

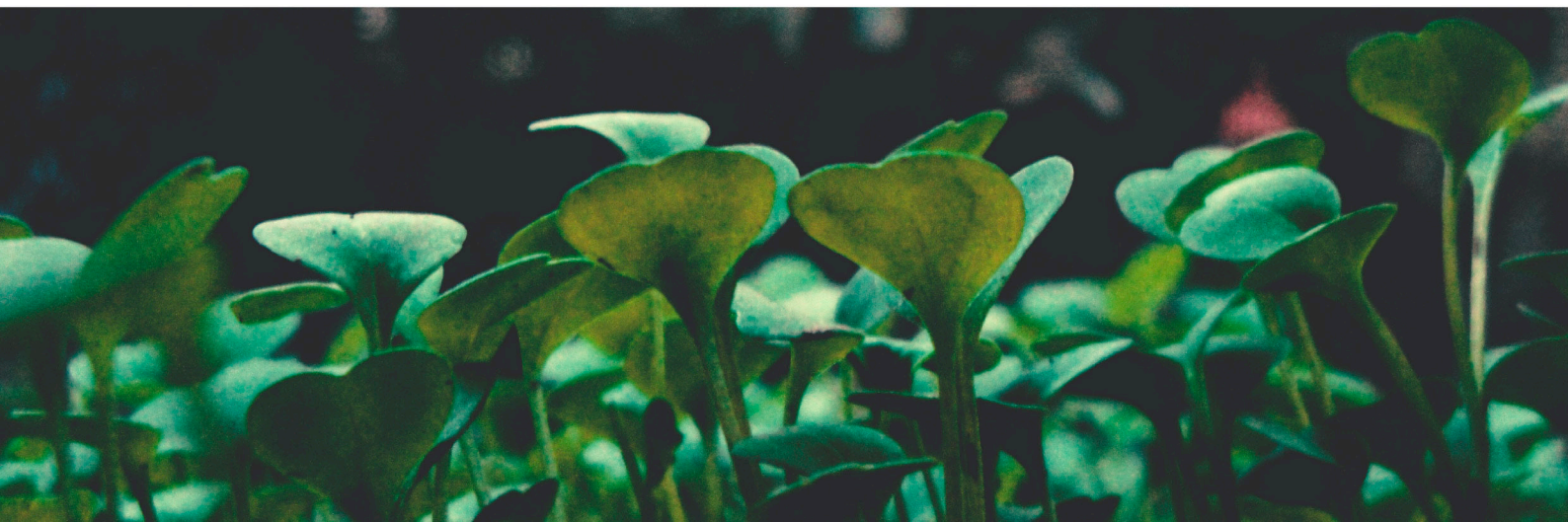


Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address
climate change and care for the environment
and natural resources



- Resilient Agriculture in the Caribbean
- Applying bioeconomy concepts to capitalize on coffee byproducts
- Sustainable livestock
- Natural Grasslands
- Direct Seeding
- System of Rice Intensification
- Agrosilvopastoral systems



Introduction

At a time when a convergence of crises on multiple levels—the environment, health, armed conflict, the economy and society—is endangering the planet's food security, we turn our attention once again to rural territories and farmers.

We do so in the firm conviction that agriculture is essential for peace and sustainable development, as is also supported by empirical evidence.

Thus, we are reaffirming the strategic role of the sector and joining forces to highlight the value of agricultural activity, as fundamental to life.



Manuel Otero

(^() Director General of IICA
(Inter-American Institute for Cooperation on Agriculture)*

