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Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
CANU, FEDERICO. ANTONIO., Wretlind, P. H., Audia, I., Tobar, D., & Andrade, H. J. (2018). *Nama for a Low Carbon and Climate Resilient Livestock Sector in Honduras*.

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NAMA FOR A LOW CARBON AND CLIMATE RESILIENT LIVESTOCK SECTOR IN HONDURAS

Gobierno de la República de Honduras

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Dirección de Ciencia y Tecnología Agropecuaria

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Solutions for environment and development
Soluciones para el ambiente y desarrollo

NDF Nordic Climate Facility
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NEFCO

UNEP DTU Partnership

NAMA for a Low Carbon and Climate Resilient Livestock Sector in Honduras

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Acknowledgements:
This publication was financed through th e project 'Roadmap to Nationally Appropriate Mitigation Actions i n t he Livestock Sector o f Honduras a nd Nicaragua', f unded through t he generous support provided by the Nordic Climate Facility (NCF).

January 2018

UNEP DTU Partnership
UN City Copenhagen, Denmark

Graphic design: DESIGNafd., www.DESIGNafd.dk

Cover photo credits: Shutterstock/Enrique Romero

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LIST OF ACRONYMS

BANADESA..... National Bank of Agricultural Development
BANHPROVI ..... Honduran Bank of Production and Housing
BANRURAL..... Honduran Bank for Production and Housing
BAU..... Business As Usual
BCIE ..... Central American Bank for Economic Integration
CAC ..... Central American Agricultural Council
CAHLE ..... Honduran Milk Chamber
CATIE ..... Tropical Agricultural Research and Higher Education Centre
CDE ..... Business Development Centre
CDM..... Clean Development Mechanism
COFOGAH ..... Chamber of Livestock Development
CTICC ..... Inter-Institutional Climate Change Technical Committee
DICTA ..... Directorate of Agricultural Science and Technology
DNCC ..... National Directorate of Climate Change
ECA ..... Fields School
ENCC..... National Strategy on Climate Change
FAO ..... United Nations Food and Agriculture Organization
FENAGH ..... National Federation of Farmers and Ranchers of Honduras
FIRSA..... Trust Fund established for the Reactivation of the Agriculture Sector
FONAC ..... National Convergence Forum
GEF ..... Global Environment Fund
GHG ..... Greenhouse Gases
IFAD ..... International Fund for Agricultural Development
IICA ..... Inter-American Institute for Cooperation on Agriculture
LULUCF ..... Land Use, Land Use Change and Forestry sector
MiAmbiente..... Secretariat of Energy, Natural Resources, Environments and Mines
MRV..... Measurement, Reporting, Verification
NAMA..... Nationally Appropriate Mitigation Actions
NCF ..... Nordic Climate Facility
NDC ..... National Determined Contribution
NGO..... Non-governmental Organization
PRONAGRO..... National Agricultural Development Program
PSAN..... Policy for Long-term Food Security and Nutrition
REDD ..... Reducing Emissions from Deforestation and Forest Degradation
SAG..... Secretariat of Agriculture and Livestock
SDC ..... Swiss Development and Cooperation

SEDUCA ..... Agricultural Education, Training and Agribusiness Development Service
SENASA..... National Agricultural Health Service
SERNA..... Secretariat of Natural Resources and Environment
SSP..... Silvopastoral Systems
UNAH..... National Autonomous University of Honduras
UNDP ..... United Nations Development Program
UNFCCC ..... United Nations Framework Convention on Climate Change
USAID ..... US Agency for International Development

1. Overview

1.1. Basic information

<table>
<tr><td colspan="2">Title of NAMA: NAMA for a Low Carbon and Climate Resilient Livestock Sector</td></tr>
<tr><td>Country/ies: Honduras</td><td></td></tr>
<tr><td>NAMA Implementation coordinating entity:
Dirección de Ciencia y Tecnología Agropecuaria (DICTA)
Secretaría de Agricultura y Ganaderia (SAG)
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With the coordination of DICTA and MinAmbiente
Support for NAMA development has been provided by the Nordic Climate Facility (NCF)</td></tr>
<tr><td>Sector/Subsector:</td><td>Agriculture and Land Use Change and Forestry
Bovine Livestock</td></tr>
<tr><td>Greenhouse Gases covered by the Action (marked x) :</td><td>
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<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="2">Status of Endorsement by appropriate National Authority:
This NAMA is been developed with assistance from DICTA and in close coordination with the National Directorate on Climate Change of the Ministry of Environment, and the Secretariat for Agriculture and Livestock. The NAMA is awaiting final inter-institutional consultation and endorsement.</td></tr>
</table>

1 The NAMA Approval Authority is the designated national focal point/entity for submitting NAMAs to the UNFCCC NAMA Registry.

1.2. Overview of the key aspects of the NAMA

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

Brief description of the objectives of the proposed NAMA and summary of measures to be included in the NAMA.	Climate change projections show that Honduras is expected to have the highest aridity in the Central American region, potentially leading to severe adverse impacts on the productivity of the livestock sector. This sector is one of the main activities in the Honduran rural economy, but it is also one of the largest contributors to GHG emissions in the country. It is therefore urgent to identify good practices that promote adaptation and mitigation to climate change. The livestock sector has great potential to reduce emissions and increase carbon sinks, while allowing increased intensification of livestock production and greater efficiency on the part of farms, thus contributing to the sustainable development of the country and the implementation of national development policies. As a result of broad stakeholder consultations with local producers and national institutions with the relevant mandates on climate change and agriculture, as well as national and local institutions engaged in capacity-building in the livestock sector, the following NAMA livestock practices were identified, which it is the objective of the NAMA to implement. 1. Implementation of silvopastoral systems, including rotation and division of pastures 2. Introduction of biodigesters 3. Production and application of organic fertilizers (composting and biofertilizers) 4. Production and application of nutritional blocks Implementation of these practices will contribute to net emissions reductions by decreasing GHG emissions from enteric fermentation by livestock and manure management per animal head, decreasing the amount of nitrogen and carbonates applied to pastures and other forage systems, decreasing dependence on fossil fuels and non-renewable biomass for cooking and lighting, and increasing carbon stocks in woody biomass and soil carbon. The NAMA, by introducing the practices that have been identified and prioritized, and through its alignment with the NDC, national policies, strategies and action plans, will exploit synergies between agricultural policies and policies that reduce deforestation, reduce emissions, increase the amount of carbon sinks and protect biodiversity and water resources, as well as contributing to improving farmers' lives. The NAMA presents two scenarios with the following targets, 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, with 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, with 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. Following current trends in the sector assuming no state intervention, total net emissions are expected to be 10,100,000 tCO_2e/year in 2030, representing a net increase of 2,500,000 tCO_2e/year, and cumulative emissions of 132,000,000 tCO_2e between 2016 and 2030 in the BAU scenario. Net emissions would decrease in both NAMA scenarios assuming state policies to promote the improvement of livestock practices in the country, while allowing for increases in the number of cattle from 3,657,000 to 4,994,000 heads. Cumulative net emissions reductions would be 50,600,000 tCO_2e over the next fourteen years in scenario 1 and 29,300,000 tCO_2e with scenario 2. The NAMA would therefore potentially contribute net GHG reductions at a rate of between 22% and 38%, given a 20% or 30% conversion rate to improved practices respectively.
Relevance to the national sustainable development plan(s) or national strategies and/or to the sectoral mitigation goals.	The majority of the Honduran population live below the poverty line, being concentrated especially in rural areas, where agriculture is the main source of income, and where the sufficient exploitation of natural resources is an indispensable condition for the rural population's continuing sustenance. Current livestock practices are contributing to the degradation of land and deforestation, eroding the conditions that enable efficient livestock production to continue. The introduction of sustainable practices will provide sustainable management of natural resources, while contributing to reforestation and adaptation to climate change, in line with national development policies and strategies, and with Honduras's Nationally Determined Contribution. The Honduran national development strategy, as set out in the national Country Vision 2010-2038, will be supported by the NAMA through its alignment with the Vision's following targets: • Reduce the percentage of households living in poverty to less than 15% • Reduce the open unemployment rate to 2% and the invisible underemployment rate to 5% of the employed population. • Raise the participation rate of renewable energy to 80% in the country's electricity generation mix. • Place 1,000,000 hectares of forest land in the process of ecological and productive restoration, accessing the international carbon market. • Bringing Honduras's position in the Global Climate Risk Index to a level above 50.

	NAMA implementation is expected to increase the productivity of the farms involved, while ensuring sustainable management of the farms' natural resources, limiting soil degradation and improving their resilience to climate change. This will result in increased income-earning opportunities and assist in poverty reduction in the rural areas, where poverty is concentrated. Implementation of the selected practices in the NAMA will contribute to job creation, and the increased productivity and sustainability will have positive spill-over effects on the sector's export opportunities. The introduction of biodigesters on farms will contribute to the rate of renewables, while the application of silvopastoral systems will increase the amount of forested area in Honduras. The NAMA MRV system will contribute to the monitoring of a selection of indicators that will be reported to the National Convergence Forum (FONAC), which is in charge of monitoring the implementation of National Plans and progress towards the objectives of the National Vision. The NAMA also contributes to the objectives of the Strategic Government Plan to "Facilitate the expansion and modernization of the agricultural sector, in order to increase its productivity, improve competitiveness, generate employment and increase foreign exchange earnings, making a significant contribution to the economic and social development of the country". The measures proposed by the NAMA will directly contribute to the initiatives described above, thus forming a direct contribution to the achievement of the Strategic Government Plan. In terms of climate change-related national objectives, the NAMA will contribute to strengthening the capacities of the technical staff of national institutions, and support the research, innovation, evaluation and monitoring of agricultural systems, technologies and good practices, as well as fostering inter-institutional cooperation, in line with the National Strategy on Adaptation to Climate Change for the Honduran Agricultural Sector 2014-2024. Honduras's Nationally Determined Contribution highlights the following needs for action as relevant and aligned with the NAMA objectives: Change in agricultural practices: implementation of agroforestry systems, reduction of fertilizer load with increased use of slow-acting organic fertilizers, modification or elimination of inappropriate agricultural burning practices, measures to combat erosion, development of organic fertilization systems, and stimulus and/or inductive impulse to organic agricultural production, including tax and financial incentives.

	Changes in livestock practices: changes in pasture time; sowing of improved pastures, limitation of pasture burning to the control of mites in cattle. Capacity-building and research: selection and development of varieties and species of crops and pastures that are resistant to drought and flood, and development of sustainable systems based on agroecology. NAMA implementation will therefore directly contribute to the implementation of practices specified in the NDC, as well as to the achievements of the NDC targets. The NAMA practices will also contribute to the increased productivity of the livestock sector, improve farmer's income-earning potential, ensure sustainable management of the farms and make production systems more resilient to climate change, thus contributing to the country's Policy for Long-term Food Security and Nutrition (PSAN). The State Policy for the Agricultural Sector and the Rural Environment of Honduras (2004-2021) envisages a National Reforestation Program, where the silvopastoral practices envisaged in the NAMA will directly contribute to the fulfilment of this state policy.
Brief description of relevant existing mitigation initiatives and their synergies with the proposed NAMA.	The Inter-American Development Bank (BID) supported the Secretariat of Energy, Natural Resources, Environments and Mines (MiAmbiente) during 2014 in identifying and prioritizing NAMAs, identifying a NAMA for sustainable livestock which showed a high degree of potential for reducing GHG emissions and that had significant social, environmental and economic benefits for Honduras through the establishment of silvopastoral systems. This current NAMA proposal has built upon the prioritization stimulated by this initial project, and elaborated extensively with respect to the implementation of practices, GHG emissions reduction potential and NAMA implementation mechanisms. The National Federation of Farmers and Ranchers (FENAGH) of Honduras has also developed projects to boost the adoption of silvopastoral systems, given the livestock sector's vulnerability to climate change. The NAMA will provide FENAGH and other interest groups related to milk- and cattle-producers with support to empower their members in the implementation of sustainable livestock practices. There is currently a plan for a NAMA for efficient stoves aimed at reducing consumption of firewood by 39%, thus contributing to limiting current deforestation trends. The NAMAs will work in synergy to support national reforestation and deforestation reduction efforts.

Brief description of the transformational impact, including its sustainability.	The NAMA is expected to have positive sustainable development co-benefits for producers and the nation as a whole, but its long-term contribution will go beyond providing specific co-benefits to transform the whole sector and parts of Honduran society. In terms of GHG emissions, the NAMA will contribute to drastically changing the sector's current development path, which is characterized by increasing emissions, towards reversing this trend in the direction of becoming a GHG sink over time. This abrupt transformation is expected to increase farmers' productivity and ensure the long-term sustainable management of farms' production systems, thus ensuring that farmers will not revert back to their former practices once the benefits from NAMA implementation start to materialize. This redirection of development trends for the sector illustrates the wide transformational impacts that the sustainable practices introduced by the NAMA will have in the long term. Current support initiatives to farmers have tended to consist of scattered and uncoordinated efforts with limited impacts so far. Thanks to the activities envisaged in the NAMA Action Plan, which are aimed at overcoming the identified barriers to producers wanting to implement the practices, the implementation of sustainable practices will be subject to a nation-wide concerted effort. This will ensure a rapid uptake of sustainable practices that would not have materialized in the absence of the NAMA, making the transformational impact of the NAMA not only abrupt and irreversible in terms of changes to the development path, but also swifter than could have been expected without the NAMA.

2. NAMA DETAILS

2.1. Introduction

Honduras has an area of 112,492 km² and is divided into 298 municipalities, 3,731 villages and 30,591 hamlets. Geographically it is divided into six regions. The country has an estimated population of 7.9 million, the majority of whom live below the poverty line (64%). Poverty is concentrated in rural areas, where agriculture is the main source of income. The Honduran economy is mainly based on natural resources, whose adequate exploitation is an indispensable condition for the country's development. Fortunately, next to its privileged geographical and geopolitical location, the country has an agricultural, livestock, forestry and fishing sector, which, if it were well managed, would have great potential.

Figure 1. Location of departments in the political division of Honduras

Data from the Central Bank of Honduras show that the importance of the agricultural sector has declined in the national economy, from 20% of GDP in 1990 to 12% in the last five years. Livestock production systems have been characterized by low productivity, probably due to the poor feeding of livestock with natural pastures of low to moderate productivity. Given the expected climate change scenarios for the country and the occurrence of prolonged droughts, these traditional production systems are extremely vulnerable. In some regions, prolonged droughts have meant that the incomes of production families have declined by more than 30% and that the number of dead animals per season has increased.

It is therefore an urgent matter to push for a shift towards improved production systems with practices that the producers themselves have proved to be successful. The trials carried out in various areas of this Central American state have shown that the practices selected for the development of the livestock NAMA can contribute to improving both farm productivity and strategies for adaptation to and mitigation of climate change.

To adapt to the expected change in climate, the livestock sector needs to adopt alternative livestock management practices with sustainable tools and strengthen local capacities to promote their implementation. The successful implementation of the NAMA will foster alliances between the public and private sectors, create financial incentives to promote the adoption of good practices, promote joint actions between producer organizations and cooperatives to increase efficiency, reduce transaction costs, and develop synergies with other initiatives and donors to produce a positive multiplier effect.

2.2. Alignment with national development policies

2.2.1. Country Vision 2010-2038

The overall national development strategy of the country is dictated by the national Country Vision 2010-2038. This provides an objective image of the social, political and economic characteristics the country is striving for, created through consultations carried out throughout the country. The Vision establishes four major national goals and twenty-three targets of national priority. The following lists the objectives and targets to which NAMA implementation will contribute:

Objective 1: A Honduras without extreme poverty, educated and healthy, with consolidated social security systems.

- Target 1.1: Eradicate extreme poverty
- Target 1.2: Reduce the percentage of households living in poverty to less than 15%

Objective 3: A productive Honduras, which generates opportunities and decent jobs, makes sustainable use of its natural resources and minimizes its environmental vulnerability.

- Target 3.1: Reduce the open unemployment rate to 2% and the invisible underemployment rate to 5% of the employed population.
- Target 3.2: Increase the exports/GDP ratio to 75%.
- Target 3.3: Raise the participation rate of renewable energy to 80% in the country's electricity generation maix.
- Target 3.6: Place 1,000,000 hectares of forest land in the process of ecological and productive restoration, accessing the international carbon market.
- Target 3.7: Bringing Honduras' position in the Global Climate Risk Index to a level above 50.

NAMA implementation is expected to increase the productivity of the farms involved, while ensuring sustainable management of the farms' natural resources, limiting soil degradation and improving their resilience to climate change. This will result in increased income-earning opportunities and assist in poverty reduction in rural areas, where poverty is concentrated. Implementation of the selected NAMA practices will contribute to job creation, and the increased productivity and sustainability will have positive spill-over effects on the sectors' export opportunities. The introduction of biodigesters on the farms will contribute to the rate of renewables, and the introduction of silvopastoral systems will increase the amount of forested area in Honduras. The NAMA is therefore aligned with the objectives of the Country Vision, and will contribute to its achievement.

2.2.2. Nation Plan 2010-2022

The National Plan describes the strategic public and private actions needed to meet the intermediate objectives of the Country Vision. The Plan has been formulated for successive periods of twelve years, their implementation being mandatory for the public sector and indicative for the private sector. Eleven strategic guidelines have been identified in making up the National Plan. The Plan determines the framework for all the phases of the public policy cycle, which provides a guiding framework for the regulatory framework on climate change.

Among the elements of the National Plan, there are sixty-five sectoral progress indicators linked to each of the Plan's eleven strategic guidelines. The NAMA MRV system will contribute to the monitoring of a selection of indicators that will be reported to the National Convergence Forum (FONAC), which is in charge of monitoring the implementation of National Plans and the progress towards achieving the objectives of the National Vision.

2.2.3. Strategic Government Plan 2014-2018

The Strategic Government Plan 2010-2014 was the first, and the Strategic Government Plan 2014-2018 the second of the government's plans falling within the planning system established in the Country Vision and Nation Plan. The Strategic Government Plan forms the basis for the elaboration of sectoral plans and their articulation with institutional and territorial planning, and it lays down a range of objectives. Specifically relevant for the NAMA is the objective to "Facilitate the expansion and modernization of the agricultural sector, in order to increase its productivity, improve competitiveness, generate employment and increase foreign exchange earnings, making a significant contribution to the economic and social development of the country". This objective is to be achieved, among others, through the following initiatives:

- Through the Trust for the Reactivation of the Agriculture Sector of Honduras, guarantee the financing of oil palm, sugar cane, cattle, pigs and poultry
- Encourage a national program for the production of biofuels
- Implement a national program for the restocking of cattle, pigs and poultry

The measures proposed by the NAMA will directly contribute to the initiatives described above, thus forming a direct contribution to the achievement of the Strategic Government Plan.

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

Honduras is exposed to extreme weather events, exacerbated by climate change, which, combined with a high percentage of the population living in poverty, especially in rural areas, and being dependent on agriculture for their sustenance and income, leaves the country very vulnerable to climate change impacts. Being responsible for less than 0.1% of global GHG emissions, adaptation to climate change is therefore Honduras' main priority. Nevertheless, Honduras is also committed to contributing to mitigation efforts, under the principle of common but differentiated responsibilities. The following table illustrates the country's emissions in Gg by gases and in CO_2 equivalents (CO_2e) by sector.

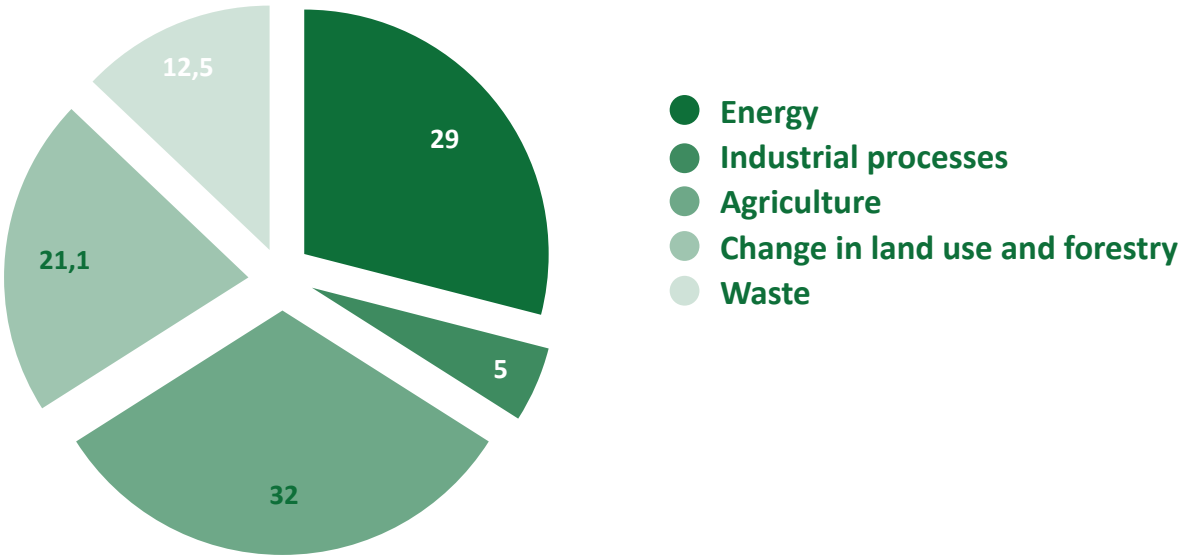
Table 1: GHG emissions by Sector in Year 2000

Sector	Emissions in t					
	CO_2	CH_4	N_2O	NOx	CO	COVNM
Energy	3,204.00	39	0.35	32	510	45
Industrial processes	689.97					6.82
Agriculture		103.61	7.31	12.03	1.22	
Change in land use and forestry	2,826.86	58.56	0.4	14.55	512.39	
Waste	268	69	0.07			
Total	**6,988.83**	**270.17**	**8.13**	**58.58**	**1,023.61**	**51.82**

Source: Second National Communication of Honduras (2012)

As shown by Figure 2, the agriculture sector, with 32% of emissions, is the largest contributor of GHG emissions in the form of CO_2e. It is therefore a priority sector to target and limit the country's overall emissions.

