Food and Agriculture Organization of the United Nations

IFAD
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Procasur
Harvesting Innovations, Spreading Opportunities.

FIELDBLOG

REGIONAL LEARNING ROUTE

FO4ACP
Farmers' Organizations for Africa, Caribbean and Pacific

Strengthening resilience capacities of Caribbean producer organizations: exploring on-the-ground solutions to enhance their participation in agricultural value chains

November 12th to 18th, 2023

BRAZIL

WELCOME

Throughout history the word 'route' has been synonymous with adventure and discovery: the Silk Route, the Tea Route, the Nile Route, the Inca Route. These famous journeys took adventurers to new horizons, to exotic places, to different worlds full of possibilities.

It is a pleasure for PROCASUR and the FO4ACP Programme to welcome you to our own travelling adventure: the Learning Route "Strengthening resilience capacities of Caribbean producer organizations: exploring on-the-ground solutions to enhance their participation in agricultural value chains". We invite you on a journey towards new knowledge, successful and revealing experiences, fresh ideas and innovative solutions.

The Learning Route is a continuous process of learning in the field, which seeks to expand and diversify rural technical advisory services, including and valuing the best experiences and knowledge of organizations, companies and Rural Champions in the country.

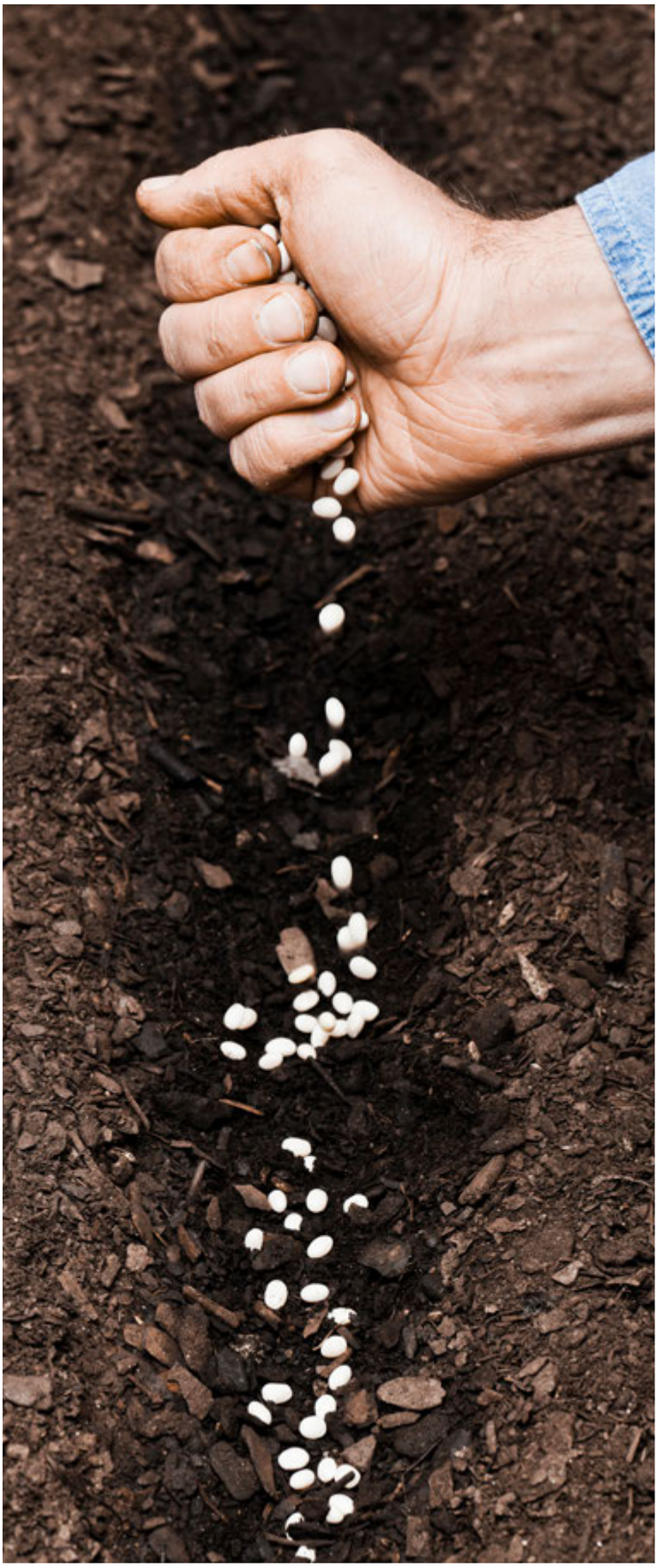
Your fellow travellers are united to learn in the field the good practices and solutions applied by rural champions to Increase the business and associative capacities and competencies promoting their participation in value chains.

We hope that in the course of this expedition, everyone's experience and knowledge will also be a rich source of learning.

The south wind is blowing strongly, the compass is pointing the way to change,

Let's get on board, have a good trip!

PROCASUR TEAM



Objective of the Learning Route

Increase the resilience and productive capacity of farmer organizations in Belize, Brazil, Guyana, Grenada, Jamaica, St. Lucia and St. Vicent and the Grenadines by implementing climate-smart practices and using technologic solutions to catalyze transformative change in their production systems.

What will we learn?

Learn about the key technology in the agricultural sector and strategies for effectively developing farmer organizations to ensure production and quality while meeting the challenges of a changing climate.

Best practices to maximize and improve water use, soil conservation, and use of renewable energy applied to the food production and processing process to minimize the environmental impact of agricultural activities.

Provide valuable solutions that improve resilience and productive capacity and mobilize human and financial resources to implement the innovation plan.

Explore the characteristics and internal processes used by farmer organizations to identify, address, and adapt to climate change-related challenges and constraints faced by small-scale producers in both production and marketing, and examine how technology and climate-smart practices can help address these challenges.

Harness the strategic potential of rural women and youth in the technological transformation, either by mobilizing and integrating their skills and talents into existing production services or by promoting the creation of new initiatives to support farmers.

Learning in the field

During the Learning Route, we will meet and exchange experiences and good practices in developing solutions to address climate change, in which the managers, leaders, and small producers become the trainers.

Experiences

1 Development of technological solutions for water harvesting, water distribution and soil management under sustainable approaches and practices.

- Empresa Brasileira de Pesquisa Agropecuária (Embrapa Semiárido / Petrolina Pernambuco)
- Escola Família Agrícola -EFA de Sobradinho
- Instituto Regional da Pequena Agropecuária Apropriada -IRPAA

2 Organic production, transformation and agro-processing, sustainable production, commercialization, and access to markets.

- Central da Caatinga
- Cooperativa Agropecuária Familiar de Canudos, Uauá e Curaçá

3 Predial and associative solutions for the inclusion of non-conventional renewable energies (solar, biomass, wind, etc.).

- Cooperative of Rural Producers of Monteiro Ltda. (CAPRIBOM)

4 Water reuse, soil conservation and/or recovery, agroforestry systems, bio-input processing

- National Institute of the Semi-Arid (INSA) - (Campina Grande -Paraíba)

Agenda

PLACE AND DATE	SCHEDULE	ACTIVITIES
Sunday, November 12th Petrolina to Juazeiro	09:30 - 16:30	• Arrival of participant to Petrolina and transfer to Juazeiro
	17.00 - 18.00	• Opening session of the Learning Route ◦ Welcome and opening remarks ◦ Presentation of Participants
	18:00 – 19:30	• Context: Climate Change and F.O ◦ Introduction to the methodology, host cases and agenda ◦ Climate Change in the Semiarid region, farmers organizations and public policy ◦ Fair experience exercise
	20:00 - 22:00	• Dinner
Monday, November 13th <u>Experience:</u> EMBRAPA, Petrolina	06:30 - 07:30	• Breakfast
	07:30 - 08:30	• Transfer from Juazeiro to Petrolina
	08:30 - 09:00	• Context presentation: the Semi-Arid and natural resources - economic and social purposes
	09:00 - 12:40	• Scalable solutions to address climate change: soil management for water harvesting
	12:40 - 13:30	• Lunch at Embrapa
<u>Experience:</u> School Agricultural Family, Sobradinho	13:30 - 14:15	• Transfer to Sobradinho
	14:15 - 17:00	• Technological alternatives to address climate change
	17:00 - 17:30	• Refreshment
Auditorium of the Territorial Service for the Support of Family Farming -SETAFI	17:30 – 18:15	• Transfer to Juazeiro
	18:15 – 20:00	• Exchange of experiences among FO4ACP and FO4LA: COOPONTAL and The Caatinga Central
	20:00 – 21:30	• Dinner

PLACE AND DATE	SCHEDULE	ACTIVITIES
Tuesday, November 14th <u>Experience:</u> Training Center Dom José Rodrigues, Vargem da Cruz, -IRPAA-	06:30 - 07:30	• Breakfast
	08:00 - 08:30	• Transfer from Juazeiro to Vargem da Cruz
	08:30 – 10:30	• **Development and experimentation of social technologies for coexistence with the semi-arid zone, Regional Institute of Appropriate Small Farming -IRPAA-**
	10:30 - 11:00	• Refreshment
	11:00 - 13:00	• Continue visit to Training Center Dom José Rodrigues, Vargem da Cruz, -IRPAA-
	13:00 - 14:00	• Lunch at Training Center, IRPAA
<u>Experience:</u> Açude da Rancharia Community	14:00 – 14:30	• Transfer to Rancharia locality
	14:30 – 16:30	• **Community sanitation and total wastewater reuse**
Uauá	16:30 – 17:30	• Transfer to Uauá
	17:30 – 18:00	• Refreshment
	18:00 – 19:30	• **Innovation Plans Workshop**
	19:30 – 20:00	• Accomodation in Brasil Hotel
	20:30 – 21:30	• Dinner