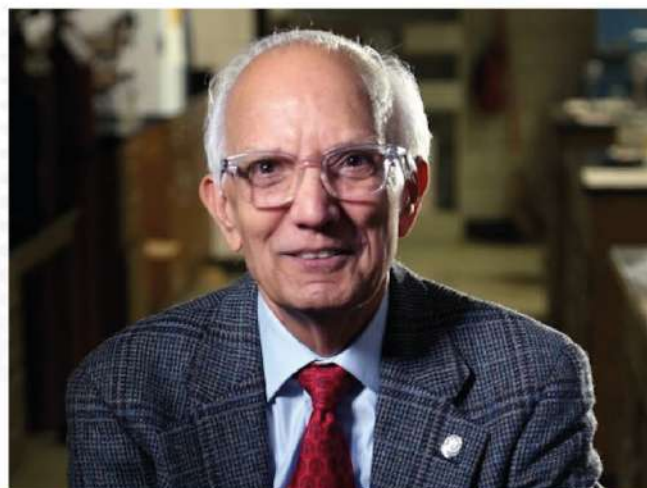
We insist, without favor or bias, that sustainable agriculture and the agrifood systems of the Americas provide structural solutions to the most serious problems faced by humanity.

It is also our view that sustainable agriculture and agrifood systems of the Americas play a strategic role, both globally and within the countries of the region, as they are indispensable to socioeconomic recovery and sustainability, as well as to food security; and their contribution is critical to harmonious economic and social development.

By Manuel Otero and Rattan Lal^()*

At the global level, one in every four agricultural products originates in the Americas. Moreover, the region accounts for more than 28% of total agricultural exports and the same percentage of food exports.

In addition to guaranteeing global food and nutritional security, the Americas and its farmers are strategic to global environmental security, given the region's wealth of natural resources—which are critical to the world's water and oxygen cycle—and their role as veritable custodians of biodiversity.



Rattan Lal

(^() Director of the Center for Carbon Management and Sequestration (C-MASC) at The Ohio State University. Winner of the 2020 World Food Prize. IICA's Goodwill Ambassador for Sustainable Development Issues and IICA Chair in Soil Science.*

Thus, if our objective is to ensure sustainable growth; the creation of decent jobs; poverty and inequality reduction; greater environmental sustainability and climate change resilience; water, biodiversity, health and nutrition protection; and the mitigation of factors driving migration and urban flight, we must inevitably view sustainable agricultural development and agrifood systems as part of the solution, rather than the root of the problems.

With this in mind, and with a view to the Conference of the Parties 27 (COP 27) of the United Nations Framework Convention on Climate Change (UNFCCC) we, the Inter-American Institute for Cooperation on Agriculture (IICA), present this document on "Sustainable Agriculture Milestones in the Americas – Relevant experiences in the region to address climate change and care for the environment and natural resources". IICA is an organization, based in the Americas, but with a global perspective.

The idea to prepare the document resulted from discussions with authorities involved in organizing COP 27, experts from the agriculture sector, agronomists, veterinarians and men and women of science, all of whom are concerned about the need for innovation to produce more and better.

This concern must be transformed into action – generating and transferring scientific knowledge about food and nutritional security, agriculture and innovation and their relationship to climate change.

This document is a manifestation of these views, providing an in-depth look, as the title suggests, at key examples of sustainable agriculture in the Americas – success stories in climate change mitigation and environmental and natural resource protection.

The vivid descriptions of these experiences, narrated by their key players, provide a first-hand account that is clear, objective, didactic and scientifically precise, providing information to readers at all levels, both specialists and non-specialists. The topics include Direct Seeding or conservation agriculture; the System of Rice Intensification (SRI); Agrosilvopastoral Systems; Native Pastures; Capitalizing on Coffee Byproducts; Sustainable Livestock Production; and Best Practices in the Caribbean. The document disseminates and prioritizes the search for effective and viable solutions and attests to the countless and significant advances in climate action in agriculture in the Americas, which we feel demonstrate an adequate balance between sustainability and environment quality.

It also aims to facilitate the search for consensus and to highlight in international forums, such as COP 27, the key role of agriculture as part of the solution to climate challenges, while demonstrating its relevance and progress in facilitating the transition towards more inclusive, resilient and sustainable systems based on the principle of producing more from less.

We recognize that our agrifood systems can be improved, but we are also convinced that they are not failed systems. We are doing many things right in the area of environmental sustainability and these cases, which are taking place throughout the region, are proof of this.

Our task is to build upon this and to ensure that environmental concerns are routinely taken into account in the agriculture sector.

This is our daily mission. We are joining forces to sensitize the public, to raise awareness and to call for political will at the highest level, with a view to accelerating the science-based transformation of global agrifood systems, while ensuring that farmers are seen as central to this process and agriculture is considered a fundamental part of the solution to climate change.