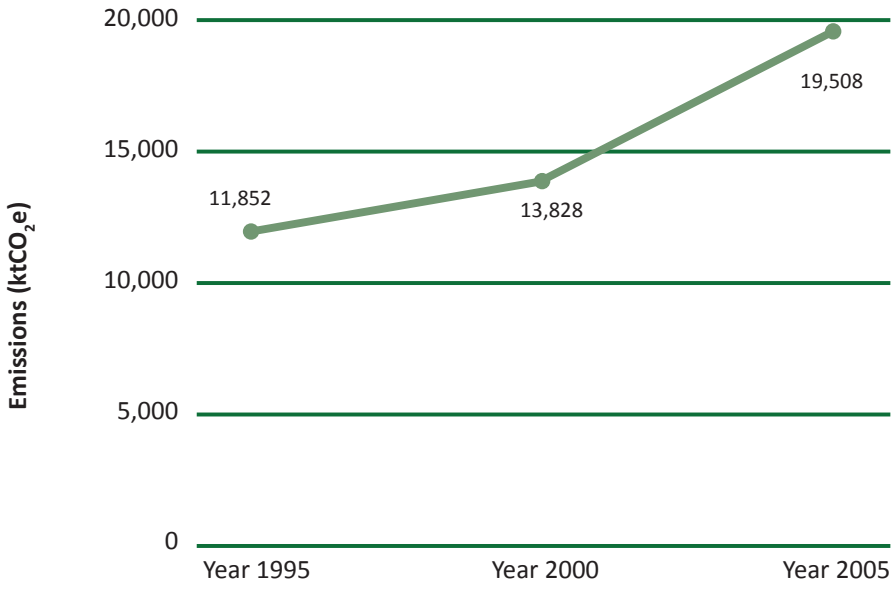
Figure 2. Contribution to global warming of emissions in CO_2 equivalents by sector in 2000



Source: Second National Communication of Honduras (2012)

An important aspect to take into account is the trend in emissions over time. The analysis of the trends in GHG emissions observed in Honduras in 1995, 2000 and preliminary estimates for 2005 show an increase of CO_2e in the Land Use, Land Use Change and Forestry sector (LULUCF).

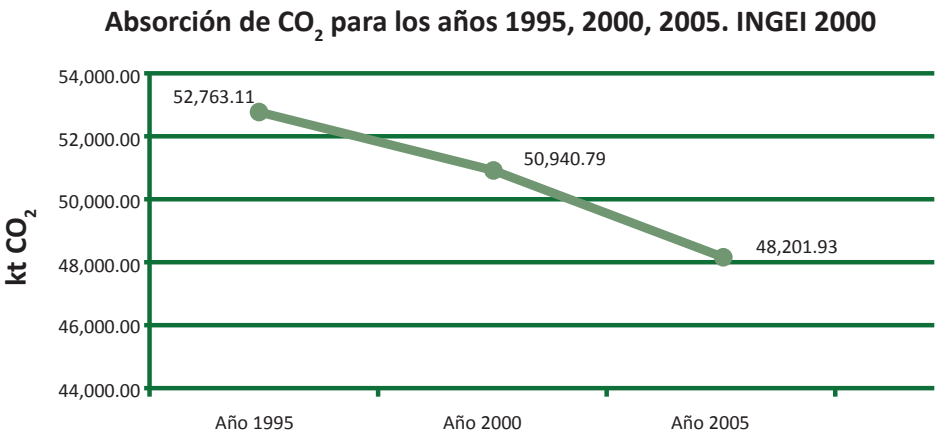
Figure 3. Total emissions in CO_2 equivalents, including sequestration from land-use change and forestry



Source: Second National Communication of Honduras (2012)

Simultaneously, it can be observed that the GHG absorption capacity of forests, grasslands and soils is decreasing. This reflects a decrease in the amount of forested area and an increase in the degradation of land, both of which increase emissions, while decreasing the national carbon sinks. This pressure on the forested land and soils is largely caused by the agriculture sector, as forest land is being converted to agricultural use, and mismanaged agricultural practices are degrading the soil.

Figure 4. CO_2 sequestration for 1995, 2000 and 2005



Fuente: Pinell C. SERNA. 2010. INGEI sector - Cambio en el uso del suelo de la tierra y silvicultura

Second National Communication of Honduras (2012)

The GHG emissions data and trends draw a negative picture of the current trends in GHG emissions and removal by sinks in Honduras. These trends are reiterated by the expected business as usual (BAU) scenario of the country's emissions until 2030, when they are expected to increase by approximately 10,000,000 tCO_2e, almost 53%, between 2012 and 2030, from 18,915,000 tCO_2e in 2012, to 22,027,000 tCO_2e in 2020, to 28,922,000 tCO_2e in 2030.

The BAU scenario for emissions is based on expected economic growth, population increase and trends in historical emissions in the absence of climate change policies. This scenario was drawn up for Honduras's National Determined Contribution (NDC) to the Paris Agreement, and even though emissions are expected to increase over time, Honduras plans to implement a range of actions aimed at emissions reductions, to which the NAMA has the potential to become a substantial contributor.

At the national level, the Climate Change Law, the National Climate Change Strategy and the Agroforestry Law for Rural Development provide the public policy framework for a low-carbon and climate-resilient future, while providing co-benefits to the population. Both initiatives are aligned with the vision to transform society into a culture of sustainable production and consumption that manages equity, efficiency and protection of the environment and natural resources, and promotes adequate adaptation to climate change. The following describes the central policy framework related to climate change in terms of strategies and institutional framework in more detail.

2.3.1. Honduras's Nationally Determined Contribution (NDC)

Honduras has committed itself to a reduction of 15% in the sectors of Energy, Industrial Processes, Agriculture and Waste compared to a BAU scenario for 2030. Honduras has also established a goal for the forestation/reforestation of one million hectares, and a decrease in the use of fuelwood by households of 39% by 2030 through a NAMA on efficient cooking stoves, indicating the need for attention and specific approaches for smallholder and subsistence farmers, as well as the high levels of vulnerability that characterize them. The target is conditional upon the availability and predictability of support and the creation of a viable mechanism for climate financing. Among the actions identified in the NDC, Honduras lists the change in livestock practices as an adaptation measure, aligned with the National Strategy on Climate Change.

2.3.2. Honduras's National Strategy on Climate Change (2014)

The National Strategy on Climate Change (ENCC) is aligned with the Strategic Government Plan. It describes current and projected climate change scenarios in terms of both vulnerability and GHG emissions, presents objectives and policy guidelines for mitigation in different priority sectors, and provides measures for the institutionalization of the ENCC. The latter sets concrete strategic objectives related to adaptation and mitigation. Relevant to this NAMA are the following:

- Promoting the reduction of emissions of methane (CH_4) from the waste and agricultural sectors, and their energy initiatives.
- Promoting the reduction of emissions of nitrous oxide (N_2O) from the agriculture sector.
- Facilitate initiatives for the removal of CO_2 through actions to strengthen absorption sinks in the LULUCF sector
- Strengthening the functions of biodiversity, water supply, risk reduction and soil conservation through ecosystem conservation, the restoration of degraded areas and reductions in deforestation and degradation.

At the national level, resources for adaptation are already being mobilized through a levy on projects implemented under the CDM, although the policy instruments described in the ENCC are subject to technical and financial support, and NAMA support is envisaged as being instrumental in achieving the strategy. NAMA implementation would contribute greatly to the successful implementation and achievements of the targets set out in the National Strategy on Climate Change.

2.3.3. The Framework Policy on Climate Change

The Framework Policy on Climate Change is under development. The Policy will be based on the strategic guidelines for adaptation and mitigation laid down in the framework of the ENCC Action Plan. Its main objective is to present a reference point for the incorporation of climate change into the national public policy framework, in order to facilitate the transition towards reduced vulnerability and greater adaptability to climate impacts.

2.3.4. National Law on Climate Change

This Law, approved by the National Congress in January 2014, establishes the principles and regulations necessary to plan, prevent and respond in an appropriate, coordinated and sustained manner to the impacts of climate change. Its main purpose is to ensure that Honduras, through the central government, decentralized entities, autonomous municipalities and civil society, introduces measures to reduce the adverse impacts of climate change on the population, society and economy of the country. However, the Law does not address the agricultural sector specifically.

2.4. National institutional context related to climate change and the NAMA

2.4.1. The Secretariat of Natural Resources and Environment (SERNA)

The Secretariat of Natural Resources and Environment (SERNA) is the country's focal point in relation to the UNFCCC. Within SERNA, the government has created the National Directorate of Climate Change (DNCC) with resources for their operation allocated in the general budget for 2011. In addition, the government has created an Inter-Institutional Climate Change Committee, with mandates at both the political decision-making and technical levels, in order to define and promote actions for the implementation of the ENCC. In addition, the relevant secretariats have created linkages or focal points for the implementation of climate change actions into their sectoral policies, programs and actions.

2.4.2. The National Directorate of Climate Change (DNCC)

The DNCC has as its main objective the coordination of actions aimed at formulating and implementing climate change-related national policies and promoting the development of Climate Action Programs and Strategies related to the fulfilment of the commitments made to the UNFCCC. It is thus the entity responsible for implementing the ENCC and coordinating NAMA actions nationally. The DNCC centralizes its activities around four pillars, namely, mitigation, adaptation, climate finance and knowledge management, in order to operationalize the following activities:

Climate Change Adaptation Fund Project

- REDD +
- Third National Communication
- SDC / UNDP Project
- Other Allied Projects and Institutional Projects

The Directorate chairs the secretariat of the Inter-Institutional Climate Change Technical Committee (CTICC). Supported by CTICC, DNCC will help ensure the NAMA's transversal approach, balancing and integrating environmental and productive issues.

2.4.3. Inter-Institutional Climate Change Technical Committee (CTICC)

The CTICC is responsible for analysing the climate change action proposals to be developed and implemented in the country. It is also the agent generating the space for dialogue and institutional coordination leading to the fulfilment of the country's national communications objectives.

2.4.4. The Central American Bank for Economic Integration (BCIE)

A plan has been drawn up to create a fund to channel the financial resources mobilized through multilateral sources to the countries of the region through the Central American Bank for Economic Integration (BCIE), a component of the regional initiative under the Central American Integration System (SICA). The BCIE is also an accredited entity of the Green Climate Fund (GCF), and can therefore manage and channel GCF funds for mitigation and adaptation actions in Honduras.

2.5. Current situation in the livestock sector

Data from the Central Bank of Honduras show that the importance of the agricultural sector has declined in the national economy, from 20% of GDP in 1990 to approximately 12% in recent years, but if all goods and services related to agriculture and food are added, it is estimated that the total proportion would be between 40-45% of GDP (SAG Honduras, 2010). Even though the relative importance of agriculture as a proportion of GDP has decreased, the sector has grown in line with the entire economy, though experiencing more year-on-year variations than other sectors. According to the Inter-American Institute for Cooperation on Agriculture (IICA 2007), the agricultural sector accounts for 74.9% of the country's total exports. Total agricultural exports reached USD 3.47 billion in 2013.

Livestock contributes nearly 13% of the agricultural GDP. 36% of the economically active population is involved in the livestock sector, which generates about 180,000 direct jobs. Because it is one of the main sources of employment, it is also one of the most important productive and social activities (Sanchez 2014). This sector is also considered to be the basis of subsistence and food security for the majority of the Honduran population. 76% of farms are dedicated to dual-purpose production, meaning that both milk and meat are produced (FENAGH 2014). 15% of the country's farms are specialized in milk production, which implies more intensive production systems using energy and protein supplements.

9% of farms are devoted exclusively to fattening activities and meat production. The country's estimated production is between 500 and 650 million litres of raw milk per year, or about 1.7 million litres a day. Much of this is used for domestic consumption, the rest for export to , for example, the USA, Mexico, and Central and South America (CDPC 2013). Meat production in 2010 was 57,400 MT (FAOSTAT 2012), and meat consumption nationwide was 24,000 MT in 2009 (CMA 2011).

Milk production in Honduras increased steadily until 2008 (with the exception of the 1998-2000 period, as a result of the effects of Hurricane Mitch); from 2008 to 2010 it then underwent a further decline. This latter decline may in part be attributed to the prolonged drought of 2009, associated with El Niño. By contrast, beef production decreased from the beginning of the 1990s, due to the collapse of US markets, but then increased again due to the reactivation of markets, influenced in part by the Free Trade Agreement. As with milk, there was a further decline in beef production between 2008 and 2010 of around 23%, due to the global economic crisis and lack of support to the national ranching sector.

Table 2. Socioeconomic indicators of cattle livestock in Nicaragua

Region	Farms	Annual milk production (t)	Annual meat production (t)	Average farm size	
				Heads / farm	ha/ farm
South (Choluteca)	15.335	77.329	7.022	5,9	11,3
Central-west (Comayagua)	15.520	41.686	3.398	3,1	7,2
Atlantic Coast (Ceiba)	6.305	77.244	6.147	14,3	23,1
North-east (Olancho)	18.722	120.087	11.065	7,5	20,7
Central-east (Danlí)	15.487	71.151	7.286	5,4	13,5
North-east (Yoro)	30.177	209.478	22.077	8,1	16,8
Total	101.546	596.975	56.995	6,9	15,2

Livestock production in Honduras is highly dispersed in small herds throughout the country, with the departments of Cortés, Atlántida, Colón, Yoro and Olancho having the largest stocking populations. Most of the country's cattle ranching is managed by small and medium producers. 46% of farms are less than five hectares and have 13.2% of livestock population. More than 90% of these farms have low productivity and a low technological level in the production system. 43.2% of farms are between five and fifty hectares in size and have 34.5% of the cattle population. In contrast, the largest farms of 50 to 250 hectares only account for 9.7% of farms, but have 35.2% of the cattle herds of the country. The size distribution of farms with cattle is highly skewed: 47.7% have herd sizes of less than fifty animals. Farms of less than five ha are of great social importance (accounting for 46% of the total number of farms and farmers), but limited environmental significance in terms of the area they affect (they account for only 3.4% of the total pasture area) and limited economic importance, since they only account for 13.2% of the national herd.

The following describes the main features of each meat and milk bovine chain region (FENAGH 2014) (Table 3). The vast majority of farms with cattle in the south and west are small or very small, with herd sizes of between one and nineteen animals (on average between three and six animals) and average farm sizes of between seven and eleven ha; this contrasts sharply with the Atlantic coast and northeast, where there are significant numbers of farms with more than a hundred head, and average farm size is between 20 and 23 ha.

Table 3. Main livestock characteristics based on socioeconomic region in Honduras

Region	Department	Total herd	Number of livestock farms	Average stocking (head/ha)	Total pasture (ha)	% Improved pasture	Total rainfall (mm/yr)	Wet season rainfall (%)
North-East	Most of Olancho	453,924	18,648	1.67	271,000	96	1,200	85
Central-East	El Paraíso, parts of Olancho and Francisco Morazán	217,946	12,621	1.08	201,000	78	1,186	85
Oeste	Ocotepeque, Copan, parts of Santa Bárbara y Lempira	207,143	11,305	1.76	119,000	94	1,823	93
South	Choluteca and Valle	278,662	13,498	5.98	46,000	85	1,785	92
Central-West	Comayagua, La Paz, part of Francisco Morazán	120,984	12,730	3.55	34,000	76	1,212	90
North	Cortés, part of Santa Bárbara, Atlántida and Yoro	301,207	11,581	2.08	144,000	95	1,465	90
Atlantic Coast	Colón, part of Atlántida and Yoro	280,501	6,445	2.76	101,000	93	2,253	96

Source: FENAGH 2014

The traditional extensive grazing system is predominant in livestock production: more than 350,000 families use this system for their pastures, as the most important source of food for their animals (Aguilar et al. 2010). Most of the territory is dominated by ranching, and in some areas, such as the Atlantic coast and midwest (Comayagua, Copan and Santa Barbara), it is more common to find production systems where the stabling and semi-stabling livestock are practised at a higher technological level than in the rest of the country.

The productive parameters of efficiency in the livestock sector are low, the cattle mortality of born, young and mature cattle being approximately, 52%, 8% and 3%, respectively. The primary sector of the Honduran bovine meat chain is constituted by breeders, finishers and other members of the chain, namely industrial processors, packers, retailers, intermediaries, municipal slaughter houses and consumers.

Table 4. Socioeconomic indicators of cattle livestock in Honduras

Indicators	Honduras
Productive ha	2,500,000
Agricultural GDP by 2014	14%
Animal production index	109.5%
Yield cattle heads per year	2,015,737
Yield litres of milk per year	500–650
Average farm area (ha)	17
Number of farms	96,622 farms
National meat consumption in tonnes	24,000
Export	USD 383.8 million (meat)
Number of employed families/people	180,000 direct jobs, 350,000 indirect

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

A lack of competitiveness in the sector from the global perspective can be observed due to the following limitations:

- Macro socio-economic factors related to the economic, political and social challenges of the country and sector
- Market prices, related to global supply and demand
- Micro socio-economic factors related to the productive processes used on the farms

The value chain of the livestock sector consists mainly of the following links: inputs, primary production, collection, artisanal processing (consisting of small companies that do not pasteurize milk and produce cheese, or produce butter and cheese of lower quality, which are sold in the local and national markets) and industrial processing (which pasteurizes milk, it and its derivatives being packaged under high-quality standards, sold nationally or exported) and commercialization. The almost monopolistic concentration in the production of inputs of national origin act against the livestock producer.

Access to and the availability of production inputs is adequate, but is limited by the lack of economic resources with which to acquire them on the part of the producers . Also, producers express the urgent need for supplements of high nutritional value and low cost. Regarding milk production, yields vary depending on the production system used (intensive or extensive) and the use of good practices in production. Currently, producers face a number of challenges, including climate change (drought), high production costs, high dependence on external inputs, increased pests, reduced pasture quality, resistance to change and lack of technical assistance (productive and entrepreneurial). The main inputs demanded, with their suppliers in parentheses, are concentrates (Alcon, Alcon, Cadeca and Protein), genetic material (Pagro and Semalca), grass seed (Duwest), fertilizers and herbicides (Fenorsa and Finca) and vitamins, minerals and medicines (Nutritec, Agrinova and Cadelga). It is estimated that

about 35% of the total costs of production correspond to the value of the concentrates. The high cost of production inputs and their effect on competitiveness, especially for the non-technical farms, is recurrent.

About 98% of primary producers feed their livestock from natural and improved pastures without properly managing the latter, and the use of forage is dependent on the existence of silos and/or hay. The low level of productivity is due to the fact that producers use extensive systems with low animal loads and natural pastures and follow poor quality, bad management practices with deficiencies in the use of mineral salts and mineral supplementation, and low rotation of pastures. In specialized meat herds and on some dual-purpose farms, supplementation rations are used based on grains and minerals.

Among the main inputs of production are salts, minerals, molasses, vitamins, vaccines and deworming. The approximate costs of inputs used for livestock production are around USD 8.62 / animal (Lps. 196.80 / animal) in a seven-month fattening cycle. The costs include vaccines, vitamins and deworming. The highest cost is for medicines (USD 13.1 - USD 41.6) every three months for every 20 animals and minerals (USD 78.81 / sack of 50 pounds, for 15 days, for every 20 animals).

Honduras is a country with a vocation for agroforestry, though there are areas with a high potential for improvements in the management and production of livestock. The Honduran livestock sector has existed for several centuries using a monoculture pasture management approach, where trees are seen as a factor limiting pasture growth. This traditional management of livestock leads to an extensive and inefficient use of the soil in general (Naranjo, 2000). About 98% of producers feed their livestock on natural pastures, without proper management of pasture areas, and silage and hay are only used in rare cases. The low productivity is due to the fact that producers use extensive systems with low animal load and poor quality pastures, and follow poor management practices with deficiencies in the use of supplements and mineral salts, and low rotation of pastures (Perez 2012).

Traditional livestock-raising also represents a significant source of greenhouse gas (GHG) emissions by generating carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) throughout the production process. Livestock contributes to GHG emissions directly through enteric fermentation and manure, and indirectly through how the production system is managed and the conversion of forests to pastures (FAO 2013). In 2011, 25% of global GHGs related to agriculture and livestock were produced in Latin America and the Caribbean (Tubiello et al., 2014).

2.5.1. Case study and socioeconomic characterization of livestock producers in the Caribbean Region

In the NAMA preparation phase, a case study has been elaborated in the Caribbean region (Atlantida and Sico-Paulaya region) to gather more detailed data on livestock and the planned practices. The following presents a selection of the data on the livestock sector. Livestock is mainly managed under dual-purpose production systems. Milk is the source of primary income and calves are a secondary source, whereas females are usually kept as a replacement for animals in the production of milk and for reproduction. Milk is taken to collection centers or CRELs, who sell milk to two milk-processing companies, to Sula and Leide, or to artisanal cheese factories. Calves are sold at auction or to other producers. During the rainy season feeding is based on grazing, while in the dry season, where power problems occur, the main supplement in addition to grazing is Pollinaza 11 (about 1-2 kgs/cow/day).

Among the main limitations on production are the regular decreases in food supplies during critical times caused by intense summers or heavy periods of rain, which influences grass production and therefore the productivity of milk. Due to farming practices becoming less attractive to the young population, the average age of producers is fairly high, with a low level of education. Only a small proportion of producers have implemented improved pasture management systems and fodder banks. The main features of farming in the region are presented in Table 5.

Table 5: Representative case study of livestock farms in the Caribbean region of Honduras

Variables	Sico-Paulaya	Atlantida
% of producers living at the farm	49	27
Average age	49	54
% of educational level		
• No education	15	4.7
• Incomplete primary	50.5	0
• Complete primary	17	60
• **Incomplete high school**	**11**	**20**
• High school completed	6	10
• University or technical	0	5.3
Pasture area (has)	5,007.8	2,697.0
Improved pasture area (has)	177.8 ha (3.5%)	669 ha (24.8%)
Natural pasture area (has)	4,830 has (96.4%)	2,028 has (75.2%)
Forest area (has)	555.8 has	480 has
Fodder Banks	-------	3.2 has
No. of animals	10,204.00	6,268
Animal stock (average)	1.81 (UA/has)	2.38 (UA/has)
Milk production	3.3 kg /day /cow	4.3 kg/cow/day
Financial Indicators		
Producers with a cost benefit relation of ≥ a 1	99%	85%
Producers with a positive NPV	96%	85%
% of producers with credits	0	0
Credit interest rate	0	0

2.6. Alignment with sectoral strategies and development plans for livestock

2.6.1. Strategic Government Plan 2014-2018

The plan already described above specifically targets the livestock sector and is aimed at facilitating its expansion and modernization in order to increase production and productivity, improve competitiveness, generate employment and increase foreign exchange earnings through:

- Guaranteeing the financing of oil palm, sugar cane, cattle, pigs and poultry by the Trust for the Reactivation of the Agri-Food Sector of Honduras.
- Encourage a national program for the production of biofuels.
- Implement a national program for the restocking of cattle, pigs and poultry.

