Food and Agriculture Organization
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Low carbon rural communities

Enhancing resilience and mitigating climate change for rural development: one experience in Honduras

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Introduction

Climate change is one of the biggest global threats faced today, as its negative impacts are already affecting those most vulnerable and could impede global development. The Food and Agriculture Organization of the United Nations (FAO) recognizes in its *Strategy on Climate Change* that actions to combat climate change are key to eradicating hunger, food insecurity and malnutrition as well as promoting rural development and improved sustainable agriculture, forestry and fisheries.

In order to achieve the Sustainable Development Goals (SDGs) of the 2030 Agenda and FAO Strategic Objectives (SO), the innovative concept of *low carbon agriculture* has been developed, which aims to transform current production systems while strengthening entire agricultural value chains by reducing greenhouse gas (GHG) emissions and increasing resilience to climate change hazards.

Rural communities and smallholder farmers in developing countries are among the most vulnerable populations to climate change impacts as their economy and subsistence depend on agricultural production (Harvey *et al*. 2018; Menike & Keeragala Arachchib 2016). Moreover, they are the basis of food and agricultural systems, whose actions and improvements will be reflected throughout the whole agricultural value chain.

On this basis, and under the low carbon agriculture approach, the concept of *low carbon rural communities* has been created. The concept aims to promote food security and enhance the climate resilience, well-being and livelihoods of smallholder farmers in rural communities, through actions that enable adaptation to and mitigation of climate change.

The promotion of a low carbon development approach in rural communities includes providing access to renewable energy, aside from improving agricultural production practices through agroforestry and sustainable management of natural resources. These actions allow the quantification and certification of GHG emissions reduced or avoided, which will mark a first step in accessing carbon markets and new sources of income.

The replication and scalability of this concept in rural communities at national, regional and global level has high potential to generate positive impacts and promote environmentally, socially and economically sustainable development.

The first experience with low carbon rural communities was carried out in Honduras. As a result of the project, it is expected that the community increases its resilience to climate change, implements adaptation and mitigation activities, promotes sustainable food systems and provides an increase in incomes and employment sources. The results, impacts and achievements of this case study provided evidence-based data that will serve as a foundation for its replication in rural communities around the world through similar climate action.

Impacts of climate change in rural communities

Climate change is severely affecting those populations living in rural isolated areas of developing countries. The dependence of their agricultural productivity and infrastructure on natural resources and weather conditions, in addition to their isolation from regional markets, services or external resources, leave them particularly vulnerable to climate change. Migration, loss of livelihoods, poverty, malnutrition, and food and water insecurity are among the main threats they are facing (FAO 2015).

Rural communities located in the Mesoamerican Dry Corridor (MDC) area of Central America are already suffering the impacts of climate change. The MDC extends from Chiapas in Mexico to Guanacaste in Costa Rica, comprising Guatemala, El Salvador, Honduras and Nicaragua.

The region is characterized by the cyclical phenomena El Niño-Southern Oscillation (ENSO), causing prolonged drought periods followed by heavy rains and floods, leading to landslides and soil erosion and a lack of sufficient available water resources. The intensity and frequency of these extreme climate events has increased in the last few years due to climate change and the socioeconomic and environmental vulnerability of the area (FAO 2017).

In 2016, FAO estimated that more than 3.5 million people need humanitarian assistance along the MDC, 40 percent of whom are located in Honduras. Almost half of the population live in rural areas and their main activity is subsistence agriculture, cultivating maize and beans. Statistics show that maize has already experienced a yield decrease of around 60 percent (Calvo-Solano *et al.* 2018; FAO 2016), whereas bean yield losses reached 80 percent (FAO 2016). In 2014, a 132 percent price increase compared to the previous year, led to a decrease in food security and economic stability (CEPAL 2015; WFP 2015).

In this regard, there is a need for solutions that contribute to enhancing the resilience of rural communities to climate change by promoting a shift in the current agricultural and food systems. FAO can play a crucial role in achieving these sustainable development objectives, considering its technical expertise and experience in strengthening countries' capacities in relation to food systems, climate action and rural development.