We need pro-agriculture, pro-farmer and pro-environment policies and we are confident that this document will fuel our progress along the path of leaving no farmer behind.

Resilient Agriculture in the Caribbean

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources



Highly vulnerable to climate change, Caribbean nations make strides towards organic, resilient, low-emission agriculture

Caribbean countries are among the most vulnerable countries in the world to the impact of climate change.

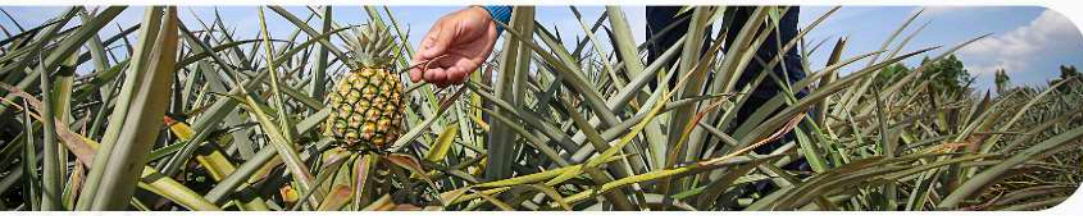
For these nations, many of which are small island states, the effects of climate change are not a future threat, but rather a current reality they know all too well. Weather events are becoming more extreme and frequent, causing natural disasters every year that result in human and material losses.

In these countries, food production has been one of hardest-hit activities. However, despite the dramatic scenarios they have faced, farmers in the Caribbean have made significant strides towards increasing agriculture's resilience to climate change and reducing its greenhouse gas (GHG) emissions. Through the application of good agricultural practices, they are working to preserve soil health and care for water resources.

Agricultural producers in many rural areas of Caribbean countries are implementing regenerative practices and innovative models aimed at transforming problems into opportunities and reducing the strong dependence on food imports, which has generated major economic imbalances in these nations for decades.

As a result of the 2019 coronavirus pandemic (COVID-19), which increased the need for social assistance and imposed prolonged restrictions on international tourism—the main source of income for these islands—the governments of Caribbean countries have faced severe budgetary constraints. Despite the limited resources, however, Caribbean countries are undertaking tremendous efforts to transform good practices into long-lasting public policies that can contribute to greater resilience and lower emissions in the agriculture sector.





One country that is leading efforts in this regard is Trinidad and Tobago, where the Caribbean Agri-business Association (CABA), the University of the West Indies (UWI) and the Ministry of Agriculture, Land and Fisheries are promoting innovation models to overcome the limitations imposed by natural conditions. One such example is Rocrops farm, created by Ramgopaul Roop.

The son of illiterate Indian peasants who were taken to the Caribbean as rural laborers by the British Empire, Roop pursued undergraduate and graduate studies in an effort to increase his farm's resilience. He incorporated agroecological practices to rehabilitate soils and utilize water in an environmentally friendly manner through management and planning around seasons of drought, flooding and erosion. As a result, Rocrops has become a focal point for visits by students from all over the Caribbean who are pursuing agricultural studies.

Ramgopaul Roop's farm is not an isolated case, however. There is growing awareness among all farmers in Trinidad and Tobago of the need to identify more environmentally friendly production methods that can better adapt to the impact of climate change.

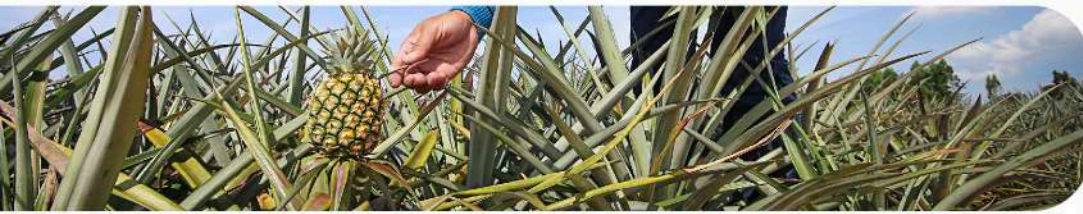
Various organizations have played a key role in this regard. One example is the Alliance of Rural Communities, created in 2014, which has succeeded in enlightening farmers about the value of natural resources, ensuring their role in public policymaking and facilitating their access to the requisite financial tools to boost their production and income.