To achieve the goal of poverty reduction in households, the plan is aimed at consolidating the management of rural development programs, regardless of their source of funding, in order to increase implementation levels efficiently, improve the competitiveness and productivity of small agricultural producers and generate employment and better income-earning opportunities for poor families in the rural sector.

2.6.2. Central American Agricultural Policy 2008-2017

The process of Central American integration has been intensified, resulting among other initiatives in the Central American Agricultural Policy, which has the objective of coordinating policies at the regional level by:

- Promoting conditions for the development of a modern agriculture sector that is competitive, equitable, articulated regionally and conceived as an expanded sector, with the capacity to adapt to new roles, face challenges and opportunities, and promote complementarity between public and private actors
- Contributing to the development of sustainable Central American agriculture from the economic, social, environmental and institutional points of view
- Seeking monitoring and evaluation mechanisms to ensure its effective implementation.

The policy sets out a wide range of objectives. Relevant for the NAMA are specifically the objectives regarding technologies or practices:

- Promote the incorporation of technological innovations to improve the competitiveness of the agricultural productive sector
- Strengthen the appropriate regional, legal and institutional frameworks to promote technological innovation in the agricultural sector
- Encourage public and private investment in support of processes of regional technological innovation and development institutions.
- Facilitate access to rural financial services for micro and small agricultural enterprises.
- Create favourable conditions for the strengthening and deepening of financial services in rural areas.
- Foster a greater diversity of financial services that are adequate and innovative for rural areas.

NAMA implementation is aligned with the objectives of the regional policy and will contribute directly to the achievements of the objectives listed above. The adoption of technologies, institutional cooperation, co-benefits, financing mechanisms and MRV are described in more detail in the following chapters.

2.6.3. National Strategy on Adaptation to Climate Change for the Honduran Agricultural Sector 2014-2024

The Strategy and its implementation frame strategic objectives for the agriculture sector regarding risk management and climate change mitigation and adaptation actions. Among the strategic areas defined in the strategy, two are specifically related to the activities the NAMA is envisaging:

- Strengthening the capacities of the technical staff of the SAG and other institutions regarding adaptation to climate change
- Research, innovation, evaluation and monitoring of agricultural systems, technologies and good practices, fostering inter-institutional cooperation.

2.6.4. The Policy for Long-term Food Security and Nutrition (PSAN)

A Strategic Plan for Implementation of the Food and Nutrition Security Policy was derived from the PSAN. Both instruments regard the issue of food and nutrition security as a sectoral issue that is complementary to other strategies, such as the Poverty Reduction Strategy. The long-term objective of the PSAN is to ensure that all Honduran families attend to their basic food needs in quantity, quality, timeliness and safety in order to achieve an adequate state of health and well-being and fully develop their cognitive and physical potentials (UTSAN, 2010). By increasing the productivity of the livestock sector, improving farmer's income potential, ensuring the sustainable management of farms and making production systems more resilient to climate change, the NAMA will directly contribute to the objectives of the PSAN policy.

2.6.5. The State Policy for the Agricultural Sector and the Rural Environment of Honduras (2004-2021)

The policy presents approaches to the development of agricultural product chains in different agricultural products that depend on rain. Relevant to this NAMA, the policy envisages the design and implementation of a National Reforestation Program, whereby the planting of four hundred trees per hectare would be mandatory in areas that are being harvested for either commercial or non-commercial forest use. To finance this program, the SAG will issue a Presidential Agreement so that in all livestock projects a minimum of 10% will be devoted to reforestation. As silvopastoral practices are envisaged in the NAMA, this will directly contribute to the fulfilment of this state policy.

2.6.6. Honduras's Nationally Determined Contribution

Honduras's NDC was mentioned briefly earlier, but more relevant for the livestock sector is its recognition that the agriculture sector is of great economic importance for the country, as well as being one of the most vulnerable to climate change, and it highlights the following need for action that is relevant and aligned with the NAMA objectives:

- Change in agricultural practices: implementation of agroforestry systems, reduction of fertilizer load with increased use of slow-acting organic fertilizers, modification or elimination of inappropriate agricultural burning practices, measures to combat erosion, development of organic fertilization systems, and stimulus and/or inductive impulse to organic agricultural production, including tax and financial incentives.
- Changes in livestock practices: changes in pasture management sowing of improved pastures, limitation of pasture burning to the control of mites in cattle.
- Capacity-building and research: selection and development of varieties and species of crops and pastures resistant to drought and flood, and development of sustainable systems based on agroecology.

NAMA implementation will therefore directly contribute to the implementation of practices specified in the NDC and to achieving the NDC targets.

2.7. Sectoral GHG emissions and potential reductions through alternative practices

The Honduran Climate Change Office of the Ministry of Natural Resources and Environment has prioritized the agriculture sector in directing its mitigation efforts in view of the sector generating 32% of the country's total emissions. Enteric fermentation by livestock in Honduras emitted 2,447,000 tCO_2e (SERNA, 1995), corresponding to 95% of the methane in the agriculture sector, followed by the manure management sector (4%) and by methane emissions from burning agricultural waste in the fields (1%).

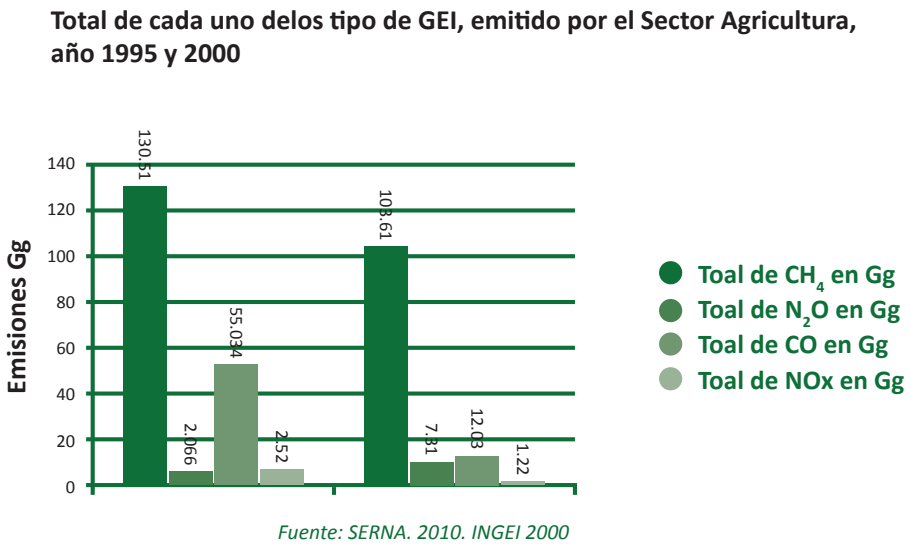
Table 6. Estimated GHG emissions from the agriculture sector

Subsector	Emissions (kt)						
	CO_2	CH_4	N_2O	NOx	CO	COVNM	SOx
Enteric fermentation		97.9					
Manure management		4.33	3.27				
Rice cultivation		0.29					
Agricultural soils			4.00				
Prescribed burning of savannas		0.001	0.02	0.33	0.57		
Agricultural waste burning		0.54	0.02	11.7	0.65		
Total		**103.61**	**7.31**	**12.03**	**1.22**		

Source: Second National Communication of Honduras (2012)

There was a decrease in GHG emissions from 1995 to 2000 due to a reduction in rice production and the number of heads of cattle, which is not congruent with the country's sustainable production strategies. The following graph shows the total volumes of GHG emitted by the agriculture sector in 1995 and 2000.

Figure 5. Total GHG emissions by gas for the agriculture sector in 1995 and 2000



Source: Second National Communication of Honduras (2012)

The national balance between emissions and removals shows negative emissions of 13,828,940 tCO_2e in 1995, while in 2000 there was an increase in emissions of 5,680,000 tCO_2e. This shows that the level of deforestation in the country has increased.

The major sources of emission along the supply chain in livestock are as follows:

- Land use and land-use change: 2,500 $MtCO_2e$/year, including forests and other natural vegetation replaced by pastures and feed crops in the Neotropics and the carbon liberated from soil, grassland and cultivated land used for the production of feed
- Feed production (excluding carbon released from the ground): 400 $MtCO_2e$/year, including fossil fuels used in the production of chemical fertilizers for feed crops and N_2O from chemical fertilizer application to feed crops, leguminous crops and feed
- Animal production: 1,900 $MtCO_2e$/year, including enteric fermentation from ruminants (CH_4) and fossil fuel use on farms

- Manure management: 2,200 $MtCO_2e$/year, mainly through the storage, application and depositing of manure (CH_4 and N_2O);
- Processing and international transport: 30 $MtCO_2e$/year

Source: Steinfeld et al. (2009)

Even though overall emissions have decreased, Honduras still needs to increase its productivity, including in the production of cattle. Under current livestock management practices, this is expected to lead to increased emissions through the increases in enteric fermentation and manure management, and the increased pressure on the forested area due to the expected expansion of pasture areas. Current livestock practices also contribute to soil degradation, which is generated by the use of non-rational management practices in livestock lands, such as uncontrolled burning, inappropriate tillage practices, lack of vegetation cover and other soil conservation methods, ineffective management of soil fertilization and overgrazing. The deforestation and degradation of pastures have a negative impact leading to a loss of biodiversity, soil compaction and erosion, rupture of basin balance and increases in GHG emissions (SAGARPA 2011). However, there are several practices that can reduce emissions per produced unit, or even make livestock systems capture more carbon than would be emitted otherwise (Andrade et al. 2008a).

There is a close relationship between the amount of food, diet digestibility and the production of CH_4. Practices focusing on reducing emissions while not affecting production negatively focus on changes in the animal diet that have the potential to reduce CH_4. Dietary changes can have an impact on production levels that may affect the livelihoods of livestock producers in the region, so it is important to select practices which do not affect production negatively. Among the practices deemed not to affect production negatively is improving the quality of animals' diets with forage of high digestibility. This decreases the overall consumption of dry matter while meeting animals' energy requirements, a fact that reduces emissions of GHGs by five percent. Another dietary strategy is the inclusion of legumes in the diet of animals living in warm weather, leading to a twenty percent reduction in methane emissions compared to animals only fed with grass (Archimède et al. 2011). Similarly, beef cattle grazing on pastures of alfalfa and grasses showed lower enteric emissions than the same cattle grazing only on grasses (McCaughey et al., 1999).

The implementation of specific herd-management strategies can lead to both reductions in enteric fermentation and increased productivity of the herd overall, meaning fewer emissions per litre of milk or kg of meat produced. A cow producing 40 kg of milk/kg of protein emits about half of the emissions of a cow producing 10 kg of milk/kg of protein; intensive grazing, based on high productivity of forage in established pastures, can reduce the methane emissions of meat cattle by 22% (Deramus et al. 2003). Using silvopastoral systems (e.g. with Leucaena leucocephala) produces more methane than improved treeless and extensive conventional grazing (105 vs 38 vs 16 kg CH_4/ha/year pastures respectively) but less per product unit (128 kg CH_4/t meat), which is 10-44% lower than the other two systems (Murgueitio et al. 2014). Refining animals' diets by using improved pastures and fodder banks decreases the intensity of enteric CH_4 emissions, especially when the consumption of this type of forage reaches over 35%. Enteric fermentation is also decreased by reducing stress in the animals, indicating that particular attention should be paid to providing adequate shade and water to diminish heat stress (Hristov et al. 2013).

Improved pastures (pasture rotation) is another management practice that can lead to large reductions in emissions by improving animals' diet, but it also increases the sequestration of carbon by the soil, while also allowing for a higher intensification of the herd. Compared to native pastures, improved pastures lead to higher net emissions, but lower emissions per head of cattle. The net emissions calculated for different silvopastoral practices in the case study of the Caribbean Region in Honduras are listed in Table 7.

Table 7. Emissions, intensification potential and carbon sequestraition potential of different silvopastoral practices

Land-use system	Animal stock (animal unit/ ha)	Carbon fixation rate	GHG emissions	Net emissions
		$tCO_2e/ha/y$		
Native pastures	0.4	0.0	1.8	1.8
Native pastures with trees	0.6	7.8	1.6	-6.2
Improved pastures	1.2	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)

Waste management of the cattle's manure can also reduce CH_4 emissions, and the application of manure can replace the use of nitrogen fertilizers, thus controlling N_2O emissions (Minaet 2009). Moreover, N_2O mitigation can be based on regulating the amount of time the animals remain in the paddocks (Gerber et al. 2013).

In addition to these production systems, there are some practices that can reduce emissions further. A cow can produce 1.73 m^3 biogas/day, which can be used by farmers as a thermal energy source, and the residual sludge can be used as a natural fertilizer, corresponding to an emissions reduction of 9.0 tCO_2e/year (Casas-Prieto et al. 2009). Likewise, introducing organic fertilization and using legumes can reduce GHG emissions by 0.7 tCO_2e/ha/year, which contributes to improving the carbon footprint of land-use systems (Snyder et al. 2008). In this scenario, changes in land use depend on the size of farms, and small farms are expected to establish a smaller area of improved systems than larger farms.

2.8. Institutional framework for the livestock sector and NAMA management

2.8.1. Secretariat of Agriculture and Livestock (SAG)

SAG is the national public institution in charge of governing and organizing the livestock sector, and it will therefore act as the NAMA coordinating entity, liaising with DNCC for NAMA approval and coordination with other climate actions through CTICC. Its objective is to ensure a competitive and sustainable national agricultural production capable of integration into the international economy and of integrating human, social and environmental development based on self-management, gender equality and the sustainable management of natural resources. In this context, SAG plays a triple role in the public administration, since it coordinates the planning and execution of the Agricultural Public Sector Policy. At the sectoral level, SAG coordinates the sectoral policies implemented by the institutions that make up the Agricultural Public Sector, which are concerned with land tenure, rural finance, marketing, forestry, agricultural production, and rural and forestry development. At the institutional level, SAG intervenes through its Directorates-General, and its programs and projects implemented in the short, medium and long terms, which incorporate quantifiable and measurable indicators for their evaluation. Regionally and globally SAG is a member of a number of agencies, including the Central American Agricultural Council (CAC), the Tropical Agronomy Centre (CATIE), the Inter-American Institute for Cooperation on Agriculture (IICA), the United Nations Food and Agriculture Organization (FAO) and the International Fund for Agricultural Development (IFAD).

SAG heads a range of institutions related to different aspects of the sector (health, competitiveness, education etc.), like the National Agricultural Health Service (SENASA) and PRONAGRO of the Directorate of Agricultural Science and Technology (DICTA), and it hosts the Agricultural Education, Training and Agribusiness Development Service (SEDUCA).

2.8.1.1. Directorate of Agricultural Science and Technology (DICTA)

DICTA has the following mandates and objectives that are relevant to the NAMA:

- Guaranteeing access to technology services and technology transfer to producers through capacity development for innovation in rural communities, agricultural job creation and increasing the amount and competitiveness of agricultural products in a socially equitable and environmentally sustainable way
- Organizing and operationalizing the National System for Innovation and Technological Development in order to ensure the generation and transfer of agricultural technology
- Designing and developing technologies adapted to producers' demand and climatic conditions, to increase production and productivity
- Transferring technologies that promote technological innovation, increase capacities and strengthen competitiveness in a socially equitable and environmentally sustainable way
- Guaranteeing access to technical assistance to small and medium-size producers to improve the food security of families, and organizing increases in production and capacity development for innovation.

DICTA heads the Program of Agricultural Technology Transfer, which has already enhanced the capacities and productive abilities of 14,525 small and medium producers, specifically targeting women, and accounting for 32% of the technical assistance, training and technological support provided. Ten agricultural professionals and 1,108 students of the agricultural sciences were trained and their technological knowledge updated. The technology focus was directed towards increased efficiency in order to enhance the agricultural sector's competitiveness. In the case of the NAMA, the technologies and practices presented here will be incorporated into DICTA's technical assistance to livestock producers. This will also form a part of the national contribution, in which parts of the current budget of L 30,552,999 (USD 1,302,300) for the Program of Agricultural Technology Transfer will be used for the targeted capacity-building of livestock producers as part of the NAMA activities.

2.8.1.2. National Agricultural Development Program (PRONAGRO)

PRONAGRO is responsible for promoting agribusiness to generate greater added value and in this way increase the competitiveness and income of producers. The primary objective of the Program is to strengthen the competitiveness of agriculture in the valleys and highlands of the country, where producers are organized in agricultural food chains and networks in order to establish dialogues, agreements and initiatives to intensify, diversify and increase the value added of agricultural and agro-industrial production.

2.8.1.3. Agricultural Education, Training and Agribusiness Development Service (SEDUCA)

SEDUCA aims to promote the training of human resources in the agriculture sector in order to equip the country's workforce with the skills and knowledge needed to produce and market production more competitively. SEDUCA has several components aimed at educating producers to enhance their capacities through agro-alimentary education, agro-entrepreneurial training and agricultural communication for development. Capacity-building and technology support provided by DICTA will be translated into educational materials for SEDUCA to disseminate in order to reach producers who will not be reached by the NAMA during its initial years. Here the aim is to achieve a spill-over effect to farmers who for various reasons might not have received support in the initial stages of the NAMA.

2.8.2. National Federation of Farmers and Ranchers of Honduras (FENAGH)

FENAGH is a private, non-profit institution aimed at representing the general interests of the agricultural sector, its member organizations and national agricultural producers. Its objective is to promote national agricultural development and the welfare of its stakeholders, as well as promote research and the dissemination of new technologies. This is done mainly by encouraging the cooperation and association of people engaged in agricultural activities, participation in policy formulation, the implementation of development programs and the promotion of national production. It also promotes the consumption, quality and added value of products, as well as the strengthening of unions. FENAGH also cooperates with public and private institutions in the sector in finding solutions to technical, economic and social challenges in agricultural production. FENAGH has participated in the stakeholder consultation process in NAMA preparation and will participate in the dissemination of the practices envisaged in the NAMA, while promoting the products produced through these sustainable practices.

8.3. Honduran Milk Chamber (CAHLE)

CAHLE is a social economy association representing the general interests of the dairy chain. It aims to produce a dairy sector with excellent sanitary standards and an adequate marketing system, to encourage the consumption of dairy products and their derivatives for the benefit of the sector and consumers, and to promote facilitative policies towards producers of milk and its derivatives. CAHLE has participated in the stakeholder consultation process during NAMA preparation and will participate in the dissemination of the practices envisaged in the NAMA, while promoting products produced using these sustainable practices.

2.8.4. Chamber of Livestock Development (COFOGAH)

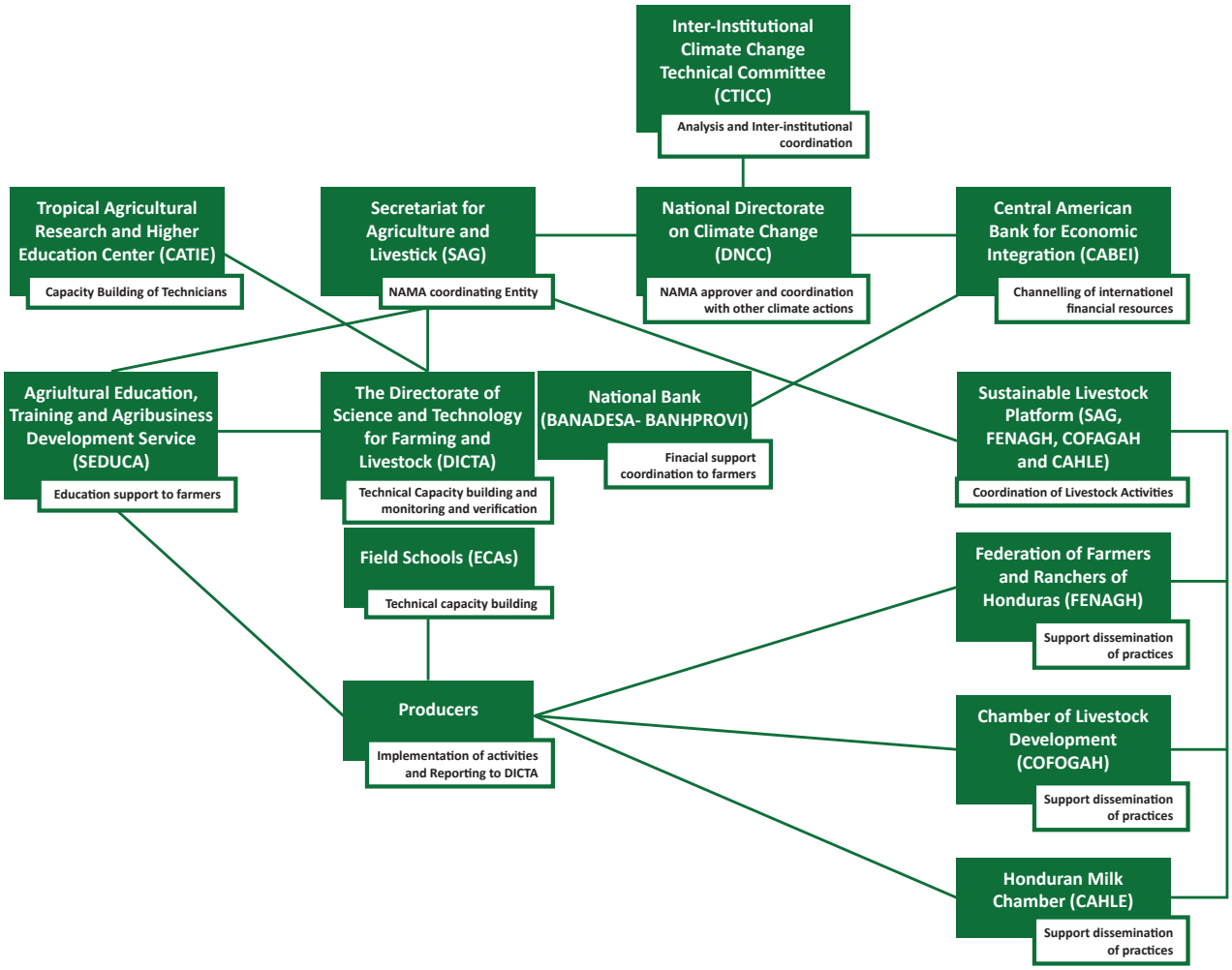
COFOGAH is the interest organization for livestock producers. It aims to promote optimum levels of production and productivity on the part of its stakeholders, excellent sanitary standards and an adequate marketing system, as well as guaranteeing the organoleptic and microbiological characteristics of meat and its derivatives, in order to offer consumers products of high quality at attractive prices. COFOGAH has been involved in the stakeholder consultation process during NAMA preparation and will participate in the dissemination of the practices envisaged in the NAMA, while promoting products produced using these sustainable practices.