Case study: the rural community El Santuario

The first case study assessing low carbon rural development is under implementation in a rural community in the Mesoamerican Dry Corridor region, selected with the support of the Central American Community Agroforestry Indigenous and Peasant Coordination Association (ACICAFOC), considering the needs and expectations of the inhabitants.

The rural community El Santuario is located in the department of Choluteca, Honduras, composed of 77 households, a church that is also used for administrative and leisure activities, a primary school and a kindergarten.

The community is located in a sloping dry forest region, with forested areas of mainly pine and oak, and seasonal streams as the main water source. The region is characterized by a sub-humid ecosystem with two well-differentiated seasons: a dry season between November and April and a wet season between May and October.

The temperature is stable during the whole year with a maximum average of 27 ºC and a minimum of 16 ºC. Rainfall is very irregular: January is the driest month, with rainfall of 0-5 mm, and September is the wettest, with 400-500 mm. The average annual rainfall is around 1 800 mm.

The main economic activity is subsistence agriculture with limited production surpluses. Maize and beans are the main crops, but cassava, sweet potatoes as well as family gardens, have been recently introduced in a process of agricultural diversification. In order to increase the family income, inhabitants have to migrate to do seasonal work harvesting coffee in other regions.

Access to the community is difficult as it is limited by a poorly maintained, unpaved road, keeping it isolated without access to the national electricity grid. These conditions are not expected to change in the short or medium term.

Components

In addition to contributing to climate change mitigation and to enhance livelihood opportunities and resilience to climate change, a low carbon approach has been promoted in the community. The components include the introduction of sustainable agricultural practices, water management, agroforestry and silvopastoral systems, as well as providing clean energy through a hybrid renewable energy mini grid which combines a solar photovoltaic grid and a biomass gasifier, designed by the Polytechnic University of Valencia (UPV).

Agricultural best practices

- **Low carbon agriculture:** For the annual production of maize, beans and cassava, the activities include the improvement of nutrient, water and waste management in at least half of the 1 86.7 hectares (ha) of land used for subsistence agriculture.
- **Agrobiodiversity:** The project intends to introduce and sustainably manage 1.4 ha of horticultural crops in family gardens, aiming at diet diversification, undernourishment reduction and increased resilience for the community.
- **Restauration and reforestation:** Part of the degraded land in the area will be used for planting 50.9 ha of cashew nut trees that, sustainably managed, will contribute to recovering soil properties and will be a new source of income for the inhabitants of the community. Moreover, 35 ha will be reforested with local tree species, including trees for energy, timber and fruit trees.
- **Sustainable use of biomass:** Forested areas in the community provide the inhabitants with wood for cooking, lighting, heating and processing cashew nuts. The forest has approximately 100 ha and a deforestation rate of around 13.2 ha/year. With efficient wood consumption, the deforestation rate is expected to decrease to 5 ha/year.
- **Silvopastoral systems:** Currently, 125 heads of dairy cattle graze in 100 ha. The activities in this project will improve feeding and breeding practices. Emissions from this activity will be mitigated by planting 1 400 trees.
- **Soil conservation:** Organic fertilizers will be used in all the plantations to ensure sustainable agriculture. The current amount of nitrogenous fertilizers for crops reaches around 10 tonnes, which will be replaced with 30 tonnes of organic fertilizer.
- **Water management:** An efficient irrigation system will be installed in the communities' agricultural fields. (See Technical Notes).

Hybrid renewable energy mini grid

In addition to enhancing climatic resilience, the aim of the project is to increase the resilience of the community itself. With high migration rates in the country, providing access to basic services in the most isolated communities may offer a strategy to ensure permanence in the rural areas, while strengthening agricultural value chains as an income source in marginalized areas.

Access to electricity will contribute to increased well-being and will facilitate cashew nut processing activities. The energy supplied by the installation has been estimated based on the energy needs of agroforestry and silvopastoral activities, and on basic energy needs at household level and in community buildings.

The hybrid mini grid was designed to include a photovoltaic plant, a biomass gasifier and a battery bank to ensure constant provision of electricity (see Technical Notes).