The organization encouraged cocoa farmers to produce their own artisanal chocolate and to develop community-owned businesses in Trinidad and Tobago and in neighboring countries, such as Grenada, Jamaica, Dominica, St. Lucia and Guyana.

Trinidad and Tobago is a country where people had traditionally been accustomed to growing their own food and living at one with nature. Yet, in the 1950s, the situation changed dramatically when the focus shifted to the extraction of petroleum and gas and food quality worsened for a lot of people.

One of the leaders of the Alliance of Rural Communities is Gillian Goddard, a Trinidadian who left her country to study in the United States and later returned with a keen interest in creating change in the community. She moved to a semi-rural area and began thinking about how to produce food on patios or in backyards.





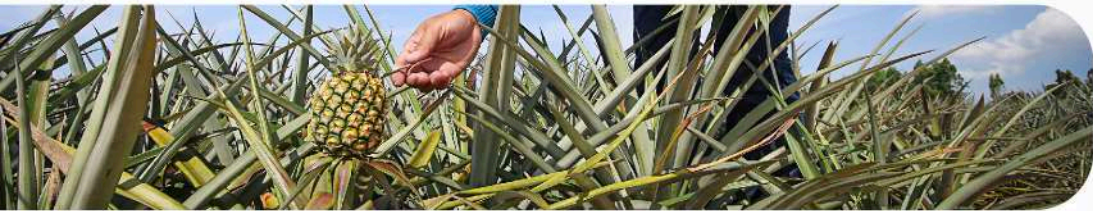
She then opened Trinidad and Tobago's first organic food store. At first, she sold imported food, but then she began to encourage local farmers to produce organic food and then to organize themselves and sell their products.

Goddard subsequently focused on promoting cocoa processing by the communities that grow cocoa. "We depend on natural resources to exist and most of these resources originate in rural areas. Thus, people who live close to these resources and who have cared for them for generations should have power over these resources. In other words, if cocoa plants grow in your region and you have been considerate, not cutting them down and caring for them, then you have the right to benefit from the

value of these plants. This awakened my interest in learning how to make chocolate, since I had not even been aware that we had cocoa in our region and that we could process it", she says.

The objective of the Alliance was to assist in human resource development and in restoring the natural environment, not only through agriculture, but also through chocolate manufacturing. Thus, tasks included teaching rural communities to make artisanal chocolate, nurturing community-own chocolate companies and fostering full use of crops and related resources on cocoa farms. Sales and distribution of products and the search for new markets are the responsibility of the Alliance.





The impact of natural disasters

The Bahamas is another Caribbean nation facing similar issues due to its strong dependence on food imports. Like Gillian Goddard in Trinidad and Tobago, farmer Deon de Costa Gibson went to college abroad and, upon returning home, began to promote backyard food production.



Gibson was living on Abaco Island in The Bahamas when it was devastated by Hurricane Dorian, the strongest hurricane to affect the northwestern Bahamas. Deon experienced firsthand the natural disaster's impact on the livelihoods of rural communities. He later returned to the island of Eleuthera in The Bahamas, where he joined the One Eleuthera Foundation, a non-profit organization created in 2012 to aid rural communities in The Bahamas in becoming self-

sufficient and resilient, while caring for their ecosystems and improving production through low-emission agriculture.

As manager of the foundation's farm, Gibson's work focuses on empowering and providing technical support to local farmers, as well as collaborating with ongoing agricultural education at high schools across the country.

According to Gibson, the impact of climate change is undoubtedly the biggest threat to Caribbean agriculture. "Hurricane Dorian is the best example", he recalls. "Many farmers lost their crops and their homes. We've also had major flooding and periods of drought lasting months, which are impossible to survive without irrigation systems. I believe we need much better education on climate resilience. On our farm, we're using hydroponics, which helps to reduce water consumption. I like it and I think it can be a positive tool in facing climate change. All living generations realize that we must improve. Recently, even my grandmother told me that she thinks we should study climate change better and that should be our main objective today".