2.8.5. Livestock producers

Farmers who own livestock constitute the main beneficiary of the project. In order to maximize coverage and cost effectiveness, the NAMA targets farmers through the relevant institutional partners. Successful implementation of the NAMA therefore depends to a large extent on the participatory mechanisms managed by each of these partners to obtain feedback and inputs from participating farmers in relation to NAMA and its impacts.

The following figure illustrates the institutional framework for NAMA implementation, the institutions involved and their respective roles:

Figure 6. Institutional framework for NAMA implementation



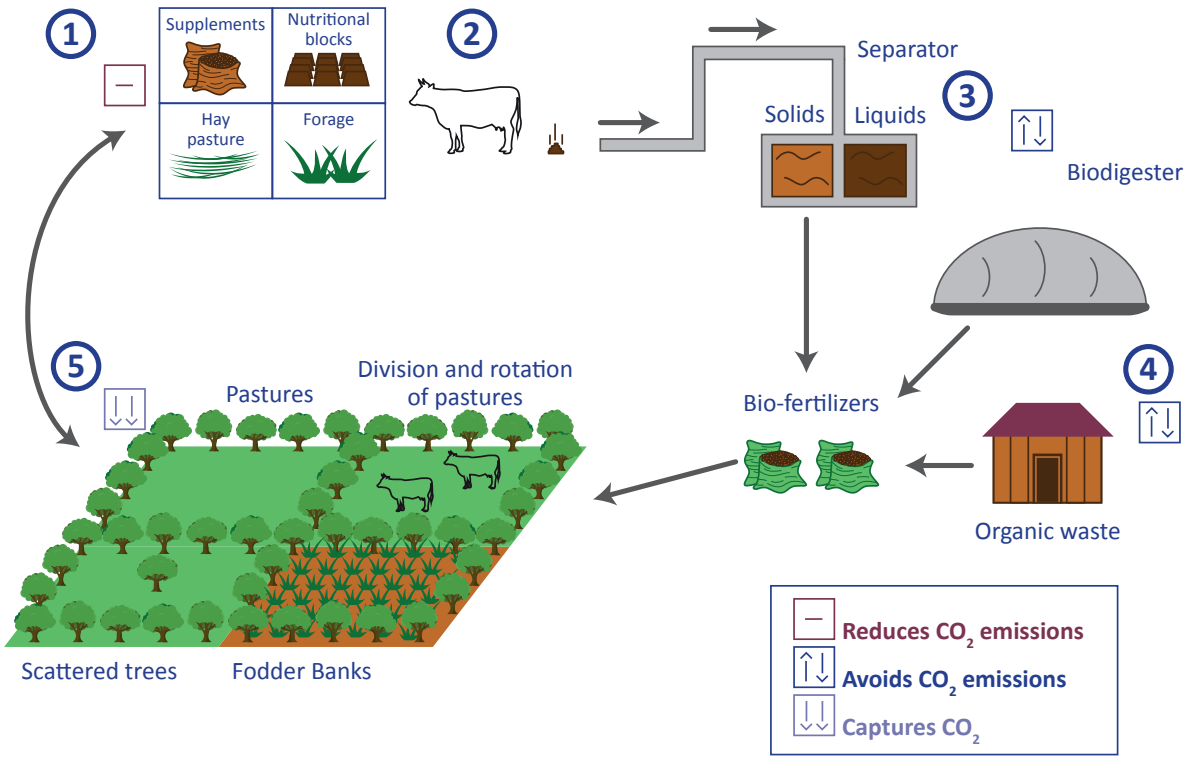
3. Description of sustainable livestock practices for NAMA implementation

The following sustainable mitigation and adaptation practices for livestock 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. Application of biodigesters
3. Production and application of organic fertilizers
4. Production and application of nutritional blocks

These practices can be implemented separately, but most positive synergies can be achieved by implementing them as part of holistic systems, where the implementation of one practice facilitates the implementation of the others symbiotically, as illustrated by the figure below:

Figure 7. Synergies and symbiotic relationship between sustainable practices



3.1. Silvopastoral systems

A silvopastoral system is a livestock production management system 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 increases above- and below-soil carbon and reduces soil degradation, favouring adaptation to and mitigation of climate change, diversifying production systems, reducing dependence on external inputs and intensifying land use. Implementation of these measures also improves the quality and

availability of food for domestic animals throughout the year through fruit and forage produced by trees and shrubs and promotes the diversification of livestock production, thus increasing the income and welfare of producers and their families. Good silvopastoral system designs therefore also have economic, social and environmental co-benefits. Reductions of GHG emissions are achieved through the following mechanisms:

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

Silvopastoral systems may incorporate the following sub-practices:

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

The various silvopastoral designs offer a number 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 farm sustainability, necessitating economic, social and environmental benefits.

Table 8 shows the economic, social and environmental benefits that, according to Montenegro and Abarca (2002), are achieved with an SSP:

Table 8. Benefits most commomly 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		Contribution to biodiversity conservation and generation of ecosystem services
		Protection of riparian forest and forest

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 know in approximate terms the production of the grass by surface unit and the number of animals to be grazed. The division of tillage to be made, according to the days set aside for grazing and rest and the number of animals to be grazed, determines the investment in fences.

Table 9. Estimated costs of fencing one hectare of pasture

Activity	Manpower (d/h)	Cost (Lempiras)	Cost (USD)
Cutting of posts	4	857.14	37.32
Cutting of piles	3	642.85	27.99
Wire roll	-	3,428.57	149.26
Staples	-	457.14	19.90
Sowing of posts and stakes	18	3,857.14	167.92
Fixing wiring	10	2,142.85	93.29
Total cost		11,385.71	495.68

Exchange rate: October 2016: 1 U$ = 22.97 Lps. 1 working day, one person for 8 hours = 150 Lps

Figure 8. Division of pastures

3.1.2. Forage Banks

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 less grass is available (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 improves soil use and reduces the area devoted to livestock grazing, while converting areas to forests.

Figure 9. Forage Banks

Table 10 Average costs for the establishment and maintenance of one hectare of energy forage bank (Maralfalfa).

Activity	Man-days *	Average cost (Lps)**	Cost (U$)
Manual land-clearing	6	900.00	39.18
Preparation of the ground	-	1,600.00	69.65
Bedding	-	800.00	34.82
Cutting, hauling and sowing of grass	-	3,800.00	165.43
Earth up	-	1,250.00	54.42
Fertilization	-	3,350.00	145.84
Cleaning after sowing	6	900.00	39.18
Sub-total	49	12,600.00	548.54
Manual weed control	5	750.00	32.65
Cutting, hauling, chopping and offering	52	7,800.00	339.57
Subtotal	59	8,850.00	385.28
TOTAL	108	21,450.00	933.82

** 1 day man is composed of 8 working hours. The average value of a man's day in Honduras is 150 lempiras. ** Values include product prices. Exchange rate October 2016 $ 1 = 22.97 Lempiras. Source: based on workshop results*

3.1.3. Establishment of live fences

One of the most common silvopastoral systems on farms in Honduras is the establishment of trees and/or shrubs of different species on the boundaries of the farm or to demarcate divisions of pastures or crops.

Figure 11). These live fences are widely used because they lower the costs of the establishment and maintenance of 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 for the establishment of new fences and the reduction of fence maintenance costs. 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, obtain food or nest (Villanueva et al., 2008).

Figure 10. Living fences as biological corridor

Table 11. Cost of establishing a hundred linear metres of simple and compound living fences

Activity	**Cost per activity**	
	Lempira	**Dollars**
Cleaning the ground with machetes	150	3,350
Cutting and hauling pickets	450	600
Cutting and hauling dead poles	600	3,950
Digging of holes, planting of cuttings, dead poles and laying of wire	900	
Cost of one roll of wire and one pound of staples	1250	54.41
Total	**3,350**	**145.84**
Activity	**Cost per activity**	
	Lempira	**Dollars**
Establishing a hundred linear metres of simple live fence	3,350	145.84
Fruit and wood plants	600	26.12
Total	**3,950**	**171.96**

Exchange rate: October 2016: 1 U$ = 22.97 Lps.

Figure 11. Live fences Source:Shutterstock/Enrique Romero

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

In traditional schemes, the livestock farmer seldom sows trees in his paddocks. Dispersing trees and/or shrubs in the paddocks is a practice that increases tree cover but also provides benefits in terms of animal productivity (Figure 12). Trees and shrubs provide greater comfort to the animals because the shade of the trees improves the microclimate of the pasture; the animals are more comfortable and spend more time in food consumption. In addition, this improves soil fertility through the contribution of organic matter and provides wood resources for family use such as for firewood, wood, etc. In the dry season the trees and shrubs also become a source of foliage and fruit for the animals. They contribute to the removal of carbon at a rate of between 12 and 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 costs USD 150 per hectare.

Figure 12. Trees scattered in pastures Source: Shutterstock/Yana Mavlyutova

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 to generate electricity. For traditional farmers small applications are envisaged, leading to energy savings and replacing fuelwood of approximately 90 kg of firewood per week, leading to reduced 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 the waste sludge, a liquid rich in nutrients and an excellent organic fertilizer that can be used to fertilize the grass or crops or for sale in the community. GHG reductions are expected at 6-10 tCO_2e/year, 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 food, and therefore reduction of deforestation

Figure 13. Low cost and medium cost family biodigesters

Honduras has the potential to generate 5.49 million cubic feet of methane per day from cattle manure, equivalent to generating 61.2 MWh. However, 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.

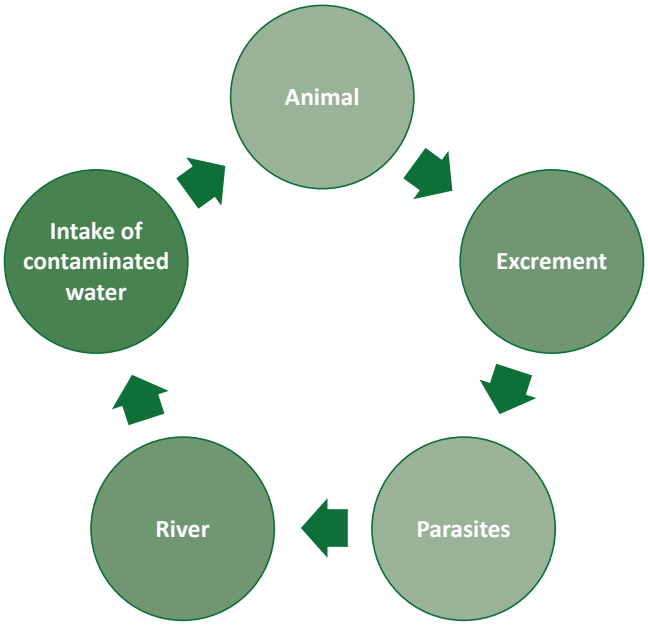
Family-size biodigesters are generally constructed using plastic polyethylene sleeves or tubes. These materials are inexpensive and easy to install, and the materials are locally available. The cost of a plastic biodigester, with a capacity of 12m^3, can range from USD 300 to USD 500 (Figure 13), depending on the material used. The cost of a 4m^3 biodigester with a carrying capacity of 64kg of dry biomass is estimated at USD 500. A three-year investment recovery period is expected.

Figure 14. 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 15). Good management of excreta can instead produce 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 15. Processes of 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, improve water retention and prevent erosion (Restrepo 2001). Due to the diversity of organic waste that is found on a ranch, it is possible to produce a wide variety of organic fertilizers. The NAMA 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 16. 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 decomposition process; the microorganisms that carry out the decomposition or mineralization of the materials occur naturally in the environment. The method of producing this type of fertilizer is economical and easy to implement. Cost are estimated at USD 20/t and would typically require 1- 2 days a month for maintenance, with a repayment period for the initial investment of approximately 1 year.

Expected emissions reductions with this practice are between 5 and 100 tCO_2e/ha/year, depending on the application of fertilizers used by the producer.

Figure 17. Elaboration 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 dynamically balance the soil and plants. Microorganisms can also be added to improve the quality of the fertilizer. The microorganisms are the same as those that exist naturally in agricultural soils, but that have been selected to improve the physical condition of soils. In the preparation of biofertilizers based on bovine manure, a biofermenter with a hermetic lid is required in which to place the raw materials. 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 liter of biofertilizer, with no costs of operation.

Figure 18. Manure-based biofertilizers

3.4 Nutritional Blocks

Nutritional blocks are food supplements that provide the cattle with proteins, energy and minerals to help to maintain them in good productive and reproductive health (Fariñas et al. 2009). By improving animal nutrition, their survival and increases in the production of meat and/or milk is ensured, while contributing to the reduction of GHG emissions from enteric fermentation. The block provides the necessary nutrients to meet the requirements of rumen microorganisms, thus creating favourable conditions to improve the utilization (digestibility) of the pasture (fibre) consumed by the animal. Depending the type of grass used by the producer, this practice increases weight gain by up to 50% of the initial weight. In the case of milk, production can increase by 2-6 kg of milk/cow/day.

The word "block" is used because it comes in the form of a compressed solid mass that animals cannot consume in large quantities. Because of the hardness of the block, animals can only lick and ingest small amounts and thus avoid being intoxicated by over-ingesting. In addition, it is easy to transport from place to place, reason why the block can be applied in pastures. Applying nutritional blocks on a farm is a strategy that favours the maintenance of production during critical times of food reduction like the dry season and increases weight gain and milk production during periods of higher profitability on the farm. Weight gains in cattle consuming nutritional blocks range from 13% to 228% (Pinto-Ruiz and Ayala-Burgos 2004). One of the advantages of the blocks is that they can be used for beef cattle, milk cattle or sheep (ruminants). There is no restriction by type of production, nor the age of the animals.

The cost of production is estimated at USD 50, with an investment recovery period of one to two years.

Table 12. Recommended blend options for 100 kilograms

Formula 1		**Formula 2**		**Formula 3**		**Formula 4**	
Molasses	24	Molasses	24	Molasses	27	Molasses	27
Mineral salt	10	Mineral salt	10	Mineral salt	18	Mineral salt	18
Cement	15	Cement	15	Cement	17	Cement	17
Sorghum or bean nescafe	20	Sorghum or bean nescafe	23	Sorghum or bean nescafe	20	Corn and ground sorghum	18
Ground corn or canavalia	23	Dried fruit trees	20	Dry legume leaves	18	Dry leaves of non-legumes	20
Urea	8	Urea	8				

Figure 19. Grinding and weighting of ingredients

Grinding of ingredients to improve mixing. The weighing of the ingredients must be exact to avoid poisoning or digestive problems to animals (Photo: Jiménez-Trujillo, JA in 2013)

Figure 20. Scraping and stirring

All the solid ingredients must be thoroughly stirred so they can be distributed throughout the mixture. The ingredients are stirred similarly to cement (Photo: Jiménez-Trujillo, JA in 2013)

Figure 21. Introduction of the pasty mass and drying in the moulds

Introduction of the pasty mass in the mould and drying (buckets of twenty litres) (Foto Jiménez-Trujillo, JA in 2013)

4. Identification of barriers and implementation options

4.1.Barrier analysis

The main approach used to identifying the barriers to NAMA implementation was a bottom-up one. Three approaches were employed in conducting the barrier analysis and identifying the barriers hindering farmers in implementing the NAMA practices: 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 consisted particularly of experts from national ministries and regional offices, such as the Directorate of Agricultural Science and Technology (DICTA), the Ministry of Environment (MiAmbiente), the Honduran Chamber of Milk Producers (CAHLE), the Ministry of Agriculture and Livestock (SAG) and the Honduran Livestock Development Chamber (CAFOGAH). During the preparation of the NAMA, workshops were held in the presence of key government, private and civil-society members in July 2016 and June 2017. The stakeholders consulted identified the barriers listed here, which are presented in more detail in the following sections:

Human capacity:

- Low level of knowledge and technical capacity
- Ability of the value chain to receive, process and monetize increased outputs
- Lack of administrative management of farms and financial knowledge

Financial:

- Lack of access to credits

4.1.1.Low level of knowledge and technical capacity

Data from the National Agricultural Survey 2007-2008 indicate that only 16.5% of agricultural producers (44,704) received technical assistance, the majority being small farmers with fewer than five hectares. These services were mainly provided by NGOs and international cooperation projects. Technical assistance services provided directly by government institutions such as the DICTA accounted for only 3.5% of the 83,000 producers.

Local producers argue that they have little technical assistance, and when they do receive it, it is often considered unreliable or very expensive. In addition, there is a general lack of up-to-date knowledge on market conditions and service providers, so producers must be informed about these areas. For instance, with respect to the practice of biodigesters, many producers are not well acquainted with the technology and need assistance in getting them installed. Some producers who were consulted thought that other producers had had negative results, as the equipment didn't work as promised, and they do not want to risk installing them. In this sense it is important to inform them about reliable providers and proper methods of installation. Once they have been trained in the installation, they should continue to have access to technical support if needed.

There are deficiencies in the quantity and quality of activities carried out both in controlled environments and on producers' farms. Experience indicates that it is hard to maintain a direct and prolonged relationship between technicians and a large number of farmers. International technical and financial agencies, often with national and international NGOs such as the FAO and USAID, carry out projects with different development objectives, including technical assistance. Many of these projects are channelled and implemented through government institutions such as DICTA. The decentralization of public services and capacity-building has been asymmetric, partly because there has been no clear direction, but also because partnerships have their own specific focus and areas of intervention.

Producer associations primarily provide advice to members and partners in certain areas through networks formed on a more trade union-like basis. They also provide specialized capacity-building services for suppliers and producers. However, producers' perceptions of the opportunities and quality of service they offer present challenges that need to be recognized and strengthened in order to improve the care they can provide to the sector.

With regard to technical assistance providers, there are already a number of institutions with the capacity to provide training in the implementation of the NAMA practices to farmers. For example, DICTA and HEIFER are already providing training in improved pasture management, and ICADE is providing training in live fences, sanitation and nutrition. Since DICTA is the state organization with the mandate to provide technical capacity to Honduran farmers, it is the key actor in providing capacity-building to farmers, though CAHLE and CAFOGAH can also become important actors by promoting the NAMA practices to their members. Currently, the DICTA is an important reference point for providing technical support to the projects of international donors.

4.1.2.Ability of value chains to receive, process and monetize increased outputs

Another issue which it is important to address is related to the NAMA's expected outputs. One of the main objectives is to contribute to the increased productivity of the sector, which is expected to result in higher outputs of milk and meat. For this expected increase in outputs to be monetized, however, the rest of the value chain must be able to receive and process the products, enabling farmers to service their loans and benefit from the technical assistance provided to them. The way the milk value chain is structured, increased production will not yield much if no measures are taken to increase the quality of the milk as well. According to the stakeholders who were consulted, there are already challenges in the collection, storage and quality control of milk. Currently, quality tests are only undertaken by the processing companies. This has three major implications. First, if there is something wrong with the milk, the entire batch is wasted. It also takes time for the information to come back to the specific CREL, reducing their opportunity to identify what the issue is.

4.1.3.Lack of administrative management of farms and financial knowledge

The success of financing and farmer's access to credit depends to a large extent on the decisions of the lender and recipients, which depend in turn on the mutual financial and agricultural knowledge of these actors, the information and communication opportunities available and their technical capacity. Due in part to financial illiteracy, the demand for producer financing is often very low. Farmers hesitate to borrow, and the banks hesitate to lend. It should also be pointed out that many producers do not keep records of their activities. It is a primary requirement of the bank that the producer should be able to provide accounting records to demonstrate his or her ability to pay.

4.1.4.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 on:

- A lack of guarantees
- over-indebtedness with suppliers;
- high interest rates making investments unfeasible

In general, the livestock sector is perceived as having a high credit risk, where suppliers of inputs, intermediaries and lenders become important providers of agricultural credit. Loan and loan conditions vary from case to case: the intermediaries insure the purchase of the production (sales commitments), the lenders lend at 20% monthly, and the suppliers of inputs offer credit taking into account the customer's record.

It is estimated that 80% of producers generally do not have access to credit and only 5% do so with private banks; the rest obtain loans from friends, family and buyers. FIRSA, BANRURAL, BANADESA, Grupo Fama, the Cooperativa de Ahorro y Crédito Chorotega and the San Marqueña Cooperative of Savings and Credit offer loans to farmers at a preferential rate of 7.25% per annum. Recently, the Ministry of Agriculture – SAG, through the Honduran Bank of Production and Housing (BANHPROVI), has introduced a credit line to improve the profitability of the livestock sector through a trust fund established for the Reactivation of the Agriculture Sector (FIRSA). However, it has been perceived that producers cannot access credit due to the excessive bureaucratic procedures and requirements.

Even though different sources of financing exist, the main problem is the borrowing capacity of producers, who have a low savings and credit culture. If the producer is not listed at the "Risk Registry", which lists the producer's financial details, the producer cannot apply for bank loans. On the other hand, although there are several alternatives to access credits for agricultural development, producers cannot access them due to a lack of information or a lack of interest, so that credit opportunities are lost. For example, the Honduran Association of Banking Institutions has a program of HNL 50,000,000 (USD 2,134,000) for small producers, whose purpose is to contribute to increased investments in the agricultural sector through the efficient financial management of agricultural credit, and it has a secure credit model it can offer to producers. [2]

Credits can also be accessed through microfinance institutions or through agriculture input importers (e.g. fertilizers, pesticides, agricultural machinery). However, the necessary inputs (e.g. fertilizers, pesticides, agricultural machinery) are mostly imported, and their prices are influenced by the dollar, leading to increased production costs and greater vulnerability for producers, as well as more difficulties in accessing credits.