PLACE AND DATE	SCHEDULE	ACTIVITIES
Wednesday, November 15th <u>Experience:</u> COOPERCUC, Uauá	06:30 - 07:15	• Breakfast
	07:15 - 07:30	• Transfer to Coopercuc
	07:30 - 10:00	• Ecological agriculture and inclusion of renewable energies in agro-industrial processes
	10:00 - 10:30	• Refreshment
	10:30 -12:30	• Workshop on Solutions Analysis (water and ground)
	13:00 - 14:30	• Lunch
<u>Experience:</u> Canudos State Park, Canudos	14:00 – 14:30	• Transfer to Belém de San Francisco
	14:30 – 16:30	• Technic visit to Canudos State Park: Experience in the recovery of desertified soils
Village Hotel/ Café Pingo, Belém de San Francisco	16:30 - 19:30	• Continue transfer to Belém de San Francisco
	19:30 - 20:30	• Accommodation in Village Hotel Belém
	20:30 - 21:30	• Dinner in Café Pingo
Thursday, November 16th Café Pingo, Belém de San Francisco	06:30 - 07:00	• Dinner
	07:00 - 11:00	• Transfer to Monteiro
CAPRIBOM, Auditorium	11:00 - 12:30	• Innovation Plans Workshop
	13:00 - 14:30	• Lunch
<u>Experience:</u> Monteiro Rural Producers Cooperative- CAPRIBOM-	14:30 - 17:00	• Visit to Agroindustrial Unit and to two properties of medium and small size.
	18:00 - 19:30	• Accommodation at Hotel: Posada Seu Tião, Posada Xavier, Posada Poemas
	20:30 - 21:30	• Dinner

PLACE AND DATE	SCHEDULE	ACTIVITIES
Friday, November 17th Monteiro	06:30 - 07:00	• Breakfast
	07:00 - 07:30	• Transfer to Prata Municipality
Boa Vista Site	07:30 - 09:30	• Water reuse technology coupled with photovoltaic panels
	09:30 - 11:30	• Transfer to Campina Grande
Campina Grande	11:30 - 12:30	• Accommodation at hotel
Experience:INSA,Campina Grande	12:30 - 13:30	• Lunch
	13:30 - 16:30	• Visit to Experimental Station - Scientific research to address climate change, approaches and strategies, National Institute of the Semiarid -INSA-
	16:30 - 17:00	• Refreshment
	17:00 - 18:00	• Presentation of Water Desalination Technology
	18:00 - 18:30	• Transfer to Ibis Hotel
	20:30 - 22:00	• Dinner
Saturday, November 18th INSA, Auditorium, Campina Grande	06:30 - 07:15	• Breakfast
	07:15 - 07:45	• Transfer to INSA
	08:00 - 09:00	• Workshop on Solutions Analysis (energy & biodiversity)
	09:00 - 10:30	• Innovation Plans Workshop
	10:30 - 11:00	• Refreshment
	11:00 - 12:00	• Innovations Plans Presentation
	12:00 - 12:30	• Evaluation of the Regional Learning Route
	12:30 - 13:00	• Final remarks and closure
	13:00 - 14:00	• Lunch
Return of the rest of the participants to their countries of origin		

List of participants

Country	Name	Organization	E-mail
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Innovation Plan Guidelines

The development of the Innovation Plan aims to support the participants in capitalising on the knowledge acquired during the Learning Route, transforming this knowledge into practical actions that will improve and strengthen the performance of farmers' and fishermen's organisations.

The Innovation Plan aims to help consolidate the current results and impacts of activities and resources, adding value to existing initiatives and supporting ongoing efforts at different levels.

At the end of the Route

Innovation Plans Workshop

Participants will develop the draft of the plan they wish to develop in order to adopt a good practice that will allow them to improve their associative or business capacities.

The Innovation Plan should support farmers' organizations to strengthen their associative and business capacities, among the implementation and adoption of innovative mechanisms and tools learned during the Route.

During the Route

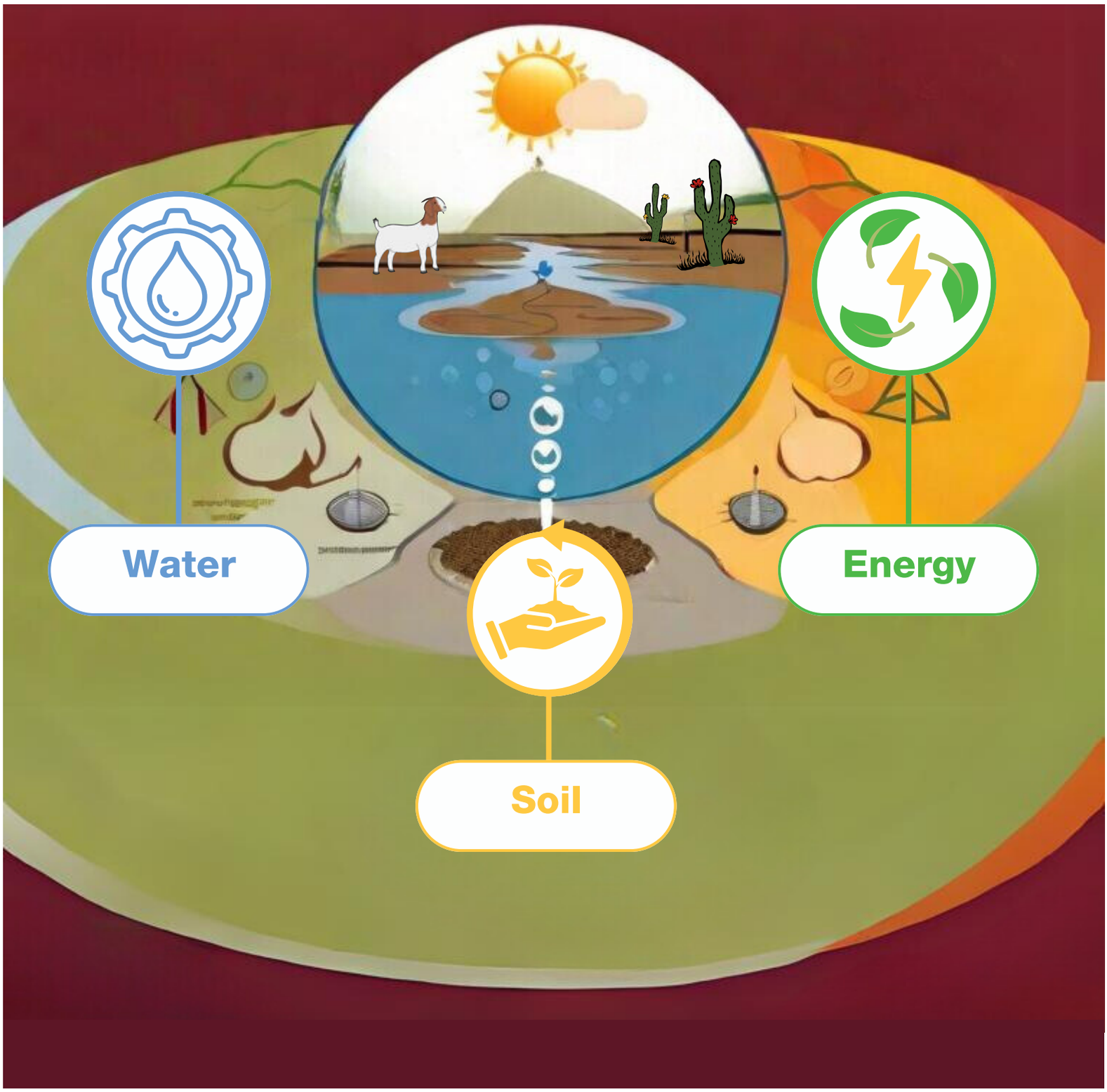
Case Analysis Workshops

Internal workspaces that will allow us to identify the lessons learned from each experience and the possible good practices that we can replicate in our contexts.

We invite you to participate in the elaboration of your Innovation Plan to bring about improvements and innovations in each of your organisations.

In the same way, we invite you to look for synergies and collaborations with the other participants of the Route, in order to keep a community of learning and exchange active.

TECHNOLOGY SOLUTIONS FOR CLIMATE RESILIENCE



WATER

Solution type: Soil water collection

Solution name: Underground dam

Objectives: Increase the capacity for accumulation and storage of rainwater, under conditions of low rainfall, increasing the availability of water during the crop cycle.

Description: The water storage technique, through the use of underground dams, is used in agriculture in situations of limited availability of surface water that prevents the construction of surface reservoirs.

The groundwater storage and conservation system consists of accumulating rainwater, from surface runoff, in two ways: 1) surface accumulation and 2) underground accumulation with the objective of increasing the food production capacity.

Location and selection of soil: The water retention capacity of the soil is a determining factor for the implementation of this technique. The depth between 0.4 to 0.5 m is essential to maintain the water for longer. Most underground dams are built on river or stream beds, using stone walls jointed with cement and sand mortar.

Regarding construction, the dams have a height of no more than 5 m. from the bed to the surface level. Dimensions vary between 10 to 15 m long and 5 m wide. For the waterproof wall or partition within the pre-existing alluvium, the following materials are used, among others:

- Stone wall repointed with cement and sand mortar;
- Brick wall with sand and lime mortar;
- Compacted clay wall;
- Plastic sheet wall or membrane layer up to the surface of the dam.