Producing in harmony with the environment

The Caribbean is a major fruit producing region. In the Dominican Republic, one of the most emblematic crops is pineapple, which is globally renowned for its one-of-a-kind flavor. However, due to marketing obstacles and environmentally harmful practices, many pineapple growers have faced issues that have led them to migrate from the countryside to cities.

In 2017, more than 100 producers in Monte Plata, one of the country's 32 provinces, partnered to work together, with the mission not only to grow a pineapple that was distinguished by its sweetness and quality, but also one that was produced through the application of good agricultural practices and could be sold in both national and international markets.

Today, the Association of Pineapple Producers of Monte Plata (ASOPROPIMOPLA) conducts its work under environmentally friendly conditions, given that the agrochemicals it employs have been awarded environmental protection certification, enabling the farmers to protect the region's biodiversity. All the elements of the plants are also re-used, thereby guaranteeing a reduction in organic waste.

"We changed the mind-set of the traditional farmer, who was unconcerned about protecting the habitat. Many of them would chop down trees to make coal,

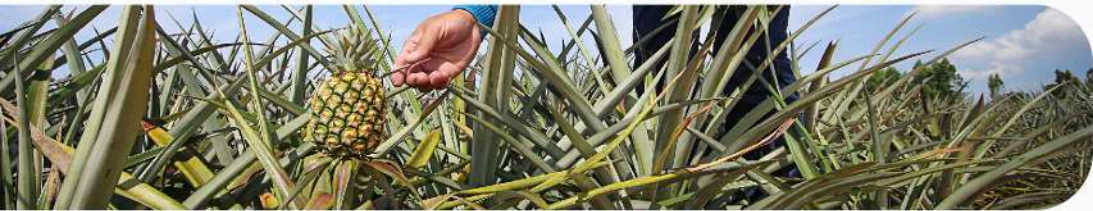
with no planning. Today we have implemented various projects, funded by the German government, which promote rational land use, while caring for the ecosystem in which the pineapples are grown. Although we are not organic producers, but conventional producers, we do use natural inputs and are reforesting many areas and practicing apiculture, to benefit the environment", explains Joelín Santos, the association's founder.

Santos was raised in the countryside and migrated to the city to pursue university studies. He later returned home and conceived the idea for the organization, convinced that professionalizing agricultural activity and seeking to increase its resilience would be the key to enabling other rural producers in the province and himself to enjoy a decent quality of life.

Thus, he created the association, which changed the lives of many farmers, who were accustomed to struggling to earn a profit from the fruits of their labor.

Today, ASOPROPIMOPLA has more than 400 farmers, who produce more than 20 million top-quality pineapples each year, through environmentally friendly agricultural practices, selling them on the national and international market.





Uniting in the face of common challenges

There are many examples of multi-country efforts to pool the energy and knowledge of farmers who work day to day to develop resilient, low-carbon agriculture. One example is the Caribbean Farmers Network (CAFAN), established in 2004, which brings together agricultural organizations and non-governmental organizations that share information and good practices to respond to common challenges—the most important of which is climate change.

CAFAN organizes training, advocacy and regional planning workshops; fosters study tours; and produces a variety of publications. It channels efforts towards implementing new technologies and mobilizing financial resources to advance climate change adaptation and reduce the use of natural resources in food production.

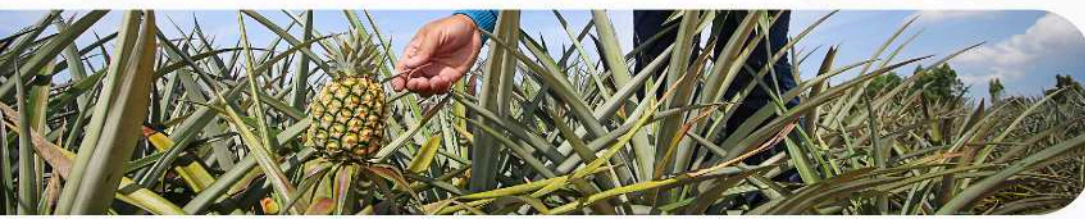
"We undertake educational efforts, because although people are aware that climate change is happening, they need to understand its dynamics,

which requires education", says farmer Pamela Thomas of Antigua and Barbuda, who is a member of CAFAN. She explains that one of the network's main objectives is to attract the younger generations to agriculture through the use of digital technologies.