In addition, smart network meters will be installed in homes and community buildings, and a "prosumer" (producers and consumers at the same time) organization will be created through which the community inhabitants will be able to self-manage the energy services.

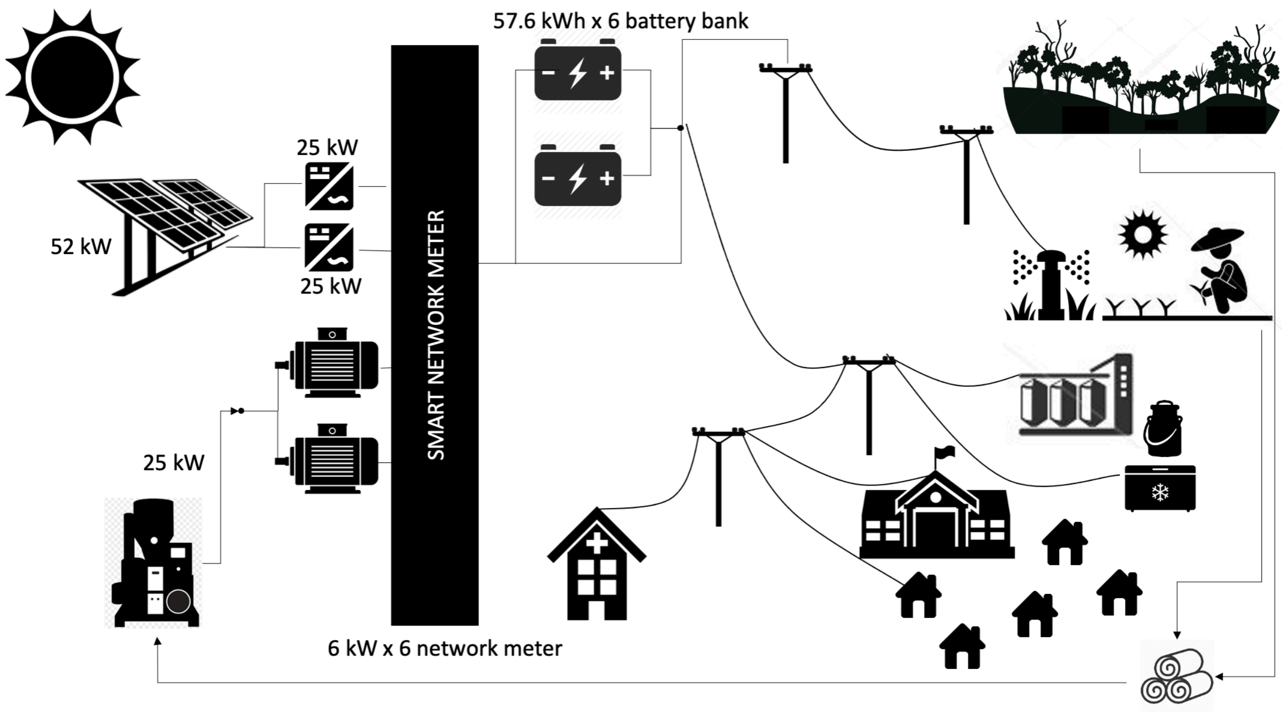

Figure I. Schematic overview of the layout of components in the hybrid mini grid

Enabling environment

Setting up an enabling environment for the promotion of low carbon activities in rural communities is crucial to maximize the sustainability and results of activities.

The enabling environment depends on several factors complementary to the technical components that are interrelated (shown in Figure 2), which were enhanced in this pilot study in the following ways:

- **Financing model and stakeholder engagement:** Access to new markets provided by the women's cooperative "La Sureñita", ensures a strong financing structure contributing to the creation of decent employment and private sector engagement.
- **Capacity building and ownership:** The support of ACICAFOC, a non-governmental organization (NGO) with knowledge about the community and responsible for capacity development, ensures project objectives are aligned with the priorities of the beneficiaries, especially women, through inclusive participatory activities.
- **Technology transfer, knowledge sharing and policies:** Ownership throughout the technology transfer process is strengthened by capacity development and the potential of the project to be replicated so that the acquired knowledge is shared., This creates an enabling environment for political and regulatory frameworks to be developed.
- **Gender equity:** Transversally promoted throughout the initiative, with the presence of the women's cooperative "La Sureñita" and the development of workshops and surveys, and the collection of disaggregated data.

