manage livestock on several farms? yes _____ no ______ quantify _______

10. Description and management per grazing paddock

No. Paddock	Area (ha)	Grass/ Forage Bank	Fertilization Y/N	Type of fertilizer	Formula	Dose (kg/ha/ yr)	Time of application	No. trees / ha	Use of trees

11. Management of fences on the farm

Fence	% Farm	Frequency of pruning	Principal species	Tree use on the farm
Fence without tree				
Electric fence				
Live fence				
Other				

12. Supplementation strategy

Animal Category	Food supplementary	Quantify	Produced on the farm?	Time
		kg/animal/day	1: Yes 2: No 3: Outside	1 Dry; 2 Rainy 3: Both

13. Management of manure

Use	Knows the practice	Uses the practice
Application of non-treated manure		
Biogas		
Compost		
Wormhole		
Production of organic fertilization		
Oxidation ponds		

14. What type of milking do you do? Manual___ Mechanical ___

15. What is the frequency of milking a day? (1) Once a day (2) Twice a day (3) Other (specify)________________

16. Production and income from milk and cheese in the previous year

Variable	Dry season	Rainy season
Number of milking cows		
Total milk production (kg/day)		
Milk for sale (kg/day)		
Price of milk (US$/kg)		
Production of cheese for sale (kg/day)		
Cheese price (US$/kg)		
Milk self-consumption (kg/day)		
Cheese self-consumption (kg/day)		

17. Purchase and sale of animals

Animal category	No. animals sold	Income from sales	Where do you sell the animals?	No. animals purchased	Purchase price

18. Income from forest, agroforestry, agricultural products

Income source	Quantity sold	Income obtained

19. Sources of energy (if the producer knows how much is consumed or the monthly or weekly cost)

Source	Weekly consumption	Cost
Electricity (kw/month)		
Gasoline (litre/week)		
Diesel (litre/week)		
Gas (litre/month)		
Firewood Unit* /week		

**Unit of mass or volume that is used in the site*

20. Do you use firewood to cook? Yes __ No_____

21. Describe in % the income you manage to support the family

Origin of income	%
Livestock	
Agricultural	
Income from off-farm	