From an agricultural standpoint, one of the most important countries in the Caribbean is Guyana. Women farmers from the region of The Pomeroon in that country created the Pomeroon Women's Agro-Processors Association, which processes a variety of crops, especially coconut, to produce a wide range of products, such as water, oil, milk and dried coconut, which are in high demand at the regional and international levels.

In Guyana, coconut is the third product with the largest cultivated area, after rice and sugar. It is estimated that 24,000 hectares in the country are planted with coconut, yielding an average of 90 to 100 million units of coconut each year.



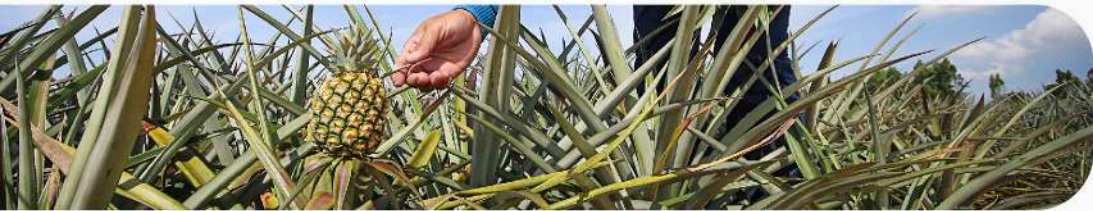


Women coconut farmers from The Pomeroun place special emphasis on the use of environmentally friendly practices, recognizing the fact that natural resources provide daily sustenance for their families. "We don't use any fertilizers and we produce a lot. There are no pests or diseases. So, The Pomeroun is self-sustainable in the production of virgin coconut oil and coconut water", explains Vilma da Silva, a small-scale producer and one of the founders of the organization.

Rosamund Benn is another one of the founders of the Pomeroun Women's Agro-Processors Association. For more than 30 years, she has been growing coconuts on her 20-hectare farm, which she began to industrialize some time ago. Today, she stands out as a leading promoter of strategies to deal with increasingly intense droughts and storms in Guyana.

In Barbados, small-scale farmer John Hunte realized that organic farming offered the best way to care for resources. "Food production is certainly one way to protect the environment. Agriculture cannot exist if we destroy biodiversity. Soils are the perfect sanctuary for biodiversity; therefore, us farmers have the duty to protect soil health", says Hunte, who is certain that Barbados' future as a nation depends on its capacity to source its own food and avoid the importation of unhealthy food and agrochemicals.

Hunte is one of the founders of the Organic Growers and Consumers Association (OGCA) of Barbados, an organization with 20 years of experience that is unique in that it brings together producers and those who buy their products. OGCA supports healthy food production in harmony with the environment.



Commitment on the part of governments

Caribbean nations are committed to transforming their agrifood systems to make them more resilient and reduce their vulnerability to natural disasters caused by climate change.

The goal established by the Caribbean Community (CARICOM), a regional integration organization, is to transform agrifood systems while increasing productive resilience, with a view to reducing the region's food import bill by 25% by 2025.

Climate change poses tremendous challenges for farmers in Caribbean countries, which barely contribute to total global emissions, but are still among the main victims. As has been raised by the Alliance of Small Island States (AOSIS) in international climate change forums, all countries in the region have experienced considerable losses and damage due to the devastating passage of hurricanes.

Unfortunately, hurricanes are not the only natural disasters. In 2021 alone, Caribbean economies and production systems faced the impact of a volcano eruption in St. Vincent and the Grenadines, an earthquake in Haiti, and flooding in Guyana and Suriname, which resulted in the loss of crops and animals. There was also an African swine fever outbreak in the Dominican Republic.

Caribbean countries are undergoing a crisis they did not cause, and which they are unable to overcome on their own because they lack sufficient resources.