The water collection and storage system has the following components:

Catchment area (CA). The land area represented by a small hydrographic basin. It is formed by topographic and phreatic divisions; Its objective is to capture rainwater from surface runoff and direct it through natural or artificial drainage to the storage or planting area.
Exploration zone with dry season or plantation agriculture (AP). It is the area represented by the hydraulic basin of the dam. At the time of formation of the system, this area settles, covering the surrounding areas, simultaneously allowing a greater volume of water to be stored in the alluvial macropores, achieving greater coverage of a greater production area.
Dam wall (DW). The purpose is to intercept the flow of surface and groundwater, leading to the formation and/or elevation of the ground water table.

Downstream of each of these dams, a cistern is built to store excess water from the dam. In this cistern, the storage tank (TA) is located underground, regularly covered by a waterproofing material. This cistern has two filtration systems, one internal to the TA and another upstream, in the underground dam, as well as aerators for internal air circulation.

Cost and resources

Approximately USD 3,000 (Cost of an underground barragem varies according to local conditions)

Advantages

This method shows the following advantages:

- Some results demonstrate an average groundwater storage per dam of 500 l/m3, using a dam with the capacity to store 1,317.9 m3, favoring the irrigation of crops between 0.6 and 0.90 ha.
- A dam requires low-cost but continuous maintenance to prevent erosion, sedimentation, infiltration, tree growth and damage caused by insects or animals.
- It allows having a volume of water greater than the demand for agricultural crops and/or animal husbandry, ensuring the supply of water, especially during the dry period, improving productivity and the income of producers.

Degree of complexity

The construction of small rainwater accumulation dams does not entail complexities. Local materials and natural resources are used, construction procedures and technical requirements for topography, hydraulic system and soil, for foundations for a small-scale project are generally simple. The broad base of an earthen dam distributes the load over the foundation.
Comparatively, it is a technique that requires little investment and tangible fixed assets for small producers.

Sources:

- Porto, E.R.; Vivallo Pinare, Ag.; WIIllams Fuentes, C.O.; Silva, A De S.; Lopes, L. H. De O. Small farmers V: methods for implementing integrated agricultural production systems (SIP). Petrolina, PE; EMBRAPA-CPATSA, 1990.
- Stephens, T. Handbook on small earthen dams. Guide to location, design and construction. Pomegranate; FAO, 2011.

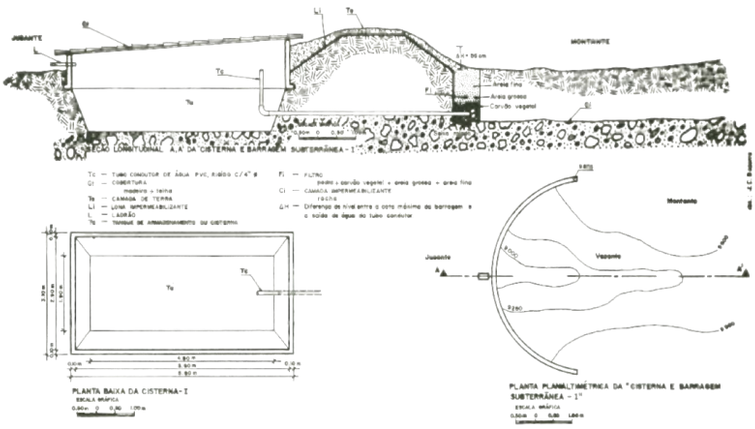


FIG. 10. Corte longitudinal de uma barragem subterrânea tipo CPATSA (SAES-BS).

WATER

Solution type: Gray water treatment

Solution name: Biowater

Objectives: Increase the availability of water for irrigation of crops and animal husbandry.

Description: The reuse of gray water can represent more than half of residential water use, becoming an alternative water supply to face periods of scarcity for irrigation purposes. For this, a technology is used in which the biodegradation of organic matter is produced by a population of microorganisms and worms inserted in the filter layers of the system and, by doing so, the main pollutants of gray water are reduced.

In a household of five people, approximately 250 liters of gray water are generated per day. This represents a production of around 90 thousand liters of water per year, which is equivalent to almost two production tanks or nine tank trucks with a capacity of 10 m^3 of water. The suitability of this gray water reuse technology is defined by criteria, guidelines and quality standards that seek to guarantee that it is carried out in a sustainable and safe manner from health and environmental aspects.

The gray water that will be treated in the biofilter consists of water from the kitchen and showers. The biofilter is preceded by a masonry grease separator box, equipped with PVC inlet and outlet pipes, and is preceded by a treated gray water storage tank.

The biofilter has a downward flow, being composed of an initial layer of boulders, followed by crushed stone, washed sand, wood chips and humus. The treated gray water then passes to the covered storage tank to avoid the incidence of light and the subsequent proliferation of algae, mosquitoes and larvae, and safety.

Within the same technological idea, the Filter Garden was developed that imitates a flooded natural area (swamp, marsh, etc.), where plants adapted to water-saturated areas (technically called aquatic macrophytes) and microorganisms associated with the roots of These plants work together to remove nutrients and contaminants in a natural way.

- For a residence of up to five residents, basically, a Filter Garden is a small lake (5 m long x 2 meters wide x 0.5 m deep) that is waterproofed by a flexible geomembrane (EPDM or Vinyl) and covered in the top and bottom with Bidim type geotextile blanket.
- The lake is filled with a layer of coarse gravel (No. 2 or 3) at the bottom, and a layer of coarse sand at the top. In the sandy phase of the system, ornamental plants adapted to flooded areas are added. PVC pipes and connections are installed so that the wastewater to be treated enters through the top and the treated liquid exits through the opposite side in the deepest part.
- The water level in the system is controlled by a set of pipes, in the form of a pipe, known as a "monk." To prevent coarse materials and grease from entering the Filter Garden filter media, a solids retention box and a grease trap are previously added to the treatment system. Figure 11 shows a schematic representation of a Filter Garden and a photograph of an installed system.

Cost and resources

USD 1.000

Advantages

This method shows the following advantages:

- It is a nature-based technology that follows the principles of "constructed wetlands" or "root zone treatment" systems, increasing the sustainability of food production.
- Technology can be used to expand access to basic sanitation and use of sustainable practices in rural communities.
- The biofilter guarantees the safe reuse of treated effluents, with significant value in areas with limited access to agricultural water and nutrients, improving productivity and food security.

Degree of complexity

Biofilter technology designed for small agricultural applications tends to be relatively simple, affordable, and easy to build and maintain. It involves the use of local materials and simple technology to reduce costs and complexity, so that farmers themselves can manage them without requiring specialized technical training.

Sources:

- CARLOS LAÉCIO EVANGELISTA FRANCA; MIRIAM CLEIDE CAVALCANTE DE AMORIM; NELCI OLSZEVSKI; CLÉRISON DOS SANTOS BELÉM. Use of treated gray water in fruit irrigation in the semi-arid region: Legal aspects and soil quality. Revista Verde 17:3 (2022) 167-177.
- WILSON TADEU LOPES DA SILVA, CARLOS RENATO MARMO, JOANA CASTURINA DA SILVA, EDILSON PEPINO FRAGALLE. 20 years of Rural Sanitation at Embrapa Instrumentation: from Basic to Environmental. DOCUMENTS 72. EMBRAPA. 2021

WATER

Type of solution : Water abstraction

Solution name: Popular water pump (BAP)

Objectives: Pumping water for food production and/or drinking water for animals, without consumption.

Description: It is a simple and highly resistant technology for pumping water from so many new or disused wells, which helps to reduce the use of fossil fuel, electricity and repair costs in propelling water at depths of up to 100 metres, capturing "crystalline" groundwater with variable salt content, usable for animal consumption, vegetable production and general household use.

This technology reduces erosion damage caused by corrosive salt water on the submerged iron parts and the parts at the base of the pump, and is resistant to aggressive ions in the water. The submerged metal parts are made of stainless steel or brass. The other parts are made of nylon or GRP (glass fibre reinforced polymer). The pipes and connections through which the water rises are made of PVC. The design of the Volanta piston, the turbulence and molecular forces of the water are sufficient to allow perfect pumping. The lubricant for the piston is water. The BAP piston is maintenance-free and guarantees safe water extraction for years.

And there is no possibility for impurities from the surface to penetrate into the tube well. The well inlet is still sealed with threaded parts and the sucker rod passes through a pressure seal.

According to official standards, a well with a flow rate of less than 1,000 litres per hour should be considered dry. It is not worth installing a motor pump, which actually has a technical reason. However, for a community with no other water source, or with hardly any drinking water for human consumption, and no water for watering animals, watering a vegetable garden and for domestic use, it is cruel not to activate a well, which can perhaps supply 1,000,000 litres of water per hour. The various pumping families produce more water in a day than a tanker truck can carry (with questionable water quality).

Advantages

This water pumping technology has the following advantages:

- Unlike surface water, water extracted at a depth of tens of metres has no organic contamination. No filtering or chlorine addition is required.
- Because the base of the BAP, a concrete block, is poured exactly above the borehole, it is at a higher level in relation to the surrounding ground, increasing the pressure.
- It allows for the reuse of the tailings with a flow rate of less than 1,000 litres per hour, which is considered to be dry.
- The non-corrosive shaft sealing parts allow quick and easy access to the pump piston for repair.
- In contrast to hand pumps of the arm or side lever type, the BAP is equipped with a heavy, large-diameter, 1.60 metre handwheel, which, after the initial impulse, keeps the pumping constant, with little effort and without having to turn the body and thus causing back pain. Even children and the elderly can use it with ease. In addition, a counterweight can be added to the flywheel in relation to the rods, which reduces the initial impulse and keeps the rotation smoother.

Degree of complexity

The implementation of the BAP system is a simple and scalable solution for rural households, replacing wind vanes, centrifugal electric pumps or fuel-powered engines with easy-to-use equipment to harness relatively shallow, low-flow water.