4.2. Identification of possible options to address the barriers

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

SAG is the public entity authorized to regulate services and develop capabilities within private institutions and companies to improve the quality and coverage of services, and to follow up the transfer of these services. Implementation of specific projects and activities, including programs and projects financed by international and national bilateral and multilateral funds, takes place through DICTA. In August 2016, the President of Honduras launched the National Rural Extension Program under the Secretariat of Economic Development, which, among other existing projects, will work as a vehicle to implement the NAMA. The National Rural Extension Program will implement its first pilot year with the support of Zamorano, Texas Tech University, the National Autonomous University of Honduras (UNAH) of Catacama, FIRSA and Dairy Consulting. The Program has a budget of HNL 50 million (USD 2.1 million), and aims to benefit rural families through capacity-building, technical assistance, innovation and technology transfers through the participation of seven universities, five agricultural schools, 27 professional schools, five state institutions, six private organizations and fifty implementing partners. The program is one of several examples of national programs targeting the livestock sector. It will be crucial for the success of the NAMA to coordinate existing initiatives with the NAMA to ensure that these initiatives contribute to implementation of the NAMA practices by providing information and training in their implementation and application.

2 (http://www.laprensa.hn/economia/dineroynecioscios/835159-410/crece-apoyo-para-pymes-hondureñas)

Education and research institutions are playing an important role in building the capacities of different actors in the sector, participating with formal and informal education, the development of skills, the management of technological innovations, the validation and transfers of knowledge to the productive sector, and improvements to methods and methodologies. In addition, technical institutes are playing an important role in building the capacity of young and future technicians and capacity-building providers. It is therefore important to disseminate information regarding NAMA practices and methods of implementation to the different relevant educational and research institutions to ensure that these practices are included in their portfolios of capacity provided.

4.2.2. Improving the ability of the value chains to receive, process and monetize increased outputs

One concrete way of addressing this problem is to allow milk collection centres (CRELs) or farms which collect the milk themselves to improve their ability to refrigerate the milk at the CREL and to establish minor laboratories where quality tests could be run. With shorter feedback loops, it would greatly facilitate identifying issues with specific batches, and thus also identify the source of the problem. It must be mentioned that the quality of the milk depends on a number of factors which go beyond just the CREL stage. Other important factors are the cows' nutrition, the farm's hygiene practices and transportation of the milk to the CREL. The refrigeration at the CRELs is, however, a low-hanging fruit and also a leverage point facilitating improvements to the organizational level of the sector, which facilitates both the rolling out and the financing of technical assistance, as it is planned to use CRELs as focal points for communication in relation to both functions.

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

Increased financial capacitation is needed to increase the demand for and acceptance of funding. In addition, increased business and entrepreneurial capacities and knowledge about available financing opportunities at the cooperative level could give farmers greater confidence in the credit opportunities available. The financial knowledge of producers 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 in commercial management. DICTA, with cooperation from the Business Development Centre (CDE), should, upon delivering technical assistance, also offer credit diagnosis and monitoring of farms through its Rural Banking Unit, thus supporting the producers to make investments and use credit through technical training, the elaboration of farm plans, drawing up investment plans and designing 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. At present, the cost 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 SAG staff should make efforts to communicate and inform the banking sector about farmer's activities and conditions in order to establish trust in and understanding of the sector.

4.2.4. Improving access to credit

As implementation of the NAMA practices will require investments from farmers, it is critical to improve access to credit for local producers. This could be in the form of preferential rates developed for credits for sustainable livestock production, conditioned with environmental commitments to provide access to credit, commitments subject to verification by a monitoring program. Funds, guarantees and 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 rural banks, to empower them in the financial aspects of investing in the NAMA practices and to make proposals for financing (sustainable financial products). Potentially this could come from suppliers that have been verified by the Central American Bank for Economic Integration (BCIE) as creditors and that have access to BCIE financing, thus making the funding less costly, as well as having BCIE as a channelling entity for potential international financing. Guidelines should be provided for the design of credit for investment in 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 to the financial system and the livestock farmers, for example, by allowing land tenure, the farm's capital, wood, harvest, 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 economic analyses of farms to establish profitability (cash flow behaviour and income with investment credits) and different interest rates.

5. Description of the NAMA Action Plan

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

As described in Chapters 1 and 4, a number of activities are already being implemented in preparing for the NAMA, and a range of activities are planned to be introduced to overcome the barriers to implementation of the NAMA practices and to ensure the NAMA 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 terms of the efficiency ratio of products (meat and milk). However, there is a shortage of technical personnel who can motivate, facilitate and follow producers in implementing the respective actions. The country need improvements in the dissemination of knowledge regarding the suggested technological practices, and access to finance should also be improved. To achieve this, technical assistance needs to be expanded through so-called field schools, or escuelas de campo (ECAs), which have been used as a means to train and implement the technologies, and through livestock-related interest groups.

As described above, a significant barrier to implementing these practices is that the farmers do not know they exist, or if they do, they find that capacity-building services are not continuous and remain of a sporadic nature. The proposed measure to overcome this barrier is to strengthen the technical capacity-building system in order to provide farmers with a sustainable system for a long period of time. It is, however, also important to build upon the existing systems in order to provide technical capacity, such as the initiatives of DICTA and CAHLE to aid small and medium livestock producers by taking advantage of their established networks.

Indeed, DICTA could develop the necessary curriculum to train farmers to implement the practices. This would be based on the “best practice manual” developed through the support to the NAMA received by the Nordic Climate Facility (NCF). The informational material should be shared with CAHLE, FENAGH, COFOGAH and SENASA, and their technical staff should receive training in it, 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 carrying out of the practices, but also cover financing opportunities, using the MRV system, general knowledge regarding the sound management of farms.

However, it is not sufficient to have well-trained staff; field schools are necessary too. Field schools serve several purposes. They are where both farmers and staff receive practical training in implementing, operating and maintaining the different practices. They also provide concrete examples of the practices to show how they actually work. Lastly, they also serve as a place where local farmers can come together, thus indirectly addressing the general challenge of a low level of organization among them.

For the ECAs, it is also important to benefit from CAHLE’s technical assistance. As it is beneficial to the state that more farmers receive technological assistance, the proposal is that the technicians and producers associated with CAHLE should also be able to access training through the Field Schools. Depending on the scale of the demand, this could be free, or a nominal fee could be charged.

It is important to stress that experiences from other countries, primarily Costa Rica and Nicaragua, show that, even if producers know about a practice and how to carry it out, this is not sufficient for them to implement it. The technical assistant often needs to visit the farms and work out a plan together with the farmer. This is naturally a time-consuming activity requiring substantial resources.

In terms of the financial aspects of NAMA implementation, there are currently banks that offer loans at preferential interest rates down to 7.25% per annum. Examples of existing financing for farmers include that available through FIRSA, BANRURAL, BANADESA, Grupo Fama, the Cooperativa de Ahorro y Crédito Chorotega and the San Marqueña Cooperative of Savings and Credit. However, most small and medium farmers cannot access these funds due to the extensive bureaucratic steps and requirements involved, as is also confirmed by academic studies (Lopez, 2012). Thus, the financial measures proposed in this

NAMA should aim to allow farmers to make the necessary investments to introduce the practices. This requires providing credit lines which these farmers can actually access and use, and also training technical assistance technicians and financial institution staff so that they can facilitate this for the farmers.

As described above, one of the barriers to implementing the NAMA practices is that they require an initial investment, which farmers do not have available. There are several aspects that need to be addressed to give farmers access to credit. These are described in the following. To achieve the objective set out in NAMA Scenario 1, a total investment of USD 355,284,000 is needed for the initial investments by farmers. In NAMA Scenario 2, this figure falls to USD 284,460,300. Currently, Honduras dedicates USD 2,134,000 to credit lines for rural development through the Honduran Association of Banking Institutions, as well as additional funds through the initiatives described above. It is evident that there is a gap between the available funding and what is needed for this. The proposal is to apply for international funding to make up for the shortfall. As this element of the international assistance would be in form of loans to the farmers, it would take the form of a concessional loan, guarantees or other risk-mitigating mechanisms, thus allowing for the provision of preferential loans to farmers.

Securing additional funding alone will not solve the issue, however, as the major barrier today is access to finance rather than a lack of finance. Thus, the requirements imposed on lenders by financial institutions, and the origin of these requirements, need to be investigated further. The ongoing project "Paisajes Productivos" (Sustainable Management of Production Landscapes) is carrying out a study where this issue will be analysed. The proposal is thus to await these results and build upon them to design a financial instrument which the targeted farmers can access and which works in the context of the realities they face.

Closely related to the design of the financial instrument is the organization of the credit line. A further investigation is needed to see which financial institutions are interested in channelling credit to farmers and which are appropriate to do so. Given the low levels of credits necessary, USD 7,853 for the smallest farms, microcredit institutions could also become important stakeholders.

The NAMA should naturally be coordinated with other programmes and initiatives, in particular the Coffee NAMA which Honduras is currently developing. As the two groups – coffee-growers and livestock producers – share many characteristics, developing the financial infrastructure so that it can accommodate them both would save considerable development and operating costs. Also, the MRV systems for the two NAMAs could potentially gain in efficiency by being aligned and coordinated together.

The technical assistance staff will require to be trained to ensure that they are up-to-date on the issue of providing financial opportunities to the farmers. Moreover, one reason the interest rates are so high for the livestock sector is the low competence levels in the financial sector when it comes to understanding livestock, and thus the perception of high risks. It is thus important to ensure that the financial institutions involved are properly informed about the sector and its opportunities and risks. The NAMA will therefore liaise with these credit institutions to stress the expected economic benefits of the introduction of these practices. The aim is to inform the credit providers and give them confidence in the practices, as well as to instruct farmers about the profitability of investing in them, the aim being to incentivise farmers to include at least one of the practices in their investment plans.

Another issue that it is important to address is related to the expected outputs of the NAMA. One of the main objectives is to contribute to increased productivity in the sector, which is expected to result in higher outputs of milk and meat. For this expected increase in outputs to be monetized, however, it is necessary to ensure that the rest of the value chain can receive and process the products, thus enabling farmers to service their loans and take advantage of the technical assistance provided to

them. Given how the milk value chain is structured, increased production will not yield much if no measures are taken to increase the quality of the milk as well. According to the consulted stakeholders, there are already challenges in the collection, storage and quality control of milk. One concrete way of addressing this problem is to allow milk collection centres (CRELs) or farms that collect the milk to access finance themselves to invest in equipment to refrigerate the milk at the CREL.

The credit line would allow CRELs to make the necessary investments to be able to refrigerate the milk while it was being stored or awaiting collection. Other eligible investments could be used to establish a minor laboratory where quality tests could be run. Currently, quality tests are only run by the processing companies. This has three major implications. First, if there is something wrong with the milk, the entire batch is wasted. It also takes time for the information to come back to the particular CREL, limiting its opportunity to identify what the issue is. Shorter feedback loops would greatly facilitate identifying issues with specific batches and therefore also identifying the source of the problem. Secondly, there is an issue of trust between the CRELs and the processing company. As the price is differentiated according to the quality of the milk, and the producers have no other choice than to rely on tests performed elsewhere, a sense of mistrust can easily be created. By equalizing this relation somewhat, it can also make it stronger in the long run. Thirdly, if a CREL takes out a loan, the associated producers are tied more strongly together. This further increases the organizational structure of the sector, making it less possible for the producers to engage in opportunistic behaviour and sell their milk elsewhere.

The CRELs would also be an important element in communicating to and informing farmers about implementation of the NAMA practices and financing opportunities.

Table 13. Breakdown of activities, timeline and responsible institutions

Activity	Timeframe	Responsible institution	Funding	Status
Identification and prioritization of NAMAs in the Agriculture and Transport sector and for efficient cooking stoves	2015-2016	MiAmbiente, Secretariat of Energy, Natural Resources, Environment and Mines-Climate Change Office	Banco Interamericano de Desarollo (BID)	Implemented
Identification of NAMA priority practices in the livestock sector	2015-2016	UNEP DTU Partnership, Tropical Agronomy Centre (CATIE), DICTA	Nordic Environment Finance Cooperation	Implemented
Analysis of GHG, sustainable development and economic impacts of the NAMA	2016-2017	UNEP DTU Partnership, Tropical Agronomy Centre (CATIE), DICTA	Nordic Environment Finance Cooperation	Implemented
Development of educational materials on the implementation of NAMA practices	2017	CATIE	Nordic Environment Finance Cooperation	Implemented
Pilot capacity-building in NAMA practices to farmers	2016	CATIE	Nordic Environment Finance Cooperation	Implemented
Expanded capacity-building in NAMA practices to farmers in other regions	2017	MiAmbiente, CATIE	GEF	In progress
Coordination with the National Directorate of Climate Change (DNCC) regarding other mitigation and adaptation activities	2015-ongoing	SAG, DNCC, Climate Change Office	National funds	Ongoing
Coordination with the Secretariat of Economic Development regarding alignment of the National Rural Extension Program with the NAMA	2017-2018	SAG, DICTA, Secretariat of Economic Development, MiAmbiente	FIRSA, National funds	Planned
Integration of NAMA practices into DICTA's Program of Agricultural Technology Transfer	2017-2018	DICTA, SAG, MiAmbiente	National funds	Planned
Capacity-building of a minimum of thirty DICTA technicians to enable training of staff to provide technical assistance to producers in field schools and CRELs, based on educational material on the implementation of NAMA Practices	2017-2020	CATIE	International funds	Planned

Capacity-building of a minimum 6,000 producers in the existing 143 field schools nationwide on NAMA practices, based on educational material on the implementation of NAMA practices	2017 - 2018	DICTA, CATIE	National and international funds	Partially implemented
Information dissemination to education and research institutions based on NAMA documents and educational material on the implementation of NAMA practices	2018	DICTA	National funds	Planned
Capacity-building of producers on financing needs and financing opportunities for the implementation of practices through field schools	2018-ongoing	DICTA, Rural Banking Unit	National and international funds	Planned
Liaising with the banking sector about farmer's and CRELs activities and conditions to establish trust and understanding in the sector and stimulate access to credit	2018	SAG, DICTA Rural Banking Unit	National funds	Planned
Source international Climate Finance to expand the capacity building component of the NAMA, expediting the process of implementation, for the achievement of the optimistic NAMA scenario.	2018	SAG, MiAmbiente, BCIE	International Capacity Building support institutions	Planned
Source international climate finance to provide preferential loans to farmers through loan finance, risk guarantees or other financing mechanisms, thus expediting the process of implementation for the achievement of the optimistic NAMA scenario.	2018-ongoing	SAG, MiAmbiente, BCIE	International capacity-building support institutions	Planned

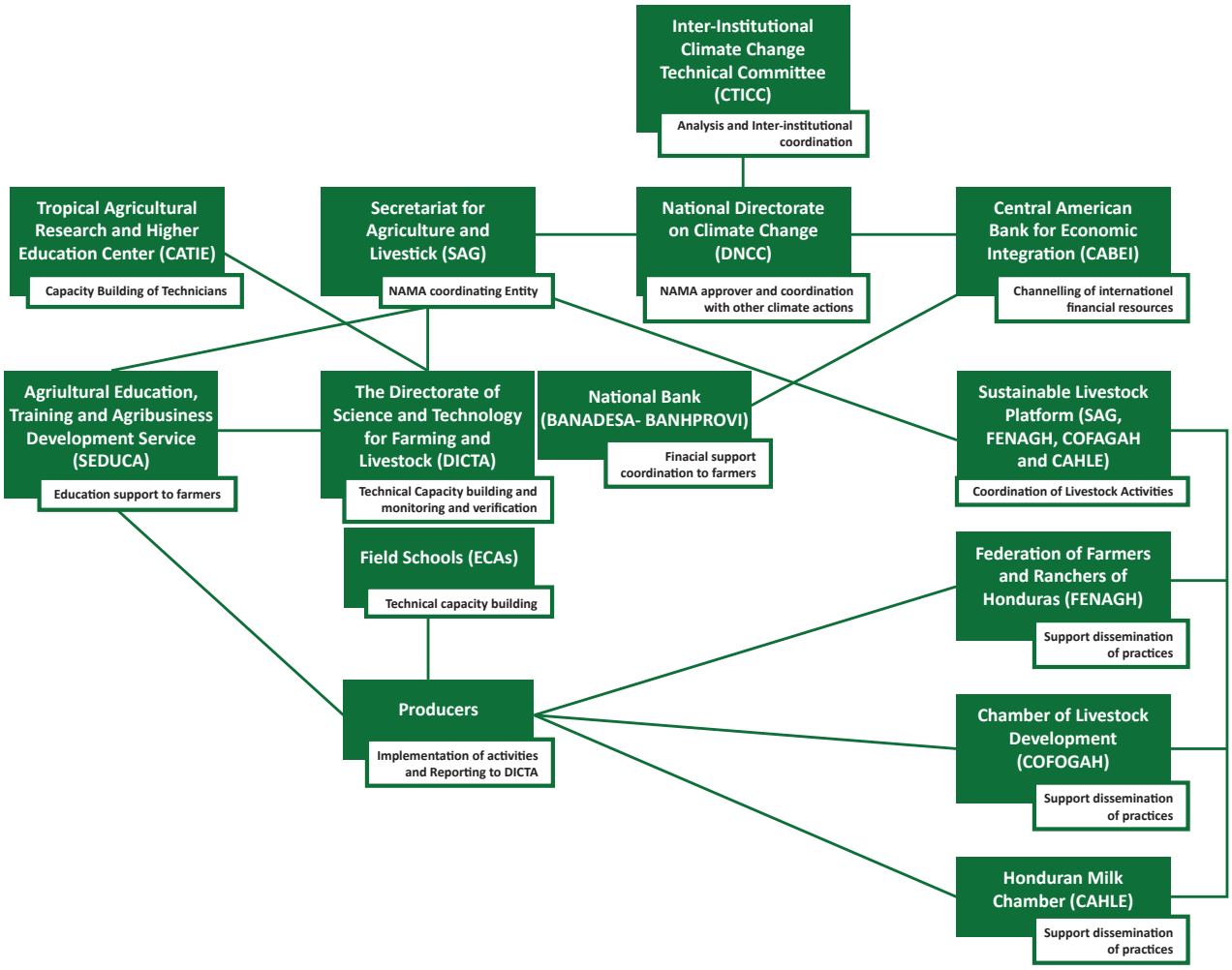
5.2 Implementation arrangements: roles and responsibilities of different entities and stakeholders involved in NAMA implementation, including institutional arrangements

The different institutions related to NAMA implementation and their role have already being presented in Chapter 2. In addition to the institutional framework already described, a Sustainable Livestock Platform has been established nationally, where all the interested national stakeholders can obtain information about NAMA implementation, as well as be consulted and provided with the opportunity to provide inputs. The Sustainable Livestock Platform will be headed by SAG, but FENAGH, COFAGAH and CAHLE will also participate in it by representing the producers, thus providing opportunities to contribute to the strategic directions of SAG, DICTA and related institutions and initiatives. In addition, field schools (ECAs) managed by DICTA will provide an opportunity for farmers at all levels to participate actively in the development and selection of technologies.

At present, 28 organizations and institutions are supporting a total of 143 ECAs nationwide. INFOP (Institute for Professional Training), in association with DICTA and CATIE, has supported ECAs focused on livestock in the Departments of Atlántida, Colón, Olancho, Francisco Morazán, Choluteca, La Paz and Copán. The Ministry of Environment, through the Sustainable Management of Production Landscapes project, has developed ECAs in the Departments of Yoro, Choluteca and Olancho. The government of Honduras is expected to develop the project at two hundred schools in the priority areas (Atlantida, Choluteca, Yoro, Olancho, Sico-Paulaya), which will reach six thousand producers and a cost of USD twenty million. ECAs have much to promise in filling the gaps left by the downscaling of traditional government support provision and in addressing the shortcomings of traditional “vertical” approaches to support. SAG has a particular interest in extending NAMA implementation based on ECAs due to its positive track record in providing capacity development to farmers and the effectiveness of utilizing an existing successful framework.

SAG is also involved in the development of a NAMA in the coffee sector. As the two sectors share a similar structure with many small-scale producers, who sometimes overlap, a coordinated approach could reveal numerous synergies, especially with regard to financial support and MRV.

Figure 22. Institutional framework, roles and responsibilities of stakeholders involved in Livestock NAMA implementation



6. Estimate of the NAMA's GHG impacts and sustainable development benefits

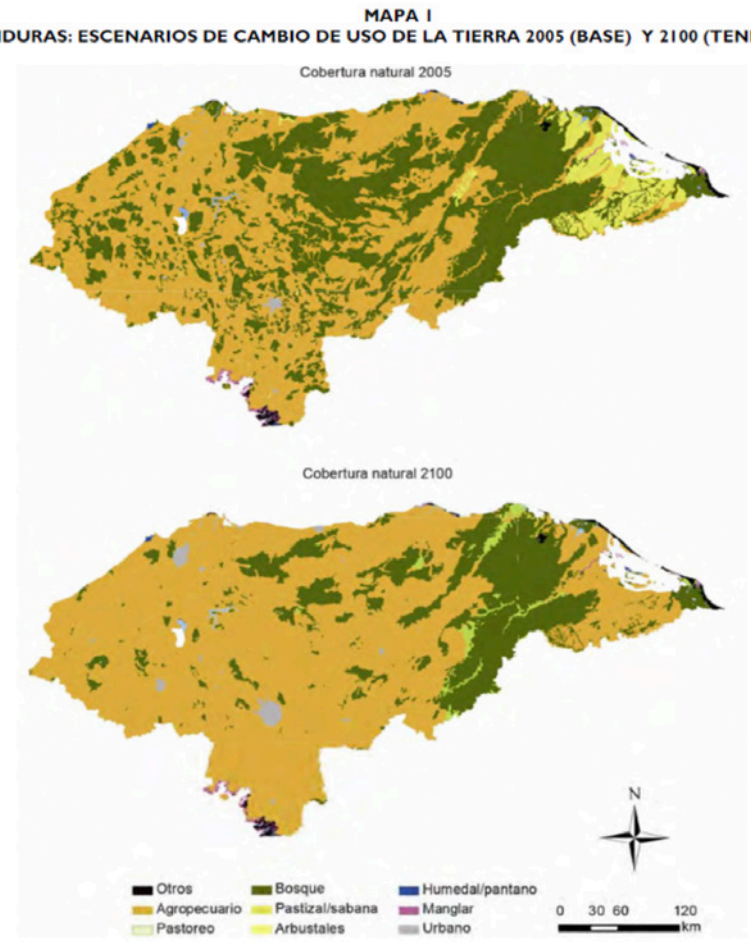
6.1 Baseline scenario in the absence of planned NAMA measures

Honduras is one of the countries in the region that is expected to have the highest levels of aridity under current climate projections (CEPAL and CCAD 2012), suggesting an increase in the number of dry months by 2070, when the departments of Choluteca, El Paraíso and Francisco Morazán could face dry seasons lasting seven months (CEPAL and CCAD 2012). The northern coast of Honduras, by contrast, is very susceptible to the impact of hurricanes and heavy rains that cause flooding. As a result, scenario B2 projects that national precipitation will decrease by between 10% and 13%, with the maximum level of intra-annual precipitation in 2100 falling in the months of September to June, while scenario A2 suggests a reduction of precipitation of between 27% and 32% (Cifuentes-Jara 2009, CEPAL and CCAD 2012). The cumulative cost of the measurable impact of climate change in Honduras, based on impacts on the agricultural sector (value of agricultural production), water resources (availability against municipal and agricultural consumption), biodiversity (costs recorded economically, and indirect impact on agriculture), hurricanes, storms and floods (increases in intensity, not including increases in frequency and other types of extreme events), and with a discount rate of 0.5%, could be 3.6% of 2008 GDP at net present value (NPV) in an optimistic scenario and 5.0% in a pessimistic scenario by 2030 and 10.2% in and 14.7% by 2050 respectively, reaching 45.8% and 79.6% by the end of the century (source: CEPAL, 2016: La Economía del Cambio Climático en Honduras).