Caribbean government leaders and farmers are the first to agree that strengthening the region's agrifood systems is crucial. However, they are also aware that this task will require funding from the public and private sectors, the State and international partners.

Innovative financial instruments and investment models are needed to improve the transfer of resources to small-scale producers. This will enable them to venture into the use of solar energy, hydroponics, aquaponics, smart greenhouses, water harvesting and storage, and other technologies that will make agriculture in the Caribbean increasingly resilient, fulfilling the dream of its people.





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Applying bioeconomy concepts to capitalize on coffee byproducts

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources





Harnessing the full biological potential of coffee, Latin American farmers are making strides in ensuring environmental sustainability, while increasing and diversifying their income

By harnessing the full biological potential of coffee, Latin American farmers have been able to implement projects that are not only adding value, generating wealth and diversifying income, but also contributing significantly to ensuring the sustainability of an activity that is a key driver of the region's rural economy.

These initiatives are based on the bioeconomy – a system that seeks to fully exploit biological resources and principles in production and industrial processes, and which has been driven by the new frontiers of science, technology, knowledge and innovation. The bioeconomy also provides an alternative to the existing model that has prevailed for decades, namely, the intensive use of fossil fuels, which has created a global climate crisis.

By applying bioeconomy concepts to utilize coffee byproducts and residue, Latin America has succeeded in implementing production, industrial and innovative initiatives that are increasing the economic, social and environmental sustainability of the coffee chain. The chain provides a livelihood for more than 14 million people throughout Central America, as well as in Bolivia, Brazil, Colombia, the Dominican Republic, Ecuador, Jamaica, Mexico,

Panama and Peru. These new biobusinesses, which are generating employment in rural territories that have been hard-hit by the crisis, have converted an environmental problem into a solution, by adding value to residue and waste that were once water and soil pollutants.

The contribution of the bioeconomy is vital for a planet that will have to increase food, energy and fiber production, despite reductions in agricultural land, fewer available natural resources and the need to curb greenhouse gas emissions.

As such, the bioeconomy must be a key component of decarbonization strategies in the economy, thus contributing to achieving the Paris Agreement objective to maintain average global temperature increases below 2 °C vis-à-vis preindustrial levels.

Today, many coffee producing families in Latin America recognize the potential of the bioeconomy to improve their production and processing activities. Increased knowledge of bioproduct markets and support services for biobusinesses will foster greater profitability, competitiveness and environmental sustainability.





Crisis and opportunity

In Central America, coffee production is an economic activity that has significantly impacted the environment and society. The production chain is extremely important for many families, organizations and businesses and is pivotal to food security, the revitalization of the rural, territorial and national economies, as well as to the capacity of rural territories to generate employment. Thus, making use of coffee residue, by converting it into byproducts, would undoubtedly be important to the region.

At the beginning of the second decade of the 21st century, low international prices and the onslaught of pests and diseases placed farmers in a bind. Since then, the sector has been recovering. However, the crisis also created an opportunity to develop ways to capitalize on the vast economic potential of the coffee chain. Therefore, farmers became involved in new value adding activities.

Less than 5% of the biomass that is generated in the traditional coffee production chain is used to prepare the beverage. The remaining 95% is lignocellulose (leaves, branches and stems obtained during coffee tree renovation); green fruit that falls to the ground during harvesting; fruit removed from the lot during processing; and other residue, including the pulp, mucilage, parchment (husk) and the grounds or dregs that remain after preparing the beverage.



Over the course of the 2018-2019 season, more than one million Central American farmers produced close to 16.4 million one hundred-pound bags of coffee, generating thousands of tons of waste, which represented nearly 80% of the total weight.

The Inter-American Institute for Cooperation on Agriculture (IICA), through its Innovation and Bioeconomy Program, has supported its member countries in designing and implementing bioeconomy strategies, policies and projects to exploit the full potential of the coffee plant in a sustainable and socially inclusive manner.





The coffee residue bioeconomy

By utilizing coffee byproducts, the bioeconomy is paving the way for productive, industrial and innovative initiatives. Moreover, the biobusinesses and bioenterprises that emerge could support countries' efforts in the area of decarbonization, environmental sustainability and climate resilience.