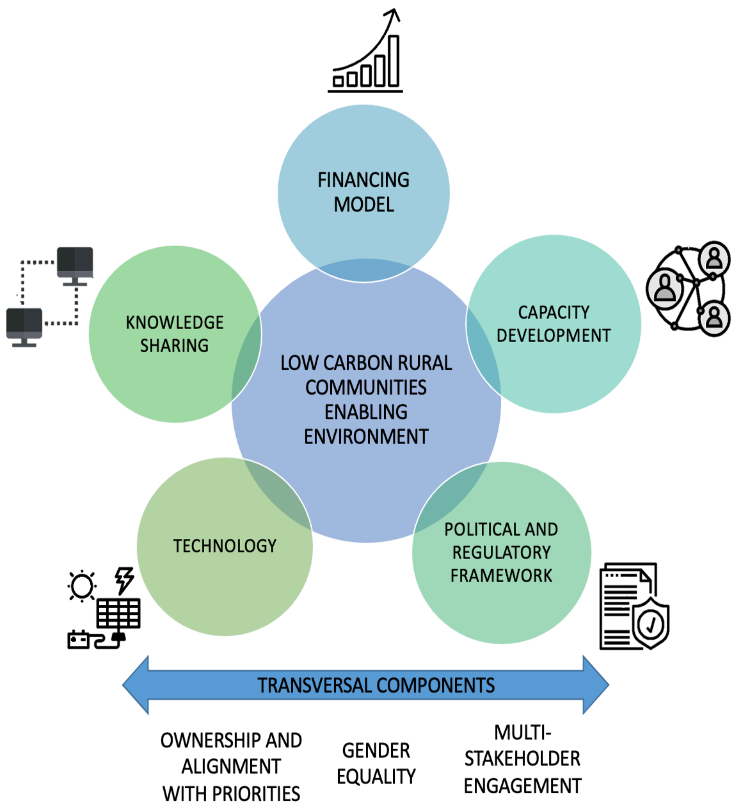

Figure 2. Low carbon rural communities enabling environment
Source: Modified from IRENA, 2018

Mitigation and carbon sequestration potential

Through the activities performed at the productive, household and society levels, rural communities with a low carbon footprint will increase their resilience to climate change mitigation activities with adaptation co-benefits contributing to the achievement of SDG13 and supporting rural development.

One of the long-term objectives pursued by this initiative is to consolidate the first step towards access to voluntary carbon markets. In order to achieve this, it is necessary to implement a methodology that allows greenhouse gas emissions to be measured and certification based on the balance of generated and mitigated emissions from socioeconomic activities in rural communities.

Through the project, sustainable agricultural practices such as reforestation, soil restoration or water retention, access to renewable energy and low carbon agriculture will contribute to climate change mitigation by reducing emissions and sequestering carbon.

These quantified emissions will define the carbon footprint of the community, thus enabling access to the Clean Development Mechanism (CDM) or Voluntary Markets for trading carbon offsets. The participation in the carbon market will represent a new income source, thus ensuring the long-term sustainability of the project. An *ex ante* emissions quantification of the case study is detailed below.

Hybrid renewable energy mini grid

The hybrid renewable energy mini grid in El Santuario will generate around 73 000 kWh/year, covering the electricity needs of the community. The emissions avoided will be 61.32 tonnes of CO_2eq/year[1] compared with the use of a diesel generator, and 25.77 tonnes of CO_2eq/year[2] compared with accessing the national electricity grid (Figure 3).

Additionally, there is a small consumption of kerosene, candles and chemical batteries of 5.09 tonnes of CO_2eq/year, which could be eliminated with the implementation of the mini grid.