Sources:

- ASA. Bomba d'Agua Popular. Tecnologias Sociais para Convivência com o Semiárido – BAP. Série sobre Estocagem de Água para Produção de Alimentos. Junio, 2013.

WATER

Type of solution: Pond water catchment

Solution name: Sidewalk and overflow cisterns

Objectives: Rainwater harvesting for food production and/or animal watering.

Description: The technology provides access to water for food production, through the implementation of plate cisterns capable of storing 52 thousand liters, with a rainwater catchment area of 200 m² that causes water runoff, in the same way that happens in a stream that carries water. The cistern has a masonry made up of a wall, filters and pipes to block, direct and drain the rainwater that falls on the land. The surface is built with slabs and ceramic bricks with eight holes at a level above the cistern.

Soil location and selection: Soil quality is not a determining factor for the implementation of this technology. The space required for the cistern is 8 m. in diameter and 1.8 m. deep, sufficient to receive the water from the catchment area (10 x 20 m.). It is necessary to locate the runoff catchment area on a higher plane, so that the water flows, according to the natural level, to the cistern.

The system basically consists of a catchment area (Ac), a water storage tank (Ta) and a filtration system (St) to ensure greater water potability. The cistern is built (Ta) by digging 1.8 m, taking care to regularize and level the depth, considering the slope of the land. The construction of walls is done in vertical cut using ceramic bricks and plates, the roof of waterproofing material and filters, one outside the storage tank, in the catchment area, and another inside the Ta, from where the water must be collected.

Cost and resources

USD 2.000

Advantages

This rainwater harvesting and storage technology has the following advantages:

- The pyramidal trunk shape of the cisterns optimizes the volume of evaporated water (less than 2.0 mm).
- The cisterns can be sized according to factors that directly or indirectly influence it, such as rainfall data, number of people in the family, period of water storage use, etc.
- These cisterns are designed to collect and store rainwater, which reduces the load on water supply systems, for domestic and productive use, contributing to the conservation of water resources.

It is an effective measure to capture rainwater in areas at risk of flooding or with drainage problems.

Degree of complexity

The construction of cisterns is a technique of intermediate complexity, but accessible to all levels of producers, since it uses local materials and resources that are easily accessible in rural areas. To guarantee the quality of the water, it requires periodic maintenance of the water flow, filters and impermeability of the cistern.

Sources:

- Araujo, J. B. C.; Pimentel, J. C. M.; Cavalcanti Junior, A. T.; Maia, C. W. C. P.; Silva, C. N. Da; Santos, M. E. C. M. Dos; Alves, A. M. C. Implantação de cisterna calçadão em área de quintal produtivo. Fortaleza: Embrapa Agroindústria Tropical, 2018.
- Porto, E.R.; Vivallo Pinare, Ag.; Wllllams Fuentes, C.O.; Silva, A De S.; Lopes, L. H. De O. Pequenos agricultores V: métodos de execução de sistemas integrados de produção agropecuária (SIP). Petrolina, PE; EMBRAPA-CPATSA, 1990.

Calçadão Cistern

Rainwater Cistern

WATER

Type of solution : Soil water harvesting

Solution name:

Guimarães Duque Method

Objectives:

Use sloping surfaces for on-site rainwater harvesting under conditions of low rainfall.

Use volumes of runoff water from pre-determined surface areas to meet crop and pasture demands.

Descripción:

This is a low-cost technique widely used in rainfall-dependent agriculture. It consists of a methodology that modifies the soil surface prior to planting so that the space between the crop rows acts as a water catchment area. This zone has a slope that increases surface runoff and directs the water towards the portion of the soil where the root system of the plants is located.

Soil location and selection: The water retention capacity of the soil is a determining factor for the implementation of this technique; therefore, a soil of medium texture, with good structure and good drainage, without obstacles for agricultural tillage, with a depth greater than 0.5 m, is indispensable for its success.

The process of creating furrows for water collection involves removing the front disc of a three-disc reversible plow. It is carried out on land with slopes whose natural gradient does not exceed 5%. The furrows are constructed with a spacing of 1.5 meters. This method is applicable to most soil types and is mainly used in the cultivation of corn, termite, sorghum, castor beans, cassava, cotton and perennial crops.

Capturing and conserving water in the soil increases autonomy in agricultural production and allows planning according to the potential of the property. Although it is mainly applied in perennial crops, it has been adapted for annual crops through the use of equidistant furrows with two inclined planes between consecutive furrows. The first forms the edge of the furrow and serves as the planting area (Ap), while the second, wider one connects the top of the first furrow to the bottom of the second, forming the catchment area. However, it presents productive limitations in the spacing between consecutive rows.

Another alternative known as the "W" method involves the creation of alternating wide and narrow ridges in contour lines. In this system, the ridges with wide sloping planes function as catchment areas, the narrow ridges act as planting areas, and the furrows between ridges are used as storage areas. The ratio between the catchment and planting zones is 2:1, which ensures the necessary water supply for the crop per unit of planting area.

Advantages

This method has the following advantages:

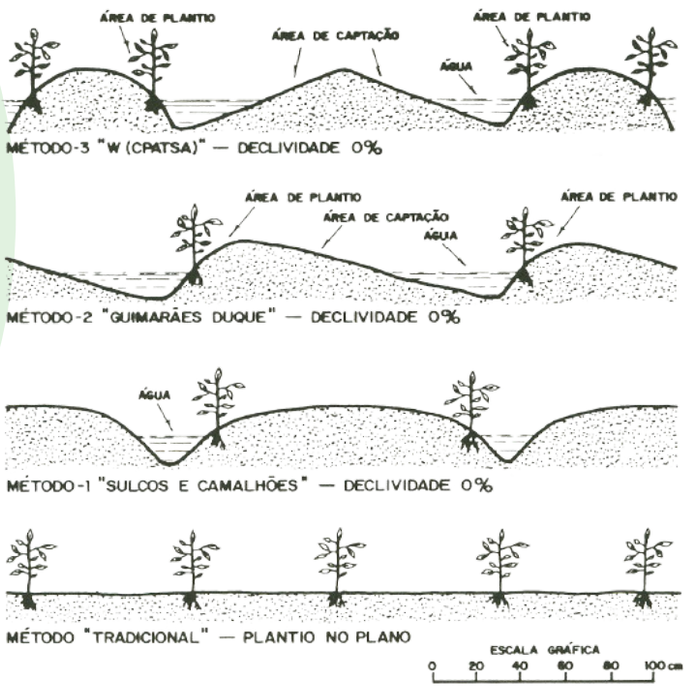
- It is estimated that the implementation of the Guimarães Duque Method uses an average of 1.6 h/ha using a tractor. This represents a 50% reduction in the time spent per hectare, in relation to the traditional system of total ploughing, in addition to the benefits of storing rainwater in the soil profile, making it available for cultivation.
- Clear demarcation between the planting area and the catchment area, allowing the latter to be compacted to increase surface runoff production;
- Placement of two rows of plants per bed; depending on the width of the planting area, it allows a choice of layout for different types of crops;
- The symmetrical shape of the system facilitates mechanisation by tractor or animal traction; Adaptable to any space.
- Various technological alternatives to create the rainwater harvesting technique "in situ".

Degree of complexity

On-site rainwater harvesting is a simple technique that is accessible to all levels of producers, as some of them traditionally already carry out rainwater harvesting practices.

Sources:

- Barbosa, J. Teixeira, L. Captação de água de chuva para cultivos de milho e feijão caupi. Petrolina, PE; EMBRAPA, 1999.
- Porto, E.R.; Vivallo Pinare, Ag.; Wlllams Fuentes, C.O.; Silva, A De S.; Lopes, L. H. De O. Pequenos agricultores V: métodos de execução de sistemas integrados de produção agropecuária (SIP). Petrolina, PE; EMBRAPA-CPATSA, 1990.



WATER

Type of solution : Community sewage treatment system

Solution name: SARA (Sanitation Environmental and Water Reuse) and production cisterns associated with photovoltaic energy systems.

Objectives: It is a combined greywater and faecal treatment system, which uses physical and biological mechanisms in three stages: preliminary - grease retention; secondary - biodegradation of organic matter in a UASB reactor; and tertiary - disinfection by solar radiation. The term UASB as described in the literature stands for "Upflow Anaerobic Sludge Blanket" or upflow anaerobic reactor.

Description: The system model adopted is based on a composition similar to that devised by INSA - Instituto Nacional do Semiárido and described by Mayer, et al. (2021)

The only difference is in the size of the structures, which are designed to collectively meet the demand of a rural school, a settlement or a village, collectively and with associative management.

Treatment begins with the retention of grease by siphoning in grease traps - at least one per household - as well as the retention of sand by sedimentation and the retention of solids, both in a sand trap equipped with a grid, which is characterised as preliminary treatment. This is followed by secondary treatment, which consists of the elimination of organic matter by microbial degradation in an anaerobic medium, inside the UASB reactor (upflow anaerobic reactor), equipped with phase separation structures to keep the solids inside the reactor, the expulsion of gases through a sigh and the evacuation of the liquid through a spillway followed by pipes to the polishing ponds. This is where the last stage takes place: the tertiary treatment, which consists of the elimination of pathogens (disinfection) by solar radiation under exposure for five to seven days. The system described here has the capacity to treat up to 10,000 litres per day, produced by about 100 people. In addition to the specific dimensioning, the collection network differs for each situation. In addition to the structures already mentioned, which are responsible for the treatment itself, the system has auxiliary structures, such as: pass boxes for the convergence of the collection networks; inspection tanks; equalisation tanks; and reuse tanks.