The country suffered a severe decline in cattle-ranching in in the 1990s, mainly due to the increase in livestock activities in neighbouring countries and to losses caused by Hurricane Mitch. In spite of this downward trend, there has been some recovery in the sector in recent years of around 3% per year between 1999 and 2002. In 2001, livestock represented 10.9% of agricultural GDP and involved about 86,000 farms. Although falling prices, the entry of new competitors, the introduction of a 25% import tariff by Mexico, strong competition from countries enjoying favourable exchange rates or production subsidies, and adverse domestic conditions like decreasing per capita consumption and strong competition from white meat, creates a future scenario in which the livestock sector will be subject to additional pressures and competition. In addition, climate projections for Honduras estimate that by 2080, the average increase in temperature will be 3.4°C and precipitation will be reduced by 13.7% on average, stressing the need to implement agricultural practices that increase resilience and take adaptation to climate change into consideration, while contributing to mitigation of GHG (CEPAL and CCAD 2012).

Baseline scenarios indicate a significant decrease in the area of forest up to mid-century, after which it is assumed to remain constant. The extension of agricultural land will increase significantly until mid-century (source: CEPAL, 2016: La Economía del Cambio Climático en Honduras). Responding to these trends requires extensive modernization and productive transformation at the primary level.

Figure 23. Scenarios of LULUCF, 2005 base year and 2100 under current trends



Given these vulnerability scenarios, and in the context of productivity, good practices that promote adaptation and mitigation to climate change must be implemented urgently. Silvopastoral systems and good livestock practices are one among of the strategies that are most relevant to the livestock sector in the country. However, in spite of multinational and inter-institutional efforts to disseminate agricultural technologies and the abundant results of research into the beneficial effects of trees and shrubs on pastures and livestock production, the adoption of silvopastoral systems and other practices for adaptation to and mitigation of climate change are relatively low. Among the reasons for this are labour demand (Ibrahim et al., 2001), high establishment costs, a lack of dissemination mechanisms and limited access to capital and credit (Ibrahim et al., 2001).

6.1.1.1 Estimates of 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 in 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 specifically designed to mitigate GHG emissions. This situation does not make allowances for a significant increase in the number of cattle, thus limiting the economic development opportunities for farmers. This approach provides a reference point with which to compare emissions with changes made to improve the carbon intensity of the livestock sector. It is important to note that, when emissions between the baseline and the alternative scenarios are compared, the latter also include a higher increase in the cattle herd, suggesting that the carbon intensity per head of cattle will be lower, even if emissions might be higher under the alternative scenarios. The BAU scenario therefore enables us to review the potential impacts of national or regional policies a priori.

To estimate the impacts of changes in livestock practices, the NAMA analyses their contributions to emissions and their capacity to fix atmospheric carbon in biomass and soil as carbon sinks. The net emissions of livestock activities and practices are estimated first for the current situation, and projections for the future are made with reference to a business as usual (BAU) scenario by analysing current trends. After establishing the BAU scenario, two alternative NAMA scenarios are constructed, taking into account changes in land use and improved livestock management practices. The methodology consists of the following phases:

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

The BAU postulated a yearly 2% increase in pasture area from 3,281,388 ha in 2016 to 4,321,423 ha in 2030. Typical livestock farms in Honduras were found to have an average carbon footprint of 4.4 tCO_2e/ha/year (Table 13). The simulation estimated total GHG emissions of 9.700 $MtCO_2e$/year in 2016, expected to increase to 12.8 $MtCO_2e$/year in 2030 in the BAU scenario. Taking carbon fixation into the equation, a total of 7.6 $MtCO_2e$/year of net GHG emissions was calculated for the baseline year of 2016, expected to increase to 10.1 $MtCO_2e$/year in 2030, representing a net increase of 2.5 $MtCO_2e$/year. These scenarios are aligned with the country trends described in the NDC for Honduras, showing expected increases in emissions with BAU. However, Honduras is prepared to implement actions unconditionally to decrease BAU emissions and to increase its ambitions if support is provided. The NAMA will similarly contribute to the country's unconditional efforts, while a greater level of ambition can be achieved if international support is made available.

6.1.1.2 Methodology for BAU generation

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

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

Future land use and herd 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 estimate the annual rate of pasture change. This rate was applied to project areas of pasture in 2016 and 2030. Land use per year was estimated using the area of use of the previous year, and the exchange rate was estimated based on the reported data in the literature (Eq. 1).

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

Where;

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

Current GHG emissions were estimated based on surveys [3] made with producers. The estimate included 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 pasture by their areas. Each farm's emissions was added up and divided into the sum of the pasture areas of all the farms surveyed (Eq. 2). GHG emissions for each year of the baseline were estimated as the product of the estimated pasture and average emissions estimated on interviewed farms (Eq. 3).

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

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)

$$E_t = A_p * E_u \quad \text{Eq. 3}$$

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 rate of change of 2.0%/year was applied. In the same way, a unitary emission of 1.8 tCO_2e/ha/year for Honduras 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 that were considered in calculating GHG emissions are the following:

1. Application of nitrogen fertilizers and carbonates. the amounts of nitrogen and carbonates applied to pastures and other forage systems were estimated. The emission factors used were 0.01 kg N_2O / kg, 0.12 kg N/kgand 0.122 kg C/kg and magnesium calcium carbonate (IPCC, 2006). N concentrations and CaO in each fertilizer applied and the soil were used.
2. Use of fossil fuels. Fossil fuels used in the management of livestock farms, such as in the use of motor pumps, scythes, chain saws and tractors. The emission 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, converted later to 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 from the enteric fermentation of livestock and manure management. Producers or directors were consulted for details about 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. Land-use systems used to produce animals or forage to provide animals with food were also taken into account.

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 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 consulted.

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. In 2000-2001, Honduras had a total of 1,859,737 head of cattle (FAO) emitting a total of 3.16 $MtCO_2e$/year from enteric fermentation and manure management (SERNA 2012). This indicates a unit emission of 1.7 tCO_2e/UA/year, which produces a CO_2e emission unit of 0.85 t/ha/year, given an average stocking rate of 0.5 AU/ha.

Statistical differences ($p < 0.05$) were found in herd size at the different levels of intensification in Honduras (46.6 vs 63.2 vs 66.8 UA / farm for low, medium and high intensification levels, respectively). An inverse relationship between farm size and level of intensification was found, hence the livestock farms in Atlantis and Sico Paulaya with greater intensification levels are the smaller ones (Table 9).

Table 14. Herd features: land uses and greenhouse gas emissions on average farms with three different levels of intensification in Atlántida y Sico Paulaya, Honduras.

	Intensification level		
	Low (<1.4 AU/has)	**Medium (1.4-2.3 AU/has)**	**High (>2.3 AU/has)**
Herd size (AU)	46.6 ± 4.8 b	63.2 ± 6.5 ab	66.8 ± 7.4 a
Animal stock (AU/has)	0.9 ± 0.04 b	1.8 ± 0.03 c	3.6 ± 0.2 a
Land use (has)			
Natural pastures	3.7 ± 0.7 a	5.2 ± 1.3 a	3.0 ± 1.0 a
Improved pastures	48.2 ± 5.1 a	33.7 ± 4.3 b	16.9 ± 2.4 c
Fodder banks	0.01 ± 0.01 a	0.0 ± 0.0 a	0.02 ± 0.02 a
Agricultural crops	2.1 ± 0.6 a	1.8 ± 0.8 ab	0.5 ± 0.2 b
Forest plantations	0.02 ± 0.02 a	0.1 ± 0.1 a	0.1 ± 0.05 a
Forests	3.8 ± 1.2 a	2.5 ± 0.9 a	1.9 ± 0.8 a
Live fences (km)	17.0 ± 2.0 a	16.4 ± 2.5 a	10.2 ± 1.6 b
Total	65.8 ± 5.8 a	44.6 ± 5.0 b	24.2 ±2.7 c
Total emissions (tCO_2e/has/year)	2.0 ± 0.1 c	3.6 ± 0.2 b	7,7 ± 0.6 a

Honduran farms were found to have high levels of livestock intensification, expressed as stocking rates (2.1 ± 0.1 UA / has). Farms with high levels of intensification have a load that exceeds middle and low levels by 102% and 307% (3.6 ± 0.2 vs 1.8 ± 0.0 vs 0.9 ± 0.2 AU / has) respectively. Level of intensification is closely related to land use, and cattle farms in these areas have a high proportion of improved pastures (73% of the total area). Despite this, Honduran farms have virtually no fodder banks. No clear trend in the use of live fences was found in relation to the level of intensification; however, Honduran farms have a length of these linear systems of 14.5 km / farm. Typical livestock farms in Honduras have a carbon footprint average of 4.4 tCO_2e/has/year (Table 14). A tendency was found to increase GHG emissions by increasing the intensification of farms, as reflected in the average animal stock of farms (Table 14). However, GHG emissions per animal unit were very similar in farms across Honduras, regardless of level of intensification (2.0 to 2.2 tCO_2e / AU / year).

6.2 NAMA GHG Emission Reduction Scenario

By introducing the practices identified and prioritized, and through its alignment with the NDC, national policies, strategies and action plans, the NAMA 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 NAMA has 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, with 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, with 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.

6.2.1 Estimates of GHG emission reductions in the NAMA scenarios

To establish the net GHG emissions and other impacts in the NAMA 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 use: description of area in productive uses 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 use of fodder in diets.

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

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

Table 15 illustrates emissions, carbon fixation and net emissions of the livestock land-use systems used in the simulations. Changes in the carbon footprint as an effect of land-use systems involve 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 with improved systems than larger farms.

Table 15. Animal stocking and carbon footprint characteristics in livestock land uses in Honduras

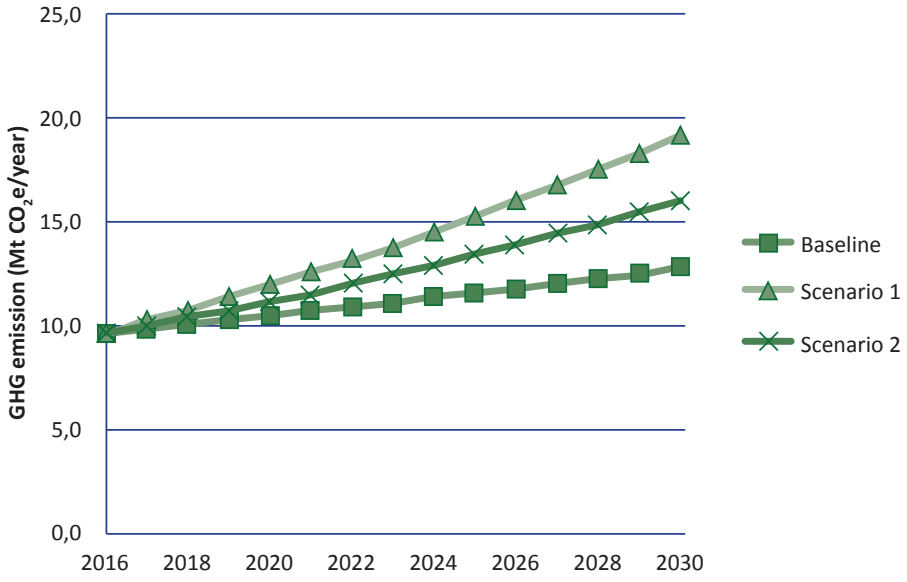
Land-use system	Animal stock (animal unit/ ha)	Carbon fixation rate	GHG emissions	Net emissions
		$tCO_2e/ha/y$		
Native pastures	0.4	0.0	1.8	1.8
Native pastures with trees	0.6	7.8	1.6	-6.2
Improved pastures	1.2	0.0	2.9	2.9
Fodder Banks	3.0	10.0	5.0	-5.0
Intensive silvopastoral systems	3.0	31.4	4.5	-26.9
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 of biogas/ day, which corresponds to 9.0 tCO_2e/year (Casas-Prieto et al. 2009). Likewise, introducing organic fertilization and using legumes can reduce GHG emissions by 0.7 tCO_2e/ha/year, which contributes to improving the carbon footprint of land-use systems (Snyder et al. 2008).

The simulation estimated total GHG emissions of 9.7 $MtCO_2e$/year in 2016, expected to increase to 12.8 $MtCO_2e$/year in 2030 in the BAU scenario. The two alternative scenario simulations show increasing GHG emissions above BAU reaching 16.0 and 19.2 $MtCO_2e$/year respectively in 2030 (Figure 24). This increase in GHG emissions is attributed to higher stocking rates in improved cattle production systems with, for example, improved pastures, fodder banks and intensive silvopastoral systems, allowing for herd intensification, and increasing the total number of cattle from 3,657,000 to 4,994,000 heads, thus providing increased productivity per ha and sustainable economic development for the farmers.

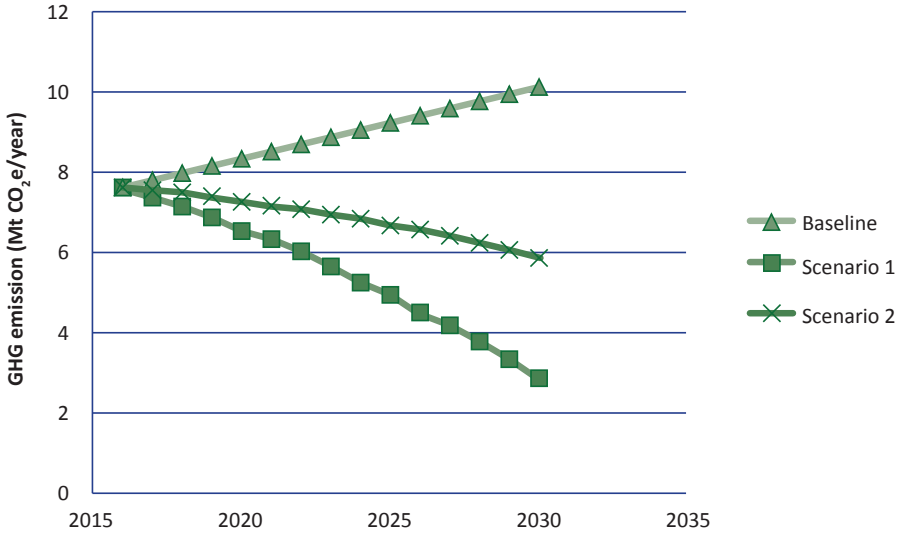
Figure 24. GHG emissions projections for the livestock sector in BAU and two NAMA scenarios



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

Taking carbon fixation into the equation, and illustrating the net GHG emissions, 7.6 $MtCO_2e$/yr of net emissions were calculated for the baseline in 2016. Following current trends in the sector without state intervention, total net emissions are expected to be 10.1 $MtCO_2e$/year in 2030, representing a net increase of 2.5 $MtCO_2e$/year, and cumulative emissions of 132 $MtCO_2e$ between 2016 and 2030 in the BAU scenario. The net emissions would fall in the NAMA scenarios, assuming state policies that promote the improvement of livestock practices in the country, while also allowing for increases in the number of cattle. Net cumulative emissions reductions would be 50.6 $MtCO_2e$ over the next fourteen years in scenario 1 and 29.3 $MtCO_2e$ with scenario 2. The NAMA would therefore potentially contribute between 22% and 38% to net GHG reductions, given a 20% or 30% conversion rate to improved practices.

Figure 25. Net emissions for Honduras's livestock sector, taking into account the NAMA mitigation scenarios



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

6.2.1.1 Methodology for establishing emissions from NAMA scenarios

In the development of both sustainability scenarios (scenarios 1 and 2), a projection of management changes in livestock farms was made, including alterations in land use, which causes changes to the farm's carbon footprint. Organic fertilization was associated with native pastures, while biodigesters were associated with manure production from a determined number of animals in each herd. The 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 of producers in both countries (Eq. 2). This represents the situation in 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 using 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 areas of converted land use were estimated by assuming a reduction in the areas of native pasture, according to the established baseline scenario, and their replacement with improved pastures, scattered trees in pastures, fodder banks and intensive silvopastoral systems. Unitary GHG emissions were estimated similarly to areal estimates for each year. Thus, estimates of 2016 emissions were made first, being calculated for the following year according to the change rate in them. The total change value was divided by the simulation time (fourteen years) to arrive at an estimate of the annual change rate in unitary emissions.

Net carbon emissions reductions caused by the introduction of alternative practices were estimated as the difference between the two assumed mitigation scenarios and the baseline for each typical farm at country level, including intensification of the herds (Eq. 4). Total GHG emissions were estimated during the simulation period (2016–2030) for each scenario and the baseline, the carbon footprint in each scenario being calculated by subtracting overall emissions between the scenario and the baseline. In these mitigation scenarios, public policies affecting livestock were taken into account. Calculations for the scenarios' impacts on GHG emissions from this sector can be summarized using 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 Honduras, and also one of main sources of employment in rural areas. As previously described, 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 expectations of prolonged drought and increased intensities of 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 will allow improvements in the biological, physical and chemical compositions of the water (Chara et al. 2007), thus improving animals' and farm families' welfare. Silvopastoral systems also lead to improvements in product revenue as a result of increased productivity and the development of new products such as wood (Andrade et al. 2008a). The benefits of the planting 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 increased revenues for 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), this being attributed to the reduction in heat stress and increase in voluntary consumption by animals (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). Introduction 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, while nutritional blocks improve the cattle's digestion and health and provide additional nutrients in times of food scarcity. The following presents the NAMA practices' sustainable development benefits in their social, environmental and economic aspects.

6.3.1 Social benefits: human benefits

Implementation of the capacity-building component of the NAMA will in general provide training for technicians from public and private institutions and stimulate producer-to-producer learning through field schools, generally enhancing the skills and capacities of members of local communities. Capacity-building provided to farmers by the NAMA will give families improved skills and control and security over their own welfare. The following describes the additional benefits related to each specific practice.

Implementation of silvopastoral systems and good management practices can improve farms' profitability and productivity while at the same time reducing emissions and the vulnerability of this activity to climate change. Silvopastoral systems, combined with crop rotation and forage banks, allow the diversification of feed for livestock production, increasing the incomes 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 to be obtained from trees and shrubs.

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

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

Training in the production of nutritional blocks will generate general knowledge to producers about animal health and ways to improve animal feeding, thus ensuring security for families in times of drought.

6.3.2 Environmental benefits

The management of silvopastoral systems favours improved adaptation and mitigation practices in respect of climate change by diversifying production systems, intensifying land use and counteracting 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 the forest by decreasing the consumption of firewood by more than 50% for each farm implementing the technology, which favours conservation of fauna and flora and helps protect water sources. Assuming that 41,729 households in the rural areas could potentially introduce the technology, 119,868 tonnes of firewood per year could be displaced. Additionally, recycling the nutrients by using the sludge used as fertilizer helps maintain the quality of the water on the farm.

Biofertilizers allow manure to be used, thus maximizing the use of the organic waste materials that can be obtained 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 the content of organic matter, the soil characteristics and water retention, and prevents erosion. Using organic fertilizers improves the physical, chemical and biological properties of the soil.

6.3.3 Economic benefits

The economic benefits of introducing the NAMA's practices are evident. Supplementation with woody tree forage has great impact on dual-purpose systems during the dry season. Experiences show 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 been shown to contribute to increasing the net incomes of farmers by 47% (milk price at USD 0.3/kg) compared to when only H. rufa pastures were used. With respect to meat production, increases range from 27% to 87% compared to traditional diets formed only by grazing (base diet) (Roa et al. 2000; Burle et al. 2003). The following presents the economic benefits of the respective practices:

Table 16. General economic benefits of good livestock 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 the crops or pastures, as purchase of fertilizers decline.
Implementation of biodigesters	Saves time in the cutting, chopping and gathering of firewood that can be used for another activity, or else 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 the family's fertilizer costs.
Production and use of organic fertilizer	Increases the amounts of nutrients that can be assimilated by plants, thus improving yields, and has 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 by chemical fertilizers. In the case of overproduction, sales can generate additional income. The availability of organic fertilizers also facilitates the production of organic products, which can be sold at higher prices.
Nutritional blocks	Provide a low-cost source to meet the energy requirements of animals and economic security in times of cattle food scarcity. The availability of nutritional blocks lowers infrastructure and labour requirements, and the healthy bodily condition of the animals improves productivity and incomes. The increased weight gain can be up to 50% of the initial weight, and milk production can increase by between 2-6 kg of milk/cow/day.