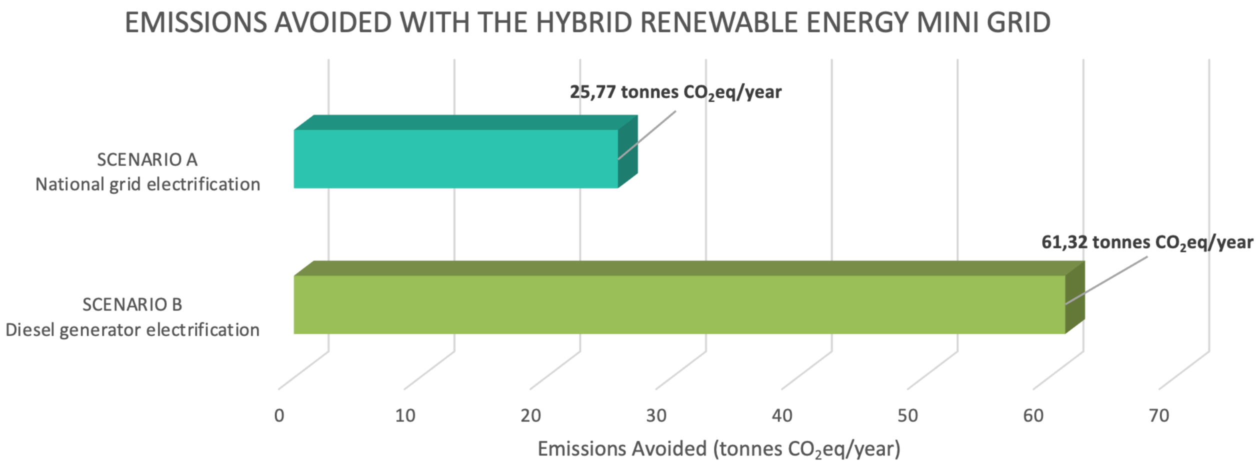

Figure 3. Emissions avoided with the hybrid renewable energy mini grid

1 Calculated using IPCC emission factors database.
2 Honduras' grid emission factor from (CEPAL 2016).

Agroforestry activities[3]

The agroforestry activities contribute by more than 200 percent to the reduction of emissions compared to the baseline scenario, with a carbon sequestration potential of 1 080 tonnes of CO_2eq/year (Figure 4).

The community consumes around 17 kg/day of wood per household for cooking and lighting, which will be reduced with the implementation of the mini grid and the sustainable use of wood by 14 kg/day per household. The reduction in wood consumption leads to a reduction in deforestation rates and hence a reduction in GHG emissions of 263 tonnes of CO_2eq/year.

The land use change activities, reforestation and the plantation of cashew nut trees in degraded land and the introduction of sustainable agricultural practices, contribute to the sequestration of 1 105 and 554 tonnes of CO_2eq/year respectively.

In spite of urea-based fertilizers being replaced with organic ones, the increase in amount per year leads to the emission of 140 tonnes of CO_2eq/year. Figure 5 shows the contribution of each activity within the agroforestry component, in percentage, to the total emissions balance of 1 782 tonnes of CO_2eq/year compared to the baseline scenario.