Cost and resources

USD 30.000 for 22 families

Advantages This system has the following advantages:

It allows community wastewater treatment, preventing the accumulation of stagnant water, responsible for (the proliferation of human or non-human diseases), soil contamination and bad odours, allowing the recycling of water and nutrients, and reducing environmental impact.

Fuentes:

- Información resumida del manual "Sistemas de tratamiento de aguas residuales y reutilización de aguas agrícolas, una contribución al saneamiento básico rural", publicado por Victor Leonam, et al, 2023.

WATER

Type of solution : Wastewater treatment and agricultural reuse system

Solution name: SARA (Sanitation Environmental and Water Reuse) and production cisterns associated with photovoltaic energy systems.

Objectives: To disseminate, within the scope of the Dom Helder Câmara (PDHC) project, the cultivation of fodder palm, resistant to Cochonilha-do-Carmim, in the Brazilian semi-arid region, using water for localised irrigation, based on SARA technology (Environmental Sanitation and Water Reuse) and production cisterns associated with photovoltaic energy systems, with the aim of reducing the water vulnerability of family farming in the semi-arid region and providing adequate sanitation to rural areas, with the continuity of agricultural production and improved income for farming families.

Description: 111 fodder palm fields were planted in 9 states, associated with the SARA system (palm irrigated with wastewater treated by SARA) and production cisterns (palm irrigated with water from production cisterns), all using solar photovoltaic energy.

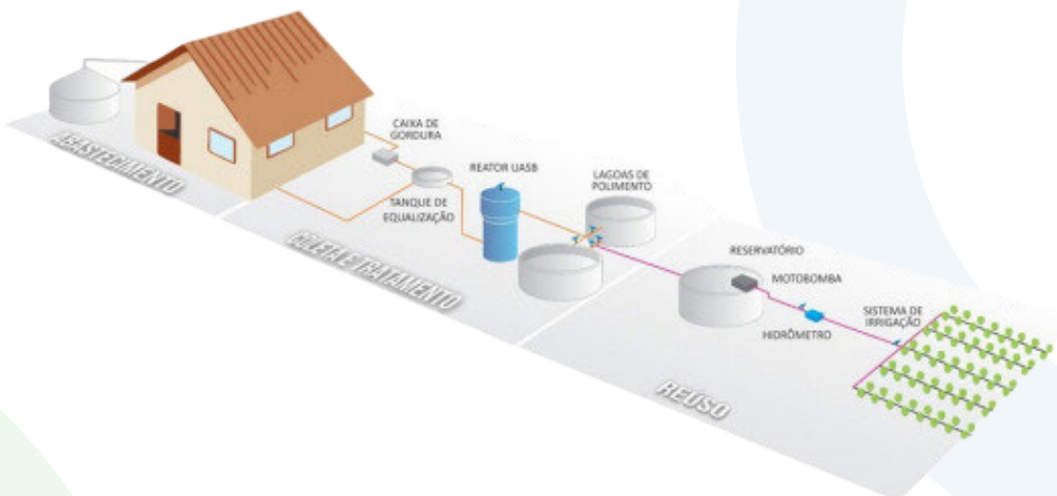
The treatment system operated on a single-family scale and consisted of a grease trap, an equalisation tank, a UASB reactor and polishing ponds. The treated effluent was sent to the reuse system, consisting of a tank, a motor pump and a localised irrigation system (Meyer et al, 2020).

The technology was submitted for patenting by INSA, with a view to protecting it for dissemination in the Brazilian semi-arid region. It has also been recognised by the United Nations (UN), through the Economic Commission for Latin America and the Caribbean (ECLAC), as a case of "Big Push for Sustainability", as a technological alternative applicable to public policies that solve the problem of sanitation in diffuse areas, and also increase agricultural production and family income, contributing to improving environmental quality (https://www.gov.br/insa/pt-br/assuntos/noticias/a-tecnologia-sara-frente-a-problematica-da-vulnerabilidade-hidrica-no-semiarido).

The results showed that this technology promotes a satisfactory reduction of organic matter levels, preserves the nutrients necessary for plant growth and reduces the concentration of pathogenic microorganisms. As a result, we have an effluent of satisfactory quality that can be used to irrigate fodder crops, timber, cereals and fruit trees (https://repositorio.cepal.org/items/89eb1376-1100-4cd4-b02d-224179a14963).

Advantages This system has the following advantages:

- A potential alternative to water vulnerability in the semi-arid region-
- "The reuse water produced can be used for unrestricted use in agriculture, as long as the aerial part of the crops is far from ground level and the plants are supplied with water through a localised irrigation system" (Mayer et al, 2020).
- "The proposed sewerage treatment and agricultural reuse system addresses the needs of family farmers in the Brazilian semi-arid region in terms of lack of sanitary sewerage and increasing the amount of water available on the property for agricultural purposes" (Mayer et al, 2020).



Sources:

- Mayer, et al, 2020. Tratamento de esgoto na zona rural visando ao reúso agrícola no semiárido brasileiro. DOI: https://doi.org/10.36659/dae.2021.023

ENERGY

Type of solution : Biogas generation

Solution name: Biodigester

Objectives: Use of animal, agricultural or industrial process organic matter waste for the production of biogas and bio fertilisers.

Description: A biodigester is a system that allows the anaerobic decomposition of organic matter by means of microorganisms, in the absence of oxygen, for the production of biogas to be applied to electric energy production processes, productive activities, industrial processes, as well as to satisfy household demand. It also allows the production of organic fertilisers and bio-fertilisers that can be used in food production.

There are various types of biodigesters (covered lagoon or canvas (tubular types), upflow biodigesters (UASB type) and complete mixing reactors (CSTR type)) which differ in their operating ranges, process control, waste dilution and retention time of matter and waste.

The biogas and biofertiliser production system has the following components:

- Loading: The organic waste is loaded by means of an upstream or loading tank, depending on the type of biomass.
- Digester: The digester is fed with the organic material, where the mixing of the biomass takes place.
- Gasometer:The tank with gasometer ensures the storage of the produced biogas.
- Discharge: The digestate output is accumulated by means of a back or discharge tank for bio-fertilisers.

According to the efficiency, robustness and safety in the biodegradation of the waste of interest, a biodigester produces:

- Energy: Biogas can be used to produce electricity and/or can be used for productive activities and household.
- Fertiliser: It can be spread in productive areas, as fertiliser, or be separated into solid and liquid fractions - it can also be enriched as an organo-mineral compound.

Location and selection of soil: The biodigester should be close to the household, in an area without shade and surrounding trees. It should be located at a distance between 12 and 20 metres away from the household, taking care of the wind circulation, to avoid the odour generated by the fermentation. As well as, the smaller distance for greater efficiency of biogas distribution.

Regarding construction, the size and type of biodigester will depend on the amount of organic matter available and the intended use (domestic, agricultural or industrial). Some small-scale biodigesters in Brazil are built in circumference with a diameter of 3 m. and, at a depth of 2 m., are connected with two 16 cm ditches. Connected with two 16 cm wide trenches on opposite sides of the digester walls to the feedstock loading system and the manure and biofertiliser discharge box.

Cost and resources

USD 900

Advantages

This technology has the following advantages:

- Its main advantage is the use of renewable energy sources for the production of heat, electricity or as fuel for agricultural machinery. From the management of organic waste and residues, smallholders reduce greenhouse gas emissions and avoid environmental pollution of water and soil that could result from their improper disposal.
- The efficient use of a biodigester allows smallholders to generate additional income, derived from the reduction of expenses related to energy consumption in production, decreasing dependence on fuel. Barichello et al. (2015) show that small properties can achieve energy savings of 1700 kWh to 5000 kWh per month.
- Biofertiliser used in the production of fruit, vegetables and forage plants has been shown to increase crop yields, contributing to the substitution of chemical fertilisers and/or organic compounds obtained outside production.
- Biogas used for domestic purposes such as cooking, lighting and heating has the potential to increase the economic power of small producers and improve basic sanitary conditions in rural areas.