6.3.3.1 Economic and financial analysis in the case study of Sico and Atlantida

To establish the economic impact of NAMA implementation more accurately, CATIE conducted a feasibility analysis for case studies in the regions of Sico-Paulaya and Atlantida, to establish the financial attractiveness and risks associated with the NAMA. In the first stage, fluctuations in cash flow over a one-year period were analysed, which revealed differences in income relative to the dry and rainy seasons. Additionally, a literature review was necessary to allow different scenarios to be drawn up for implementation of the NAMA livestock project because developing complex financial analysis was hampered by an information deficit, reflecting the difficulties in obtaining financial information for small farmers. The impact of the NAMA will be more closely monitored and its expected benefits adjusted as the NAMA is implemented and initial real impact data are gathered. Other studies are being developed in other regions of the country, in Olancho, Choluteca and Yoro, through the Sustainable Landscapes–GEF Project, which will contribute to evaluating the economic impact in these regions. The results will be available in 2018 and will enable a cross-reference of information and more statistically reliable data to be created.

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 variation in farmers' investment capacities and motivations, three different scenarios were used to compare economic viability in three different situations for every farmer.

Producers were grouped on the basis of the size of their farms, their land use and animal stock. Table 17 shows the classification of groups used in this model.

Table 17. Grouping of producers on basis of level of intensification

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

The analysis was based on the scenarios explained in section 6.2 on the GHG impact of the NAMA 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 Honduras is 3.15% p.a., consistent with World Bank (2015) data.

c) The rate of interest on annual savings is 7.5%, consistent with the rates of interest of national banks.

d) The price of milk per litre in Honduras is USD 0.4, in line with national prices.

e) The costs of silvopastoral and good management practices are approximated from workshops conducted with producers, the actual rate of inputs being averaged.

f) All activities are assumed to be under way 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 Honduran farmers, but they are of great benefit to the environment and to farmers themselves. It was assumed that farmers will install biodigesters on their farms by 2018, thereby reducing 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, which would incur an interest rate of 7.5% per annum, consequently reducing the amount of investment in 2018. The maintenance costs of the biodigester were estimated at USD 100/yr starting from 2019.

Multi-nutritional blocks constitute a low capital investment (USD 56.7) and were assumed to have been initiated starting in 2016. The cost was assumed to be a fixed cost for the critical feeding period for animals (the dry season) during the entire study period.

The rotation and division of pastures and associated silvopastoral practices represented a large investment for some farmers, but a negligible investment for others. This was 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 over ten years. The cost of converting one hectare of pasture was assessed at USD 230.32 and the cost of maintaining one hectare at USD 60 every three years. The maintenance costs of already improved pastures, was also estimated at USD 60 every three years. Consequently, a large cash outflow is assumed every third year (2018, 2021, 2024). The area of the installation of live fences depended on the size of farms. Small-scale farmers were to establish 4 kms, medium-scale farmers 8 kms and large-scale farmers 12 kms of live fences over a span of ten years. It was assumed that farmers would start installing live fences from 2016 and that the cost of installing 1 km of live fencing was approximately USD 1,332. It was further assumed that farmers would install one tenth of the required live fences every year. The maintenance costs of live fences were assessed at approximately USD 50 per annum.

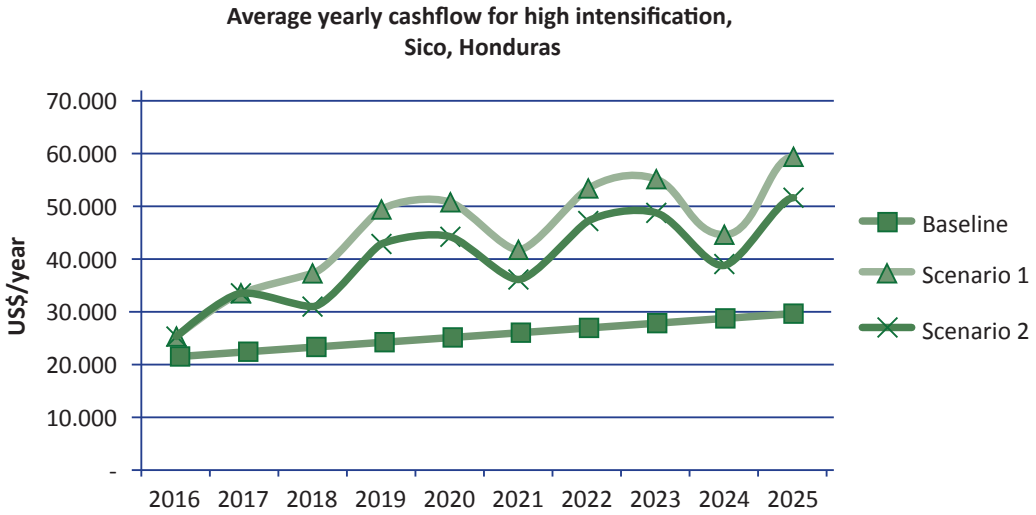
As a result of further improved nourishment from the prioritized silvopastoral and good management practices in 2017, there would be an increment of two kilograms of milk production per cow per day. In scenario 1 there would be an increment of four kilograms of milk production per cow per day in 2018 and three kilograms in scenario 2. Since many prioritized practices to improve production on the farms should have been established by 2018, 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 for 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, including 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), by 60% in second year (2017) and their complete elimination by 2018 was assumed, this being maintained from 2018 onwards. Consequently, this reduced the cost of farm inputs every year.

The adaptation of silvopastoral systems and good management practices on low-, medium- and high-intensity farms in Honduras 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 create jobs in the local economy.

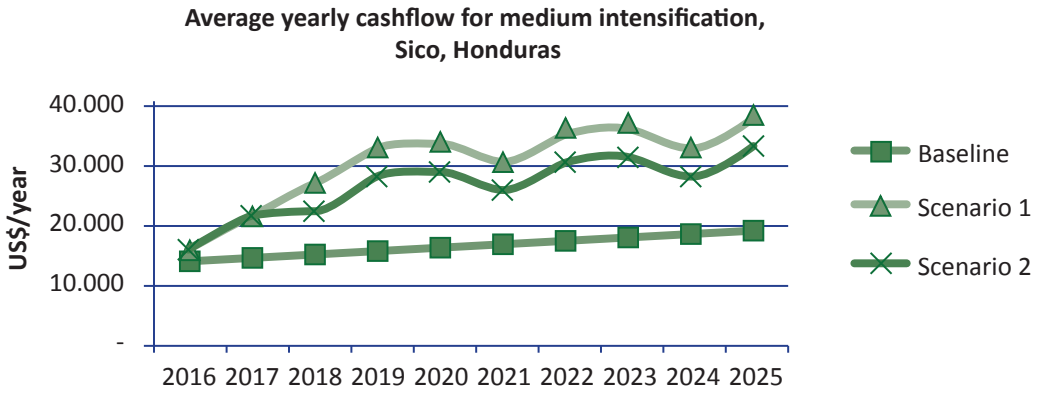
For the Sico region , the study shows a significant increase in yearly cash flows compared to the business as usual or baseline scenarios for every level of intensification, as shown in Figure 26, Figure 27 and Figure 28. It can be concluded that investment in NAMA practices is safe for medium- and low-intensity farms, though high-intensity farms would experience more extreme financial fluctuations. Another important result is the increases in cash flows every year. This is an important finding, as it demonstrates the increased profitability of silvopastoral and good management practices in the longer term.

Figure 26. Average yearly cash flows in the baseline scenario and scenarios 1 and 2, for the high intensification group in Sico, Honduras



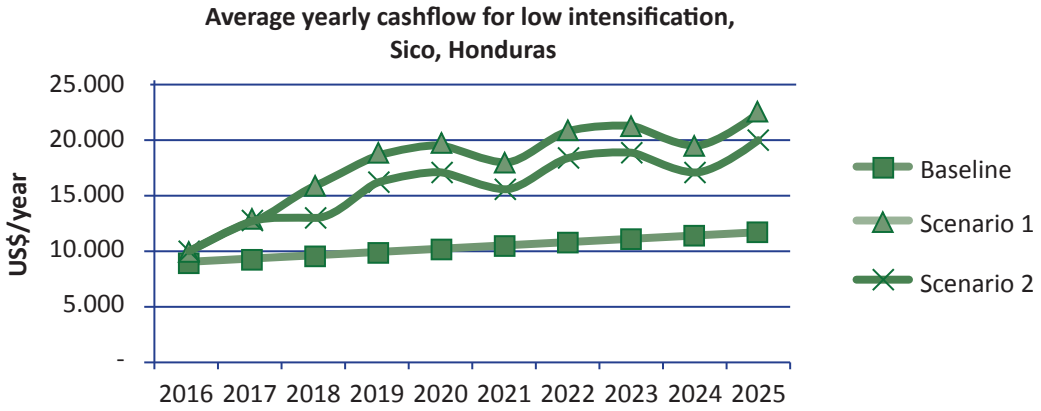
The x axis represents the time (years of the model), the y axis cash flows in US$/year.

Figure 27. Average yearly cash flows in the baseline scenario and scenarios 1 and 2 for the medium intensification group in Sico, Honduras.



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

Figure 28. Average yearly cash flows in the baseline scenario and scenarios 1 and 2 for the low intensification group in Sico, Honduras.



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

The benefit–cost ratio for the two scenarios is lower than the baseline results. The reason for this is that the period of study was short-term: in the longer term (without any new investments) the benefit–cost ratio will increase significantly. As shown in Table 18, there is a slight difference in the average benefit–cost ratio between the two scenarios. For all levels of intensification, scenario 1 shows a better benefit–cost ratio than scenario 2. This indicates that producers in all intensification groups will earn proportionally similar benefits and incur proportionally similar costs if they invested in silvopastoral and good management practices. Medium and low intensification groups have a higher benefit–cost ratio than high intensification groups due to the higher investment costs incurred by the larger scale farmers. This is an important result which clearly proves that medium and low-scale livestock farming can be profitable, and in this case more beneficial than large-scale operations. It can be concluded that investments in these practices are also economically viable for the farms.

Table 18. Average B/C ratio for all groups of intensification in the baseline scenario and scenarios 1 and 2 in Sico, Honduras

Average B/C ratio	Base line	Scenario 1	Scenario 2
High intensification	6.14	3.80	3.59
Medium intensification	8.93	4.60	4.35
Low intensification	9.37	4.70	4.45

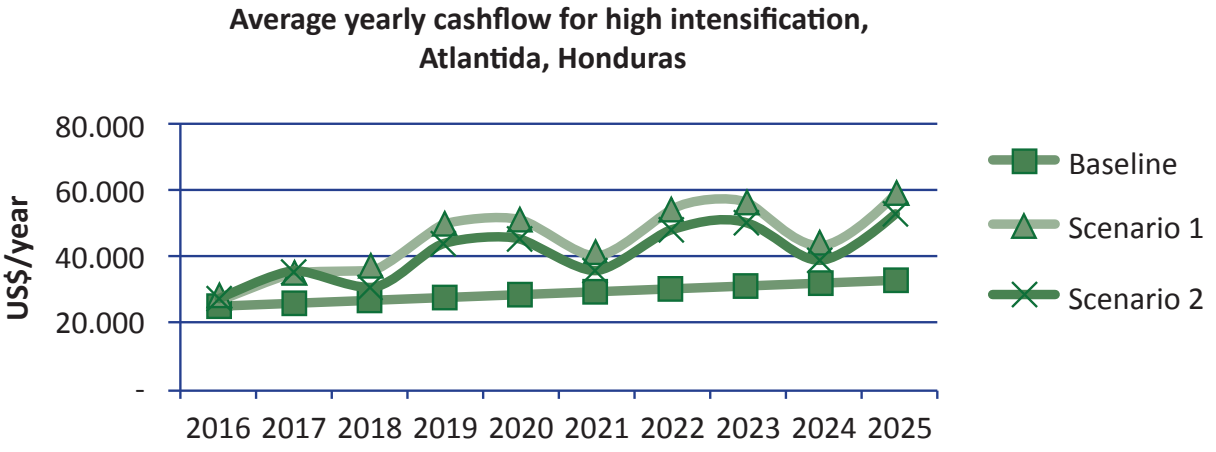
An important result is that the net present values of investments in silvopastoral systems and good management practices are significantly higher than the baseline present values, shown in Table 19. Scenario 1 represents a better investment than scenario 2 for all levels of intensification. For the high intensification group, the values of scenarios 1 and 2 are respectively 69% and 52% greater than the baseline. For medium intensification, the net present value of scenarios 1 and 2 are respectively 79% and 60% greater than the baseline present value. For low intensification, the net present value of scenarios 1 and 2 are respectively 67% and 51% greater than the baseline. Consequently, investment in silvopastoral systems and good management practices for high, medium and low intensification in the region is deemed financially lucrative for farmers. The difference in the results shows that investments in scenario 1, that is, changing 30% of native pastures into improved pastures, is a better investment for farmers than scenario 2, that is, changing 20% of native pastures.

Table 19. Average NPV for all groups of intensification in the baseline scenario and scenarios 1 and 2 in Sico, Honduras.

Average NPV	Base line	Scenario 1	Scenario 2
High intensification	153,613.43 USD	259,505.85 USD	233,224.65 USD
Medium intensification	96,517.09 USD	172925.41 USD	154,777.64 USD
Low intensification	61,215.41 USD	102,067.56 USD	92,449.82 USD

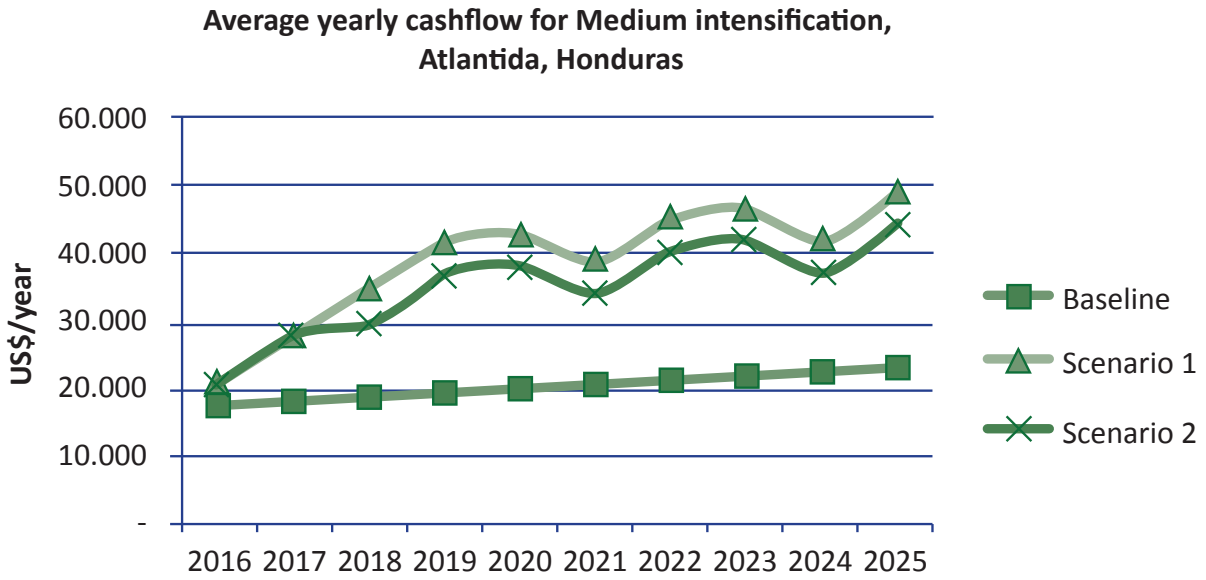
For the region of Atlántida, the findings of this model show that it is economically beneficial for the farmers in the region to invest in the NAMA practices. Scenario 1 provides higher cash flows per year compared to scenario 2 for every level of intensification, as shown in Table 18. The reason for scenario 1 providing higher cash flows is the additional increment of 1 kg of milk production per cow per day from 2018 onwards. In 2016 and 2017, scenarios 1 and 2 have similar cash flows due to the same increments in milk production occurring in these two years. The yearly cash flows fall slightly in 2018 and more strongly in 2021 and 2024 due to the maintenance costs of improved pastures arising in these years. Consistent with the results for Sico, Figure 29 shows that the high intensification group has greater variation in its cash flows than the medium and low intensification groups. This suggests that introducing silvopastoral systems and good management practices in medium and even low intensification operations would be positive. Another result that can be deduced from the Figures 29, 30 and 31 below is that yearly cash flows for all levels of intensification are significantly greater than "business as usual" cash flows, emphasizing the profitability and prospective economic benefits of introducing silvopastoral and good management practices to farms in the region.

Figure 29. Average yearly cash flows in the baseline scenario and scenarios 1 and 2 for the high intensification group in Atlántida, Honduras.



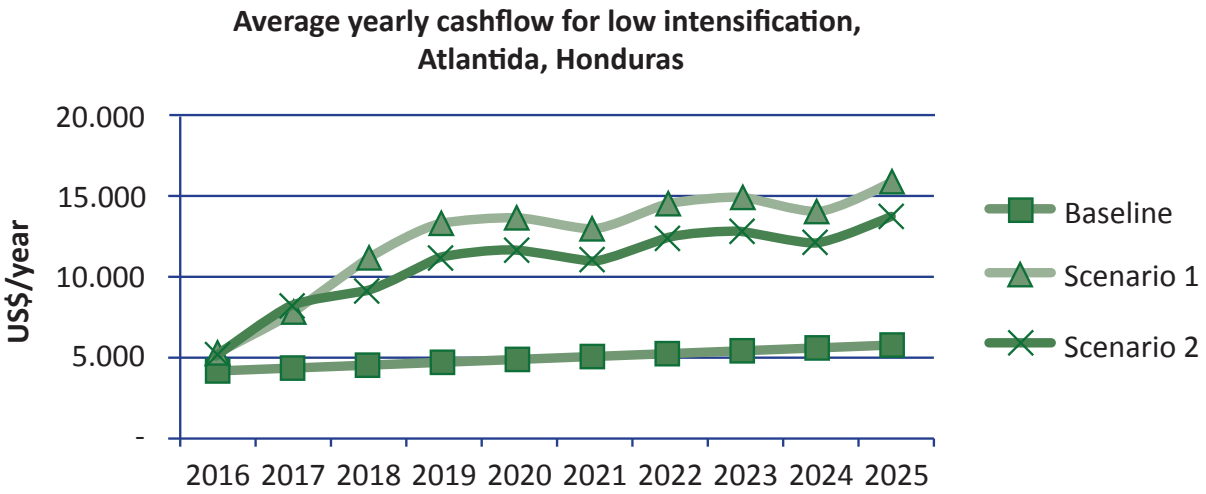
The x axis represents the time (years of the model), the y axis cash flows in US$/year.

Figure 30. Average yearly cash flows in the baseline scenario and scenarios 1 and 2 for the medium intensification group in Atlántida, Honduras.



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

Figure 31. Average yearly cash flows in the baseline scenario and scenarios 1 and 2 for the low intensification group in Atlántida, Honduras.



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

The benefit–cost ratio is higher in the "business as usual" scenario as compared to scenarios 1 and 2 for every level of intensification, due to the short-term model being used in this study. The benefit-cost ratio will improve significantly for scenarios 1 and 2 if a longer-term model with no new investments is used, as costs will then fall significantly. Table 20 summarizes the average ratios for every level of intensification. It shows that in the short term, scenario 1 is a better investment for farmers than scenario 2 for all levels of intensification. As in Sico, the benefit-cost ratio for medium intensification is higher than for high intensification, which means that the benefits for the medium intensification group are proportionally greater than the benefits for the high intensification group assuming they invested in the prioritized practices. It can also be deduced that the costs for the high intensification group are proportionally higher than those for the medium intensification group. This result is important in showing that silvopastoral and good management practices are beneficial not only to high-intensity operations but also to medium- and low-intensity operations.

Table 20. Average benefit-cost ratio for all groups of intensification in the baseline scenario and scenarios 1 and 2 in Atlántida, Honduras

Average B/C ratio	Base line	Scenario 1	Scenario 2
High intensification	9.72	4.51	4.35
Medium intensification	5.21	4.87	4.58
Low intensification	3.62	3.25	3.02

The net present values of scenarios 1 and 2 are significantly greater than the baseline values, indicating that investment in the practices is a viable investment for producers. The difference between the values of scenarios 1 and 2 for each level of intensification is due to the higher milk production in scenario 1. For high intensification, the net present values of scenarios 1 and 2 are respectively 50% and 37% greater than the baseline values. For medium intensification, the net present values of scenarios 1 and 2 are respectively 85% and 67% greater than the baseline values. For low intensification, the net present values of scenarios 1 and 2 are more than twice the baseline values. This result clearly shows that investment in these practices in Atlántida is highly lucrative for farmers and that their economic gains outweigh their costs even in the short term. The NPV analysis clearly concludes that it is highly beneficial to adopt these practices, especially for farmers in the low intensification group. It is worth noting that, in this region, scenario 1 is an obvious choice for the farmers, since it has a higher benefit-cost ratio and net present values for all levels of intensification.

Table 21. Average NPV for all groups of intensification in the baseline scenario and scenarios 1 and 2 in Atlantida, Honduras

Average NPV	Base line	Scenario 1	Scenario 2
High intensification	174,153 USD	261,938 USD	239,162 USD
Medium intensification	120,665 USD	224,068 USD	201,624 USD
Low intensification	29,686 USD	70,304 USD	61,511 USD

6.4 Description of the transformational impact of the NAMA, including its sustainability

As described in the sections above, the NAMA is expected to have large sustainable development co-benefits, but its long-term contribution will go beyond providing specific co-benefits, transforming the whole sector and parts of Honduran society as well. In terms of GHG emissions, the NAMA will help drastically change the current development path of the sector increasing its emissions over time towards reversing this trend in the direction of becoming a GHG sink over time. This abrupt transformation is expected to bring increased productivity for farmers and ensure the long-term sustainable management of farms' production systems, thus ensuring that farmers will not revert to their former practices once the benefits of NAMA implementation start to materialize. This redirection of development trends for the sector illustrates the wide transformational impact that the introduction of the sustainable practices under the NAMA will have in the long term.

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

The transformational impact of the NAMA can also be illustrated by the contribution the implementation of practices will have to support achieving the Sustainable Development Goals and their targets. Specifically relevant are the following goals and targets, MRV and its indicators being 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 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
	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, technology 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 and minimizing the release of hazardous chemicals and materials, thus 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 freshwater 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 per cent 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, and halt and reverse land degradation and 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 NAMA implementation

The following parameters will be monitored by DICTA upon the delivery of NAMA support to farmers and will be reported by farmers annually.