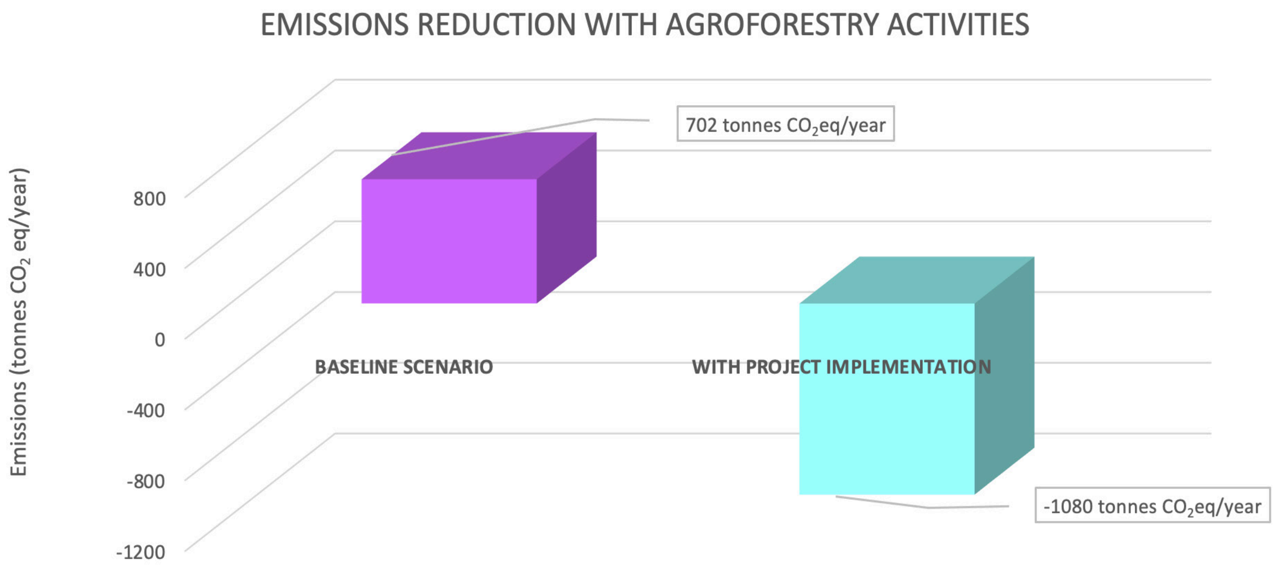

Figure 4. Emissions reduction with agroforestry activities

[3] The impacts on the emissions and sequestration potential of the agroforestry components have been estimated using FAO EX-Ante Carbon balance Tool (EX-ACT).

Overall, the annual mitigation potential of the community reaches 0.12 tonnes of CO_2eq/capita in avoided emissions from the renewable energy mini grid, and 35 642 tonnes of CO_2eq/capita of sequestered carbon with agroforestry activities, thus having an annual total of approximately 3.7 tonnes of CO_2eq/capita.

The community has a total mitigation and sequestration potential of 1 843.3 tonnes of CO_2eq/year, which the community can use as a carbon offset bond in the voluntary carbon markets. This will generate annual additional profits of USD 53 455.7.[4]

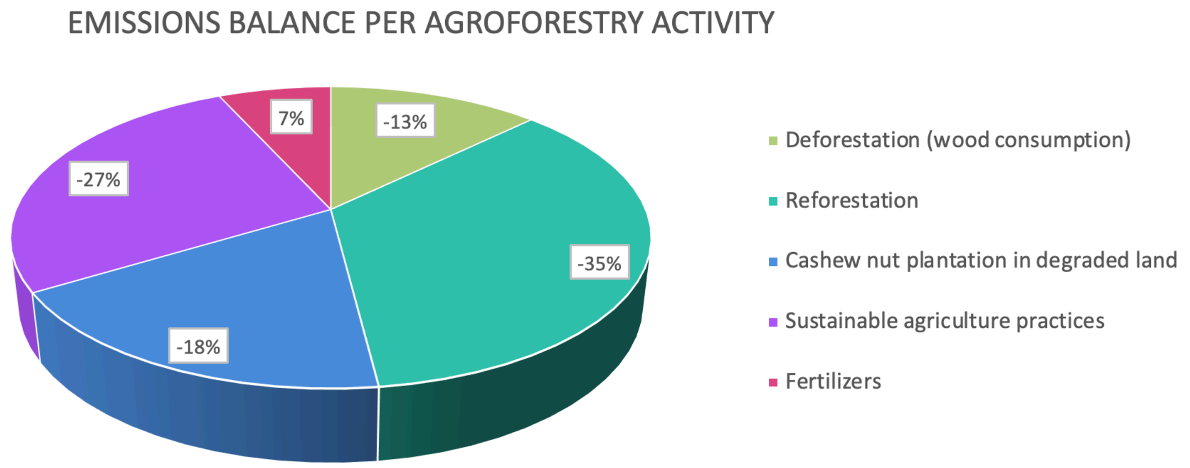

Figure 5. Emissions balance per agroforestry activity

[4] According to the European Emission Allowance of USD 29 per tonnes of CO_2. Consulted 28/05/2019

Replication and scalability

The replication of these best practices and the scalability of this project is relevant for millions of smallholders living in isolated rural communities that are highly vulnerable to climate change. Through the replication of the practical experience carried out in El Santuario in other isolated rural communities, a sustainable rural development model will be developed, tested and assessed in order to codify a global scalable methodology.