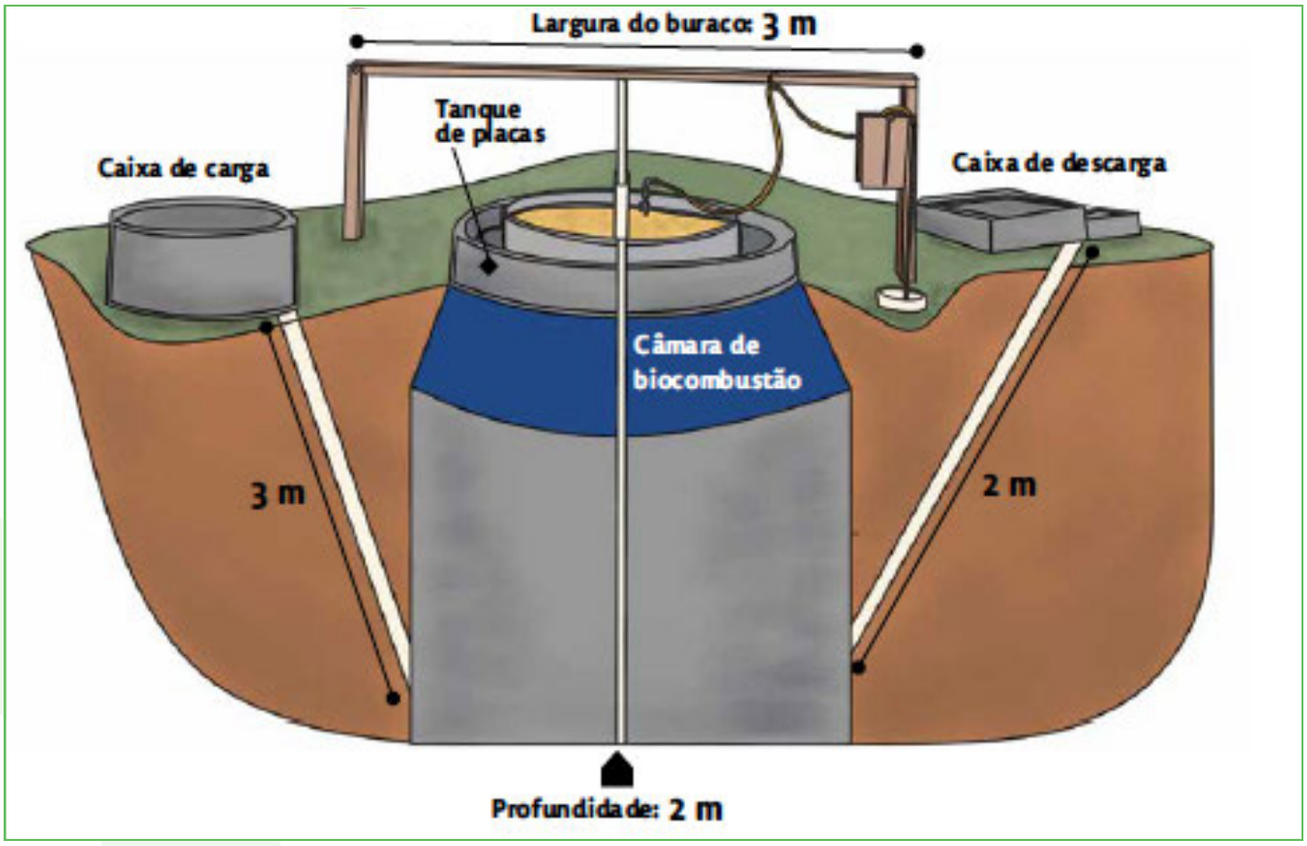
Degree of complexity

The complexity of a biodigester can vary according to the needs and resources available. Small biodigesters, designed for domestic use or small-scale production, tend to be simpler in construction. The complexity increases when incorporating control systems, organic matter feeding and maintenance of the biodigester.

Sources:

- GOMES DE MENEZES et al. O Papel dos Biodigestores na Agropecuária para Mitigação das Mudanças Climáticas: Uma Análise dos Benefícios Ambientais. EMBRAPA, 2023.
- PROJETO PRÓ-SEMIÁRIDO. Construção e Manutenção de Biodigestor. Bahía, Brasil; 2023

Biodigester Structure



ENERGY

Type of solution : Solar power generation

Solution name: Photovoltaic system

Objectives: Conversion of sunlight into electrical and thermal energy.

Description: Photovoltaic systems are composed of solar panels, which are devices designed to convert solar energy into electricity using photovoltaic cells. These cells are responsible for capturing sunlight and transforming it into both electrical and thermal energy. Unlike conventional methods of electricity generation that rely on electromagnetic induction to produce alternating current in the circuit, photovoltaic conversion occurs directly when sunlight interacts with the electrons and components of the plates, generating direct current.

- In the case of a stand-alone (off-grid) PV system, such as the one used for agricultural irrigation, additional components are required, such as a charge controller, a battery or a battery pack, and a DC to AC inverter.
- On the other hand, when connected to the grid (on-grid), a solar inverter is needed to transform the electrical energy generated by the solar panel from direct current (DC) to alternating current (AC). In addition, a bi-directional meter is incorporated which registers the electricity generated by the solar panel and allows surplus energy to be fed back into the grid.
- The additional electricity fed into the grid is converted into "energy credits", which can be used at times of low sunlight, such as at night or on cloudy days, or in the coming months. This results in reduced electricity costs, increased competitiveness of rural enterprises and strengthened income and sustainability of the projects.

Technological applications that make use of sunlight

- Aqualuz: Technology oriented to the treatment of cisterns, which only uses sunlight, without the need for chemical substances, sophisticated filters or interventions in the cistern. Its assembly only requires 10 minutes, with daily use for 20 years, and its maintenance only requires soap and water. The technology consists of a stainless steel box covered by glass and a simple pipe connected to the cistern.
- Solar distiller: This is a low-cost, easy-to-operate robotic prototype (DSR) with a solar tracking system, intended for residential, laboratory and industrial applications for water distillation. The equipment is composed of four fundamental parts: receiving trough; absorber tube; robotic antenna mobility system; and condenser cooling system.

- Solar Desalinator: This technology promotes solar distillation by completely removing all salts, heavy metals, bacteria and microbes present in the contaminated water, as well as various pesticides, due to the high temperatures and ultraviolet radiation. At the end of the process, a simple reconstitution of the salts is easily carried out for use as drinking water.

- Solar dryer: This consists of a part that simultaneously performs the function of collecting solar energy and serving as a drying chamber, where the solar radiation is directly incident on the product placed in the dryer. The air is heated and the circulation is by natural convection, resulting in a fast and low-cost drying process.

Cost and resources

The cost of a residential solar PV system (including installation and materials) is approximately USD 3,600, considering the use of a 3.46 kWp generator installed in a residence with an average monthly consumption of 372.6 kWh.

With an investment of about USD 35,000 in a solar PV system, it is possible to obtain a commercial system with an expected energy generation of 585,000 kWh per month. With a maintenance cost of USD 4,150 and depreciation of 1.5% in the first year and 0.7% of the acquisition cost in the remaining years (25 years lifetime).

Advantages This technology has the following advantages:

- Its main advantage is that it is a technology that harnesses the sun's source, reducing CO2 emissions in food production and the home, particularly in places where the conventional electricity grid is unavailable.
- It significantly reduces energy costs over time. It even generates additional income for families by selling excess energy to the grid.
- They have a 25-year lifespan and require little maintenance. Generally, they only need cleaning and checking that they are working properly.
- Photovoltaic technology is continuously improving, making the technology increasingly efficient and affordable for rural households.

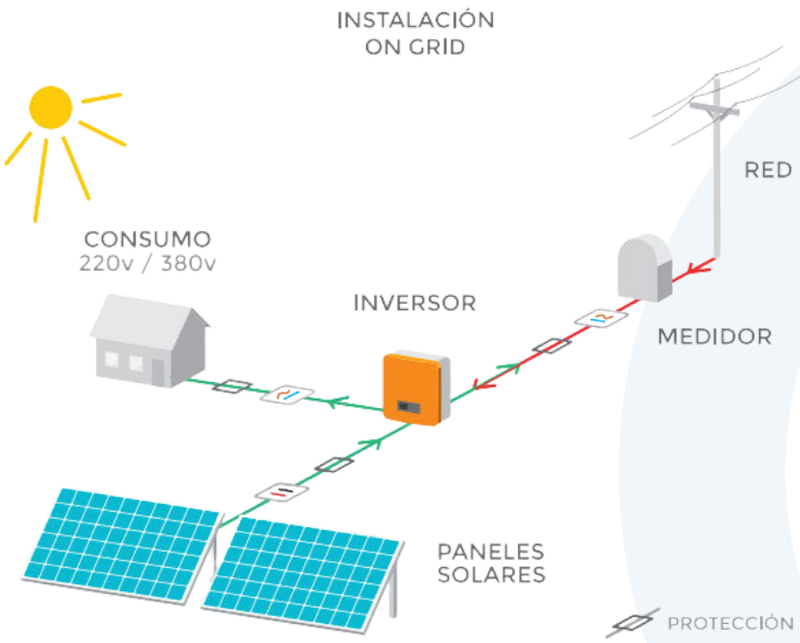
Degree of complexity

The adoption of PV panel technology is considered relatively affordable, due to its simplicity and environmental benefits. However, the initial investment in the purchase and installation of PV panels can be a barrier for most farmers with limited resources. Also, access to technical advice, availability of supplies needed for installation and maintenance, as well as the existence of supportive policies, represent a challenge for the adoption of this technology.

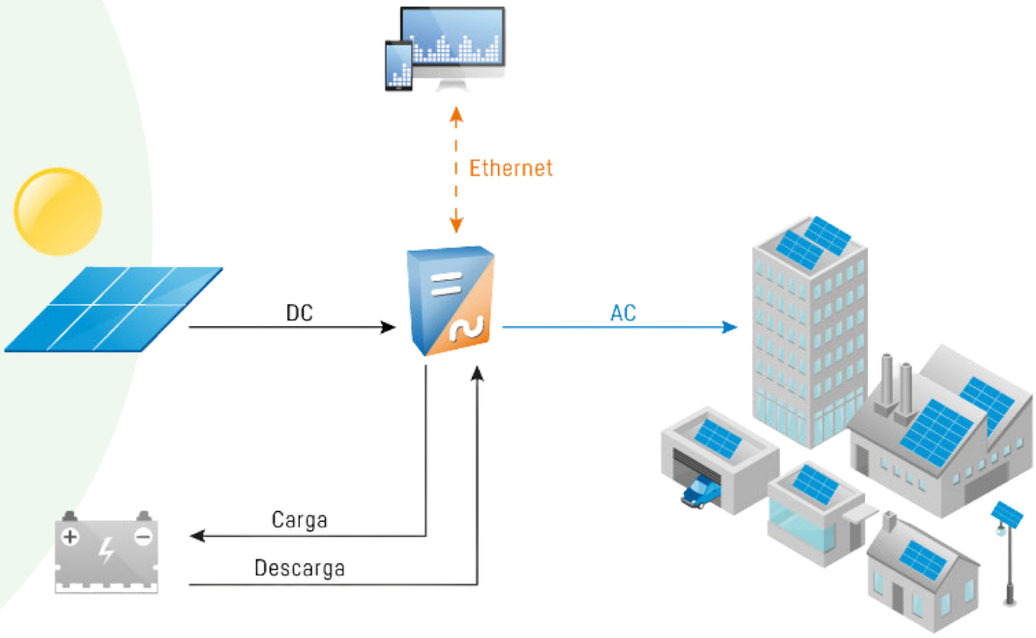
Sources:

- RENOVA-SEMIÁRIDO. Cartilla Energía Solar. https://renovasemiarido.insa.gov.br/

ON-GRID



OFF-GRID



SOIL

Type of solution: Soil and forest conservation and management

Solution name: Agrocaatinga: Agroforestry System – SAF

Objetives: Increase soil fertility capacity and improve resilience of food production.