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

Classification of farms upon receipt of NAMA 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 introducing the different practices and to what extent

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

For emissions reductions from the introduction of biodigesters on 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 fuels for cooking/lighting prior to biodigester implementation

To assess the carbon intensity of the farm's production, the emissions in the baseline and after the introduction of these practices will be compared to the farm's productivity. This is why 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 for the products and income generated
- number of people who received training
- jobs created
- state of the 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 NAMA's contribution to achieving the respective targets, while others will be measurable at the producer level, thus providing data enabling the contribution of sustainable development to the NAMA to be estimated with a high degree of confidence.

Table 22. Sustainable Development Goals: indicators

Goal	Target	Indicators	Monitoring arrangement
Goal 1: End poverty in all its forms every-where	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	Indicator: 1.2.1 Proportion of population living below the national poverty line, by sex and age	Income of producers monitored by DICTA through representative surveys and data aggregated at the national level by FONAC, aligned with Country Vision targets and National Plan
		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 DICTA through representative surveys, data aggregated at national level by FONAC, aligned with Country Vision targets and National Plan
	Target: 1.a Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation and 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 by the government directly to poverty reduction programmes	Number of producers below the poverty line receiving funds from the NAMA (partly with public support) monitored by DICTA through representative surveys, reported to FONAC

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 on the farms monitored by DICTA through representative surveys and verification. Impact analysed at national level by FONAC
	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 classes of farming/pastoral/ forestry enterprise size	Productivity in the farms per labour unit monitored by DICTA through representative surveys and verification. Data aggregated at national level by FONAC
		Indicator: 2.3.2 Average income of small-scale food producers, by sex and indigenous status	Monitored by DICTA through representative surveys and verification. Data aggregated at national level by FONAC
	Target: 2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	Indicator: 2.4.1 Proportion of agricultural area under productive and sustainable agriculture	Monitored by DICTA through representative surveys and verification. Data aggregated at national level by FONAC
	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 expenditure monitored by FONAC
		Indicator: 2.a.2 Total official flows (official development assistance plus other official flows) to the agriculture sector	Volume of government expenditure monitored by FONAC

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 FONAC
		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 FONAC
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 FONAC
	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 FONAC
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	Implementation of biodigesters with energy use monitored by DICTA, aggregated at national level by FONAC
		Indicator: 7.2.1 Renewable energy share in total final energy consumption	Implementation of biodigesters with energy use monitored by DICTA. Aggregation at national level by FONAC
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 FONAC

Goal 10: Reduce inequality within and among countries	Target: 10.1 By 2030, progressively achieve and sustain income growth of the bottom forty per cent 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 per cent of the population and the total population	Monitored by DICTA through representative surveys and verification, and aggregated at the national level by FONAC
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 DICTA through representative surveys and verification, and aggregated at the national level by FONAC
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 development of greenhouse gas emissions 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 NAMA contributes directly to this global goal. DNCC will report on the NAMA advancements 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 NAMA contributes directly to this global goal. DNCC will report on the NAMA advancements to the UNFCCC

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	Indicator: 15.1.1 Forest area as a proportion of total land area	Monitored by DICTA through representative surveys and verification, and aggregated at the national level by FONAC
	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 DICTA through representative surveys and verification, and aggregated at the national level by FONAC
	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 DICTA through representative surveys and verification, and aggregated at the national level by FONAC

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

Emissions reductions caused by changes in land-use practices, are calculated by assessing the potential amount of hectares converted from the baseline on farms to other practices, utilizing the practices' respective emissions factors. These are described in Table 7: "Emissions, intensification potential and carbon sequestration potential of different silvopastoral practices"

Land-use system	Animal stock (animal unit/ ha)	Carbon fixation rate	GHG emissions	Net emissions
		$tCO_2e/ha/y$		
Native pastures	0.4	0.0	1.8	1.8
Native pastures with trees	0.6	7.8	1.6	-6.2
Improved pastures	1.2	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

These emissions factors are estimated on the basis of literature and case studies, but they will be updated as NAMA implementation proceeds and new data is generated for the actual GHG emissions reduction contribution from the implementation of the NAMA practices.

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 by 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. This is applicable to methane recovery systems that achieve an annual emissions reduction of less than or equal to five tonnes of CO_2e per system and where the sludge from the biodigester is handled aerobically by being applied directly to the soil. The AMS-I.I. CDM methodology describes how to calculate emissions reductions from activities for the generation of renewable thermal energy using biogas in residential, commercial and institutional applications. These include biogas cooking stoves and other thermal applications displacing fossil fuels for a total installed/rated thermal energy generating 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 the biodigester on the farms are calculated by:

$$ER_y = BE_y - PE_y$$

Where:
ER_y = emissions reductions achieved by the project activity for year y (tCO_2e)
BE_y = baseline emissions for year y (tCO_2e)
PE_y = project emissions for year y (tCO_2e)

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 take the form of the following:

1. At the time of installation, all biodigesters will be inspected by DICTA 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 the installation and biannually thereafter

c. Annual average animal population

d. Amount of waste/animal manure generated on 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:

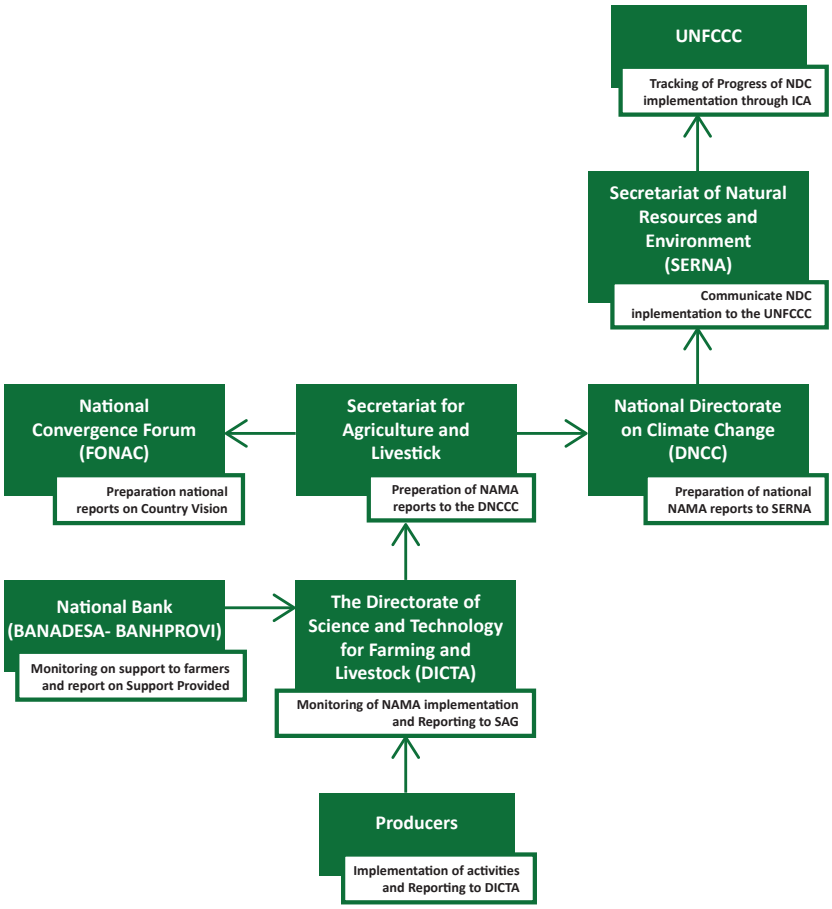
2. Farmers will self-monitor and report annually to DICTA on the continuing use of biodigesters.

3. Verification will be carried out by MiAmbiente, DICTA y SAG, biannually using survey methods,[4] selecting a statistically valid sample of the farms where the systems are installed, giving consideration in the sampling design to levels of occupancy and demographic differences to determine the percentage of systems operating, in accordance with 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 practices will provide the primary source of data to be monitored. They will conduct measurements of most of the activities and will report to DICTA on the progress of implementation through biannual surveys. The Rural Banking Unit will report to DICTA on the financial support provided to farmers, and information will be cross-checked with farmers' own reporting. DICTA will report on progress with NAMA to SAG, which will itself report to the DNCC on the NAMA's implementation and contribution to sustainable development and GHG emissions reductions. SAG will also report to FONAC on progress with NAMA in respect of sustainable development, thus enabling FONAC to monitor progress toward achhieving the National Country Vision. SERNA will receive progress reports from SAG and prepare reports to the UNFCCC on the national mitigation contribution and progress with NDC. The institutional framework for MRV of the NAMA is shown in Figure 32.

Figure 32: Institutional arrangements for MRV of the NAMA



4 The reporting survey is provided in Annex I.

7.5 Description of verification process

Verification at the international level will take place through the UNFCCC's International Consultation and Analysis procedure. More relevant for the NAMA, verification nationally will take place on two tracks:

1) Periodic progress in meeting the goals and indicators of the National Plan will be subject to an independent verification mechanism headed by FONAC, which is in charge of establishing the system of monitoring and of reporting progress in implementing the National Plans. FONAC is also the entity assigned to manage verification and independent monitoring of fulfilment of the Country Vision and the Nation Plan.

2) The transparent use of the public resources allocated to the fulfilment of the National Plan will be monitored by the National Anti-Corruption Council within the framework of the National Integrity System, which it is proposed to place within the framework of the National Anti-Corruption Strategy up to 2030. Verification of the actual implementation and continued functioning of the NAMA's practices will be done biannually by DICTA with reference to a representative selection of farms.

8. Financial resources

8.1 Full cost of implementing the NAMA

8.1.1 Cost of implementation of practices for producers

The following tables illustrate the cumulative costs in USD of the introduction of NAMA practices for small, medium and large-scale producers (a total of 75,000 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 and improved pastures and silvopastoral systems, with pasture rotation, live fences and fodder banks, combined with the gradual and incremental introduction of organic fertilization systems and biodigesters by 1%/y.

Table 23. Investment and O&M costs for the implementation of NAMA practices under scenario 1

Investment costs [USD]	For each farm		For all farms		
	Investment cost for farms investing in both SSP and organic fertilizers	Maintenance costs	SSP systems	Organic fertilizers	**Total**
Small farmers	6,533	16,380	293,976,000	2,450,250	**296,426,250**
Medium farmers	11,419	26,490	299,754,000	1,876,875	**301,630,875**
Larger farmers	29,904	113,640	112,140,000	598,125	**112,738,125**
Total	**NA**	**NA**	**705,870,000**	**4,925,250**	**710,795,250**

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

Table 24. Investment and O&M costs for the implementation of NAMA practices under scenario 2

Investment costs [USD]	For each farm		For all farms		
	Investment cost for farms investing in both SSP and organic fertilizers	Maintenance costs	SSP systems	Organic fertilizers	**Total**
Small farmers	4,715	15,180	213,409,125	1,225,125	**214,634,250**
Medium farmers	9,147	24,940	241,052,438	938,438	**241,990,875**
Larger farmers	25,240	112,160	94,949,063	299,063	**95,248,125**
Total			**549,410,625**	**2,462,625**	**551,873,250**

The initial investments and O&E expenses will be carried by the producers, but financial support is envisaged in the provision of preferential loans. The national and international financing that will 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 of the establishment of the field schools that will provide capacity-building for NAMA practices.

Table 25. Cost of the capacity-building component of the NAMA

Training	USD$	Duration	Target
Establishment of field schools and workforce	20,000,000	5 years	Establishment of 145-200 field schools
Training workshops with technical specialists for DICTA and other partner institutions in implementation of NAMA practices through field schools	15,000	1 year	Minimum 30 technicians
Field-school workshops and support to experimentation activities of ECAs (planting materials, tools and inputs): initially 30 in the first year, reaching 145 in years 1-5. Unit cost: 10,000/ field school	1,450,000	5 years	6,000 producers
Local workshops in target areas for the dissemination of project plans, results and lessons learnt (years 1-5)	20,000	1 - 5 years	Technicians and facilitators
Total	21,485,000		

8.2 Funding from domestic sources

DICTA heads the Program of Agricultural Technology Transfer, which has already enhanced the capacities and productive abilities of 14,525 small and medium producers, specifically targeting women. This accounts for 32% of the technical assistance, training and technological support provided. Ten agricultural professionals and 1,108 students of the agricultural sciences have been trained and their technological knowledge updated in recent years. The technological focus was directed towards achieving increased efficiency in order to enhance the agricultural sector's competitiveness. With the NAMA, the technologies and practices described here will be incorporated into DICTA's technical assistance to livestock producers. This will also form part of the national contribution, where parts of the current budget of L30,552,999 (USD 1,302,300) for the Program of Agricultural Technology Transfer will be used for targeted capacity-building to livestock producers as part of the NAMA's activities.

The NAMA will be coordinated with the National Rural Extension Program with the support of Zamorano, the Texas Technical University, the National Autonomous University of Honduras (UNAH) of Catacama, FIRSA and Dairy Consulting, in order to incorporate the NAMA's practices into the Program. The Program has a budget of 50 million HNL (USD 2.1 million) and will constitute part of the national funding for the NAMA.

Through the project "Sustainable Management of Production Landscapes", the Ministry of Environment has developed field schools in the departments of Yoro, Choluteca and Olancho. The project is expected to establish 145-200 schools, reaching 6,000 producers. The costs of the establishment of the field schools are estimated at USD 20 million and will form part of the national contribution to the NAMA.

Additional expenses for training technicians and farmers in the NAMA's practices is envisaged through international financing. ECAs have great potential to fill the gaps left by the downscaling of traditional government support and to address the shortcomings of traditional "vertical" approaches to providing support. SAG has a particular interest in extending NAMA implementation based on ECAs due to its positive track record in providing capacity development to farmers and the effectiveness of utilizing an existing successful framework.

8.3 Financial support from international funding

The following lists the planned activities to finance the implementation of the NAMA's activities from international sources.

The National Rural Extension Program, providing loans at preferential rates, at 7.25%/y to farmers, to cover initial investment costs, will be expanded to reach a minimum of 6,000 producers in the first five years. Estimating the average initial investment needed for small, medium and large producers over the first five years shows that a total investment of USD 195,850,000 would be needed to implement practices according to scenario 1 for 6,000 producers (USD 355,284,000 by 2029 for 75,000 producers). The initial investment to 6,000 producers is planned to boost interest in the NAMA and to create confidence on the part of local financing institutions regarding the profitability and security of investing in the NAMA's practices. Honduras would need initial international assistance to provide preferential loans to farmers in the first five years, but financing the NAMA is envisaged as becoming self-sufficient, as confidence in the NAMA grows. To this end, the NAMA envisages support in the form of 30% in preferential loans or guarantees to a total of USD 58,755,000, thus allowing the provision of loans at a preferential rate to farmers on a large scale.

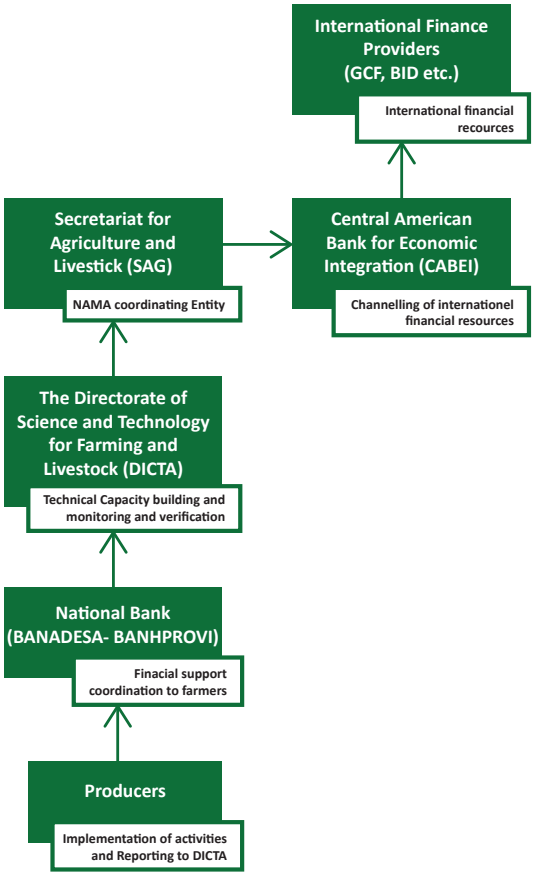
Of the USD 21,485,000 needed for capacity-building activities, 20,000,000 will come from national sources through existing programmes investing in the NAMA, but USD 1,485,000 will be sought through international climate finance support, as additional capacity will be needed for the training of technicians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

The 20 million USD represents domestic funding allocated for five years. Once this time period is over, the capacity-building system will need to secure operational funding to be able to continue. This is envisaged as coming from the producers by introducing a small levy on each litre of milk produced of around 0.35 HNL per litre. A similar system is in place in the coffee sector, where producers pay one dollar per 100 pounds they produce.

8.4 Description of arrangements to finance NAMA implementation, including domestic finances and international funding

It is planned to obtain international finance through the GCF, BID, the NAMA Facility and/or other sources. BCIE will channel the international funds to SAG, while BANADESA has the necessary capacity and experience to manage international funds for the implementation of projects and programs. The Honduran Bank for Production and Housing (BANHPROVI) has the experience and capacity to administer loans to producers.

Figure 33. Implementation arrangements for NAMA financing



9. Non-financial support required

Establishing silvopastoral systems and the other envisaged NAMA practices requires the intensive training of the producers and detailed technical knowledge on the appropriate implementation of the practices. The most appropriate type of silvopastoral system depends on the characteristics of the farm and the needs of the producer. Identification of tree and/or shrubs needs to be taken into consideration in accordance with the needs of the farm and the producer, while choosing appropriate pasture division depends on the topography and the type of soil. When dividing paddocks, producers should take into account the arrangement of tall trees and leafy trees to promote sufficient shade while grazing without affecting the growth of grass. For this purpose, it is necessary to take into account the sun's movement. It is also necessary to take into consideration the planting 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 introduce the NAMA's practices.

As already described throughout the NAMA document, institutions are already available for the provision of capacity-building activities, although DICTA and other institutions would need assistance in training more technicians in the NAMA's practices in order to empower farmers nationwide and achieve the envisaged impact. DICTA will need further capacity-building by CATIE in order to train DICTA technicians and technicians providing implementation support to farmers in field schools. The target is to provide training to a minimum of thirty technicians, who would then train other staff, in order to reach a minimum of 6,000 producers in the course of five years. In addition, DICTA should provide capacity-building to local private companies in the technical knowledge needed to construct biodigesters. DICTA should also provide information on 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 kg/animal/day	Produced on the farm? 1: Yes 2: No 3: Outside	Time 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

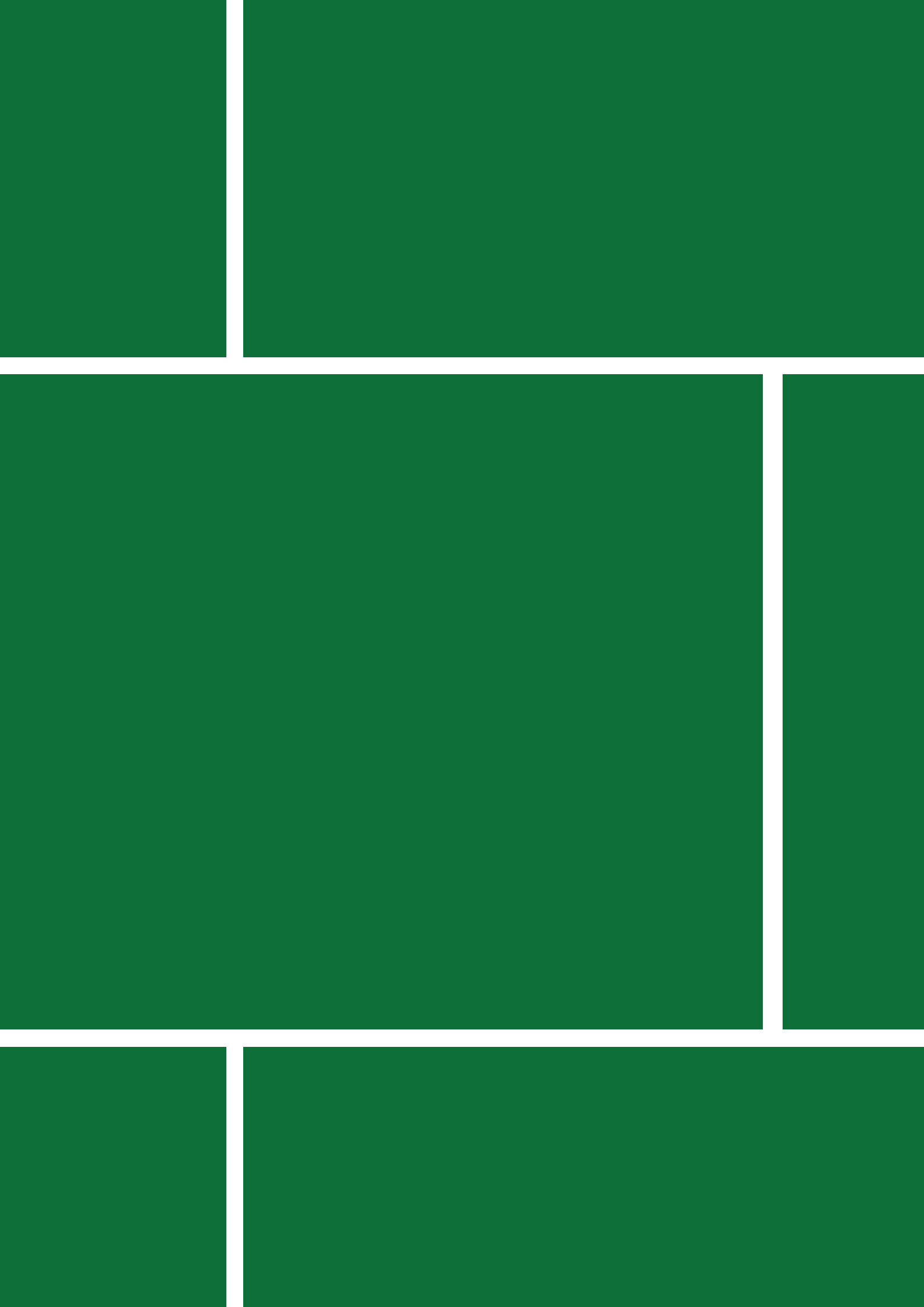
Income source	Quantity sold	Income obtained

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