In order to assure the replicability of the project, its sustainability must be guaranteed through capacity development and strengthening ownership. Inhabitants should organize themselves and assume responsibility for follow-up and monitoring of the actions implemented at community level. Thus, helping to assure continuity of the initiative beyond the end of the project cycle.

The responsibilities at community level will be divided into three commissions:

- **Economic Commission:** in charge of managing the economic model mentioned previously to ensure the long-term economic sustainability of the project.
- **Administrative Commission:** responsible for following up on stock price processes, purchasing and acquisition of goods and/or services during the development of activities.
- **Technical Commission:** responsible for developing the program activities in the field, making efficient use of resources as well as monitoring the results obtained and managing the maintenance of the facilities.

Following the logic of the project, an integrated and effective monitoring and evaluation system will be developed. Based on the development results and the agreed indicators, a scorecard will be designed. This will ensure the intervention maintains momentum, provide data on the planned activities and reflect the degree of achievement of the expected results. Not only will the monitoring evaluate the level of compliance and the budget, it will also assess how much and in what way these activities are impacting the people and the local entities for which they were developed.

The comparison of the results with the baseline scenario, the conclusions, lessons learned, documentation of best practices, and recommendations will be included in a report that will be sent to all partners and disseminated through the communication channels of ACICAFOC, UPV and FAO; thus promoting the importance of low carbon livelihoods and renewable energy use. The monitoring and follow-up system will lead to the collection of information and the creation of a database to develop the methodology, taking into consideration the need to adapt to each local context.

The project has the potential to be scalable, to improve the resilience, livelihoods and capacities of communities in marginalized areas, while enhancing their adaptation to and mitigation of climate change. Best practices, data, information and knowledge obtained from the pilot study in El Santuario, will be key elements for low carbon rural communities and their sustainable development scale-up. The community will act as a model that can be replicated in similar communities both at national and international level. The communities will be a basis that give insights into experiences and results related to low carbon approaches that could be shared further.

Expected outputs are:

1. Improve access to low carbon methodologies, best practices and technologies for people and institutions.
2. Provide evidence-based results related to the environmental, social and economic benefits of low carbon approaches.
3. Promote understanding of low carbon approaches for policy improvement, investment, program development and implementation.
4. Facilitate country ownership and empowerment.

Technical notes

Irrigation system: In order to efficiently irrigate communities' agricultural fields, six deposits and a water pump of 2 kW will be installed. Two of the deposits have a capacity of 108 m^3 and the others have a capacity of 220 m^3 each, equivalent to a total volume of 872 m^3. These deposits will be filled with rainwater during the humid season to then irrigate the land through a gravity flow system..

Hybrid mini grid: The energy supplied by the installation has been estimated based on the energy needs of agroforestry and silvopastoral activities, and through agreements on basic energy needs at household level and in community buildings. Considering the power requirements of a water pump for irrigation, community lighting and home energy needs, an average consumption of 2.5 kWh per day and per family is expected.

Components included are:

- A 52 kWp photovoltaic plant.
- Two 25 kW inverters, for the connection with the solar modules.
- A 25 kW biomass gasifier, which will serve as a support to cover peak demand and periods when the solar resource is not enough.
- A battery bank of six groups with a storage capacity of 57.6 kWh per group, which accumulates the surplus energy and provides it when necessary.
- A network management system with 6 network managers of 6 kW each. It will ensure the correct functioning of the system, adjusting the energy produced according to the demand, or to the level of charge in the batteries.

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