Description: SAF allows the consolidation of a sustainable and biodiverse agriculture oriented towards the production of vegetables, fruit, timber and animal husbandry. In environmental terms, it contributes to increasing soil fertility, reduces pressure to expand water catchment and storage systems for productive purposes and reduces greenhouse gas emissions by fixing carbon in the plants that make up the SAF.

At the level of production practices, the SAF allows small farmers to adopt and improve the use and management of natural resources. By using perennial species and/or new species in association with different agricultural crops, it allows for the expansion of animal husbandry in the same space, consolidating production.

In terms of the economic sustainability of small-scale agricultural production, the adoption of SAF practices, techniques and technologies adapted by small producers is contributing to labour savings, the development of new knowledge and innovations with the incorporation of crops adapted to the territory, and the consolidation and diversification of production, which is growing due to the demand for agro-ecological products.

The SAF applied to the semi-arid region, known as Agrocaatinga, is a strategy of coexistence as the Caatinga Biome, and a form of agricultural production, where plants from the native forest of the Caatinga are interspersed with plants of interest to the family, creating new possibilities of food production for human and animal consumption. This practice allows changing the reality of consumption, expanding the conditions for the family to guarantee food within the family unit itself, making the activity more resilient with the introduction and maintenance of strategic plants that contribute to soil efficiency and require less water, maintaining soil fertility and the necessary conditions to mitigate environmental risk factors.

To implement a SAF in the semi-arid region, the selection of planting areas should prioritise flat or gently sloping plots. Adopt conservation practices, such as contour planting. The forest inventory gives preference to Caatinga and fast-growing adapted species. The choice of agricultural crops is guided by technical and economic criteria, taking into account the agricultural tradition of the family nucleus, the relative value of the products, the food and nutritional demand and the land use capacity.

Caatinga shrubs, adapted or even exotic, are arranged in double or single rows of at least 3.0 m x 2.5 m, spaced between 12 and 17 m, with a density of up to 800 plants/hectare. Intercropping is installed with irrigation systems, providing a better use of the area and natural resources.

The SAF foresees the use of minimal external inputs, with a preference for products of organic origin, discarding external chemical inputs (synthetic), which seek to imitate as closely as possible the functioning of the natural dynamics of the Caatinga that occurs through the succession of species. This means understanding that plants live integrated in nature and each one has its place, space and duration.

Organic matter during the whole production process is generated by the constant fall of leaves and branches of the plants (especially in the dry season). In SAF this occurs in two ways: 1) with the displacement of mulch from fields and other areas; 2) with the planting of pruning species to perform this function within the system itself. This component is responsible for several benefits such as preventing erosion, maintaining soil moisture, favouring beneficial micro-organisms and providing more nutrients to plants, acting on their growth and biomass productivity. Some of these plants reproduced by seeds, aerial parts and even roots.

The double rows are established with orientation to a shade suitable for the crops interspersed between the rows, coinciding with the direction of the dominant and constant winds, favouring the movement of air masses in the different strata of vegetation, reducing phytosanitary problems. The Caatinga has natural renewal mechanisms, with constant entries and exits of plants in the systems and, to maintain this same dynamic, pruning and thinning of the Caatinga, introduction of native and exotic species in the clearings, and different practices such as beekeeping, production of fodder palm, cassava and other crops are used.

Cost and resources

Costs will depend on local conditions and the species to be used.

Advantages

This technology has the following advantages:

- The SAF offers advantages for family farming by allowing an adequate use of the soil, higher production per unit area, increased income, reduced risk of pests and diseases, and a better use of natural resources.
- It is an effective tool in the use and management of natural resources, conserving water and improving soil quality, which is essential to avoid land degradation and loss of agricultural production capacity.
- The SAF contributes to the adoption of sustainable agricultural practices, soil conservation techniques and new ways of using natural resources more efficiently to increase production, agricultural productivity and household income generation.
- It is an effective carbon sequestration mechanism, which contributes to the reduction of greenhouse gas emissions, promotes the conservation of biodiversity of local ecosystems and increases the resilience of production systems to the adverse effects of climate change.

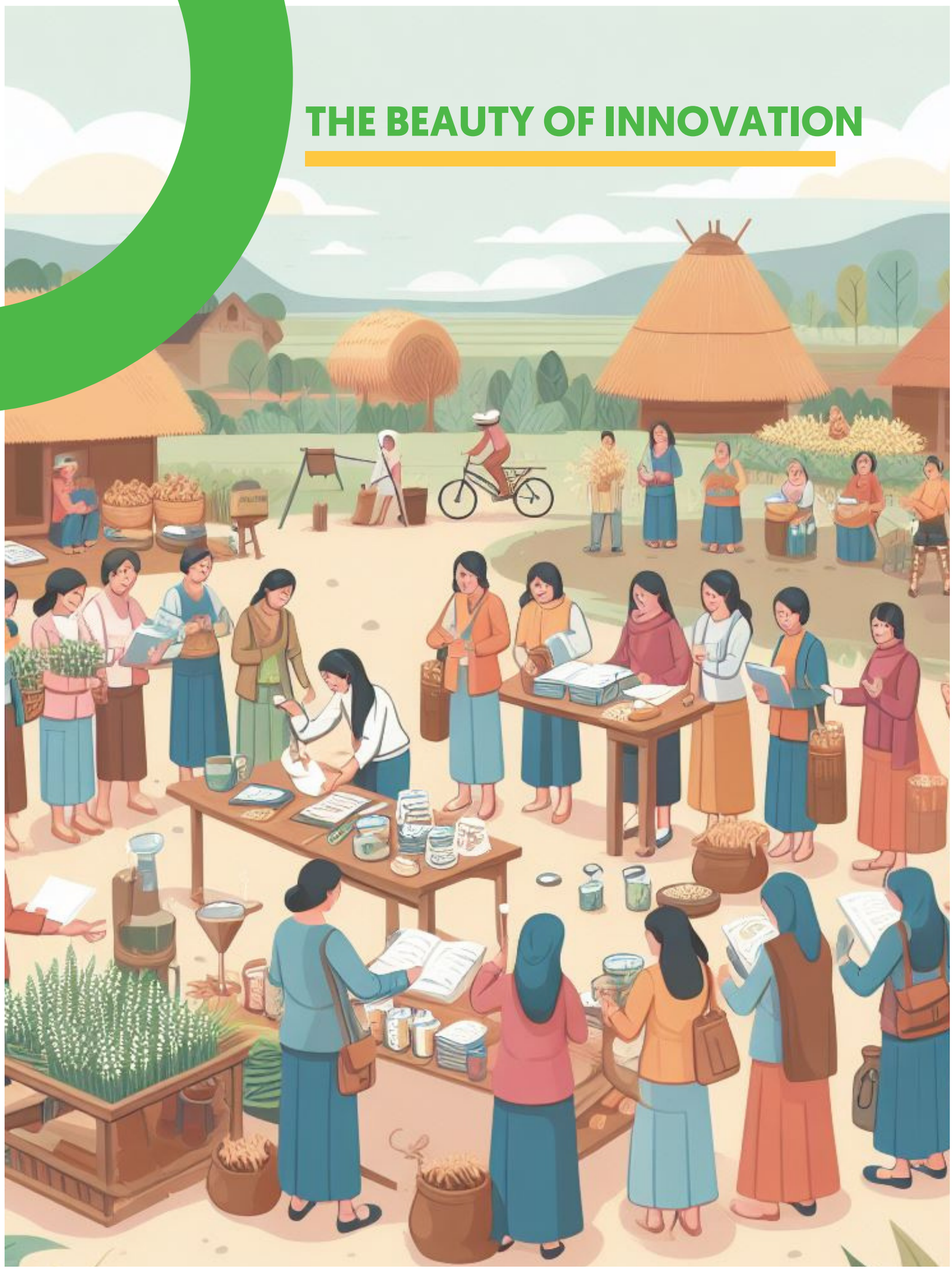
Degree of complexity

The adoption of SAF is considered relatively accessible, due to its simplicity and environmental benefits. However, it requires special care in the choice of species varieties to be implemented, as well as in the definition of the management used in the formation and management of the crops, to ensure their sustainability.

Sources:

- SEMIARIDO VIVO. Sistema Agroflorestal – SAF Da Fazenda Xique Xique. Caderno de Casos Semiárido Brasileiro. Coleção de Experiências Daki – Semiárido Vivo.

THE BEAUTY OF INNOVATION



Through this Learning Route we will have the opportunity to recognize ourselves in the other, to look in relation to the experience in Brazil at how we are doing it in our own organizations, community and territories. We will learn new ways of looking and doing and so that our efforts have a significant effect we will involve more people and organizations in a movement of change favorable to women and men in the rural world.

The Learning Route will allow each participating team or organization to develop an innovation plan, in which positive changes are conceptualized and operationalized for their work. Below we present some basic concepts related to rural innovation, we hope that these can serve as support for the development of innovation plans.

Rural innovation is a fascinating social process through which new ideas and practices emerge that seek to improve the lives of rural people. Beyond technological development, true innovation in rural areas is built from the grassroots, based on the needs and dreams of their residents.

They are the communities themselves, the organizations of small producers, youth, women, indigenous people, people with disabilities, etc. those who promote the most appropriate solutions for their realities. Their innovations are rooted in traditional knowledge, but are constantly reinvented by incorporating new visions and tools. This is how innovations arise in the ways of organizing, producing, accessing markets, and adapting to constant change.

Innovating in the field is a continuous process of imagination, trial and error, and collective learning. It does not arise from pre-established formulas, but from the wisdom and commitment of its inhabitants to build a better future. When this local background is valued is when rural innovation bears its best fruits.

These few pages seek to provide basic concepts and practical recommendations on how to promote rural innovation processes, considering examples and challenges relevant to the Latin American context and what we will learn during the Learning Route to be implemented in Brazil.

What is rural innovation?

Rural innovation is the introduction of a new or significantly improved product, service, process, marketing method or organization, among many others, that generates value and concrete benefits to solve social, environmental and productive problems in rural areas.

Rural innovation can occur in different areas: technological, organizational, commercial, environmental and social. Innovation is an intentional process of change, it does not arise by chance. It requires identifying problems and opportunities, generating and selecting ideas, designing and implementing solutions, disseminating and scaling impact, and continuously learning.

Who participates in rural innovation?

Innovators:
People and groups that drive the innovation process. They tend to be proactive, creative and committed to solving problems.

Project users:
They adopt and socially validate the innovation by using it. Your needs guide the process.

Facilitators:
They support with resources, training, coordination of actors, dissemination, etc.

Decision makers:
They enable policies and investments for innovation.

How does a typical rural innovation process develop?

There is nothing typical about innovation, but we can recognize some stages:

1.	**Participatory diagnosis**	Identify demands and gaps with strategic actors.
2.	**Search for solutions**	Investigate good practices that can be replicated from other places.
3.	**Design**	Configure the solution based on local resources and socio-cultural conditions.
4.	**Experimentation**	Test and adjust the innovation through prototypes or pilots.
5.	**Implementation**	Execute innovation on a larger scale with expanded participation.
6.	**Monitoring and evaluation**	Monitor results and impacts.
7.	**Diffusion**	Communicate learning to replicate and scale innovation.

What good practices are recommended to promote rural innovation?

1. Based on the needs and demands of those affected/beneficiaries, with an inclusive gender and diversity approach.

2. Articulate multiple actors (public, private sector, academia, civil society) through collaborative alliances.

3. Combine technical and traditional knowledge through intercultural dialogue.

4. Incorporate the active participation of local communities in all stages of the process.

5. Implement through prototypes and pilot projects, testing and adjusting flexibly.

6. Document and communicate the lessons learned at each stage.

7. Develop local capacities for appropriation and sustainability.

8. Link innovation with enabling public policies and financing sources.

What challenges arise in incorporating the gender approach in rural innovation?

1. Overcome gender gaps in access and control of productive resources.

2. Guarantee effective participation of women in community and family decision-making spaces.

3. Raise awareness about equitable distribution of domestic work and unpaid care.

4. Increase women's access to financial services, technical training and productive assets.

5. Ensure that technological innovations respond to strategic gender needs and interests.

6. Transform social norms and discriminatory stereotypes that limit women's potential.

7. Measure differentiated impacts of innovation on men and women.

8. Strengthen leadership and economic empowerment of rural women.

Innovate in organizations and projects

In a constantly changing world, innovation has become a fundamental pillar for sustainable development. This section explores in detail how innovation manifests itself in different types of organizations and projects, and how it is closely linked to crucial issues such as youth, gender, nutrition, climate change and agroecology.

1 Base organization

At the heart of rural communities, grassroots organizations are the alpha and omega of innovation. Here, innovation is born from the specific needs and demands of users and beneficiaries, focusing on practical solutions that have a direct impact on improving living conditions and production systems. Building capacity at the grassroots is essential to drive and sustain these changes.

2 Public organisms

Public bodies play a crucial role as facilitators of innovation. Its primary responsibility lies in investing in enabling infrastructure, establishing favorable regulatory frameworks and policies, and coordinating various actors. Innovation here is geared towards modernizing and improving public service provision, with a focus on the wellbeing of rural communities.

3 Non-governmental organizations

NGOs contribute significantly by identifying problems and opportunities in specific territories. Its work focuses on community mobilization, technical assistance, management of pilot projects and the coordination of key actors. Their actions are essential for the experimentation and initial adoption of innovations by rural users.

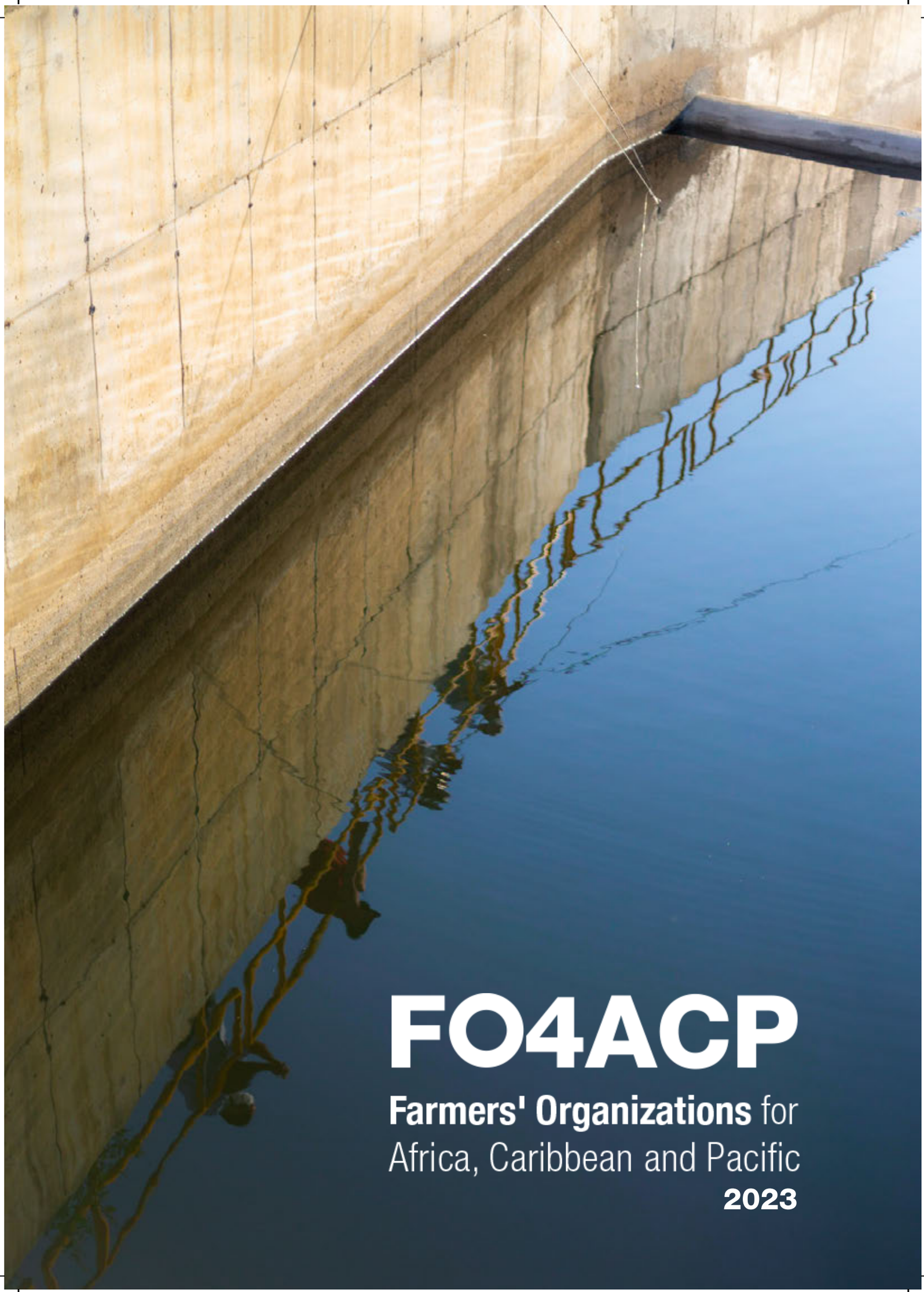
4 Cooperation Agencies and the United Nations

These agencies provide valuable financial resources, technical assistance and access to global knowledge. Its fundamental function is the facilitation of multi-actor processes, as well as the evaluation and scaling of validated innovations, providing crucial support for rural development.

Innovation Associated with Emerging Issues in Rural Contexts

Innovation in rural contexts is not limited to technology or productivity; It also addresses crucial issues affecting society and the environment. Here we present how innovation relates to emerging themes:

1 Youth	Promote generational change in agriculture through innovations in access to land, financing, use of information and communication technologies (ICTs), value addition and entrepreneurship, among other key aspects.
2 Gender	Innovate to overcome gender gaps in productive resources, decision making, distribution of domestic and care work, and economic empowerment of women in rural areas.
3 Nutrition	Develop innovations in productive diversification, value addition, food safety, nutritional education and biofortification, with the aim of improving nutrition in rural communities.
4 Climate change	Innovation in climate-smart agriculture, renewable energy, water management, climate monitoring and agricultural insurance is essential to address the challenges of climate change in rural areas.
5 Agroecology	Promote innovation in diversified crop management, biological pest control, green manures, efficient use of water and appropriate mechanization to promote sustainable agricultural practices.



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