Close to 75% of the weight of the mature coffee plant is considered residue or waste from the processing or de-pulping of the bean. For example, 100 pounds of coffee berries will produce 18 pounds of green coffee beans (ready for export) and 57 pounds of waste that can be reused as byproducts, including pulp, mucilage and the husk or parchment.

Research is being conducted to reduce to a minimum water use during industrial processes that generate other byproducts, such as the wastewater from processing (coffee effluent).

Moreover, when coffee is being processed for sale, this produces another byproduct: coffee sludge, which in Costa Rica is known as bozorola (the residue remaining after the coffee is infused) and which can be used to prepare organic fertilizer.

According to Rolando Chacón, a representative of the Costa Rica Coffee Institute (ICAFFE), the water content of the pulp must be reduced, which uses a significant amount of energy.

Currently, there are several uses for the pulp: one of them is as organic fertilizer (compost). The residue is subjected to a controlled decomposition process and is converted into a stable product, in terms of moisture and temperature. It is then returned to the field as organic matter. Every 100 pound of pulp produces 10 pound of fertilizer.

In Costa Rica, all of the pulp that was generated during the 2021-2022 harvest was used to make compost. This played an important role in fertilizing agricultural plots, given the crisis affecting the market prices of chemical fertilizers, as a result of the war in Eastern Europe.

The mucilage is employed in the preparation of energy drinks, in the cosmetics industry, for composting and in biofuel products, such as ethanol and biogas. On the other hand, the husk is processed to prepare gluten-free flour and briquettes, used for their aromatic properties and for heating.





✓ Success stories in Latin America

Latin America is already harnessing the full potential of the coffee plant, as demonstrated in a variety of success stories in the various countries.

In Brazil, the Guaxupé regional cooperative, (Cooxupé) launched a line of cosmetics, which includes exfoliating products that are made using green coffee oil and pulp. The intention is to export in the near future.

Colombia is another leader in the use of coffee byproducts. For example, the company, Sanadores Ambientales, uses mucilage to produce honey and coffee husk to produce flour. Both products are used for human consumption, as well as in animal production and the cosmetic and pharmaceutical industries.

In Honduras, Los Catadores farm has developed innovative products using the leaves resulting from pruning as well as coffee pulp. It has also developed an array of exotic beverages using dehydrated pulp. In Mexico, students at the Monterrey Institute of Technology and Higher Education (ITESM) developed a bioplastic for the textile and shoe industries. The material was obtained by extracting the pulp from the coffee bean.

Costa Rica's ICAFÉ has pioneered the use of coffee pulp. For more than five years, it has been using pulp to generate energy, make organic fertilizer (compost) and produce pellets. "If producers used 100% of pulp to generate electricity, the drying process would be self-sufficient", explains Rolando Chacón, an official at the institute.

A project involving the production of tea from coffee husks (dry pulp) has garnered attention for its innovation, sustainability and profitability. Implemented in Zarcero, Alajuela, Costa Rica, the project transforms all the dry pulp produced during a harvest (approximately 4,000 kg or 8820 pounds)

into tea, which is subsequently exported to France, the Czech Republic, the United States, Canada, Australia and Japan, where it is used to prepare infusions, energy drinks and carbonated beverages

In turn, Costa Rican cooperative Coopetarrazú utilizes unroasted coffee beans to produce whole coffee and green coffee bean extract pills, which are unique in that they release caffeine more slowly, providing a more prolonged energy supply. They also aid in accelerating metabolism and improving blood circulation. The Cooperative currently converts 98% of pulp into compost, and uses the remaining 2% to produce livestock feed and edible flour that is used to make bread, cookies, cakes and pastries. This flour, which is high in fiber and protein and contains antioxidants and minerals such as iron, can also be used in fruit smoothies.

Coopeagri, another innovative Costa Rican cooperative, uses coffee mucilage to make a natural energy drink called Naox, which contains antioxidants. It is sold in supermarkets in liquid and powdered form. Efforts are currently being undertaken to eventually sell the product in international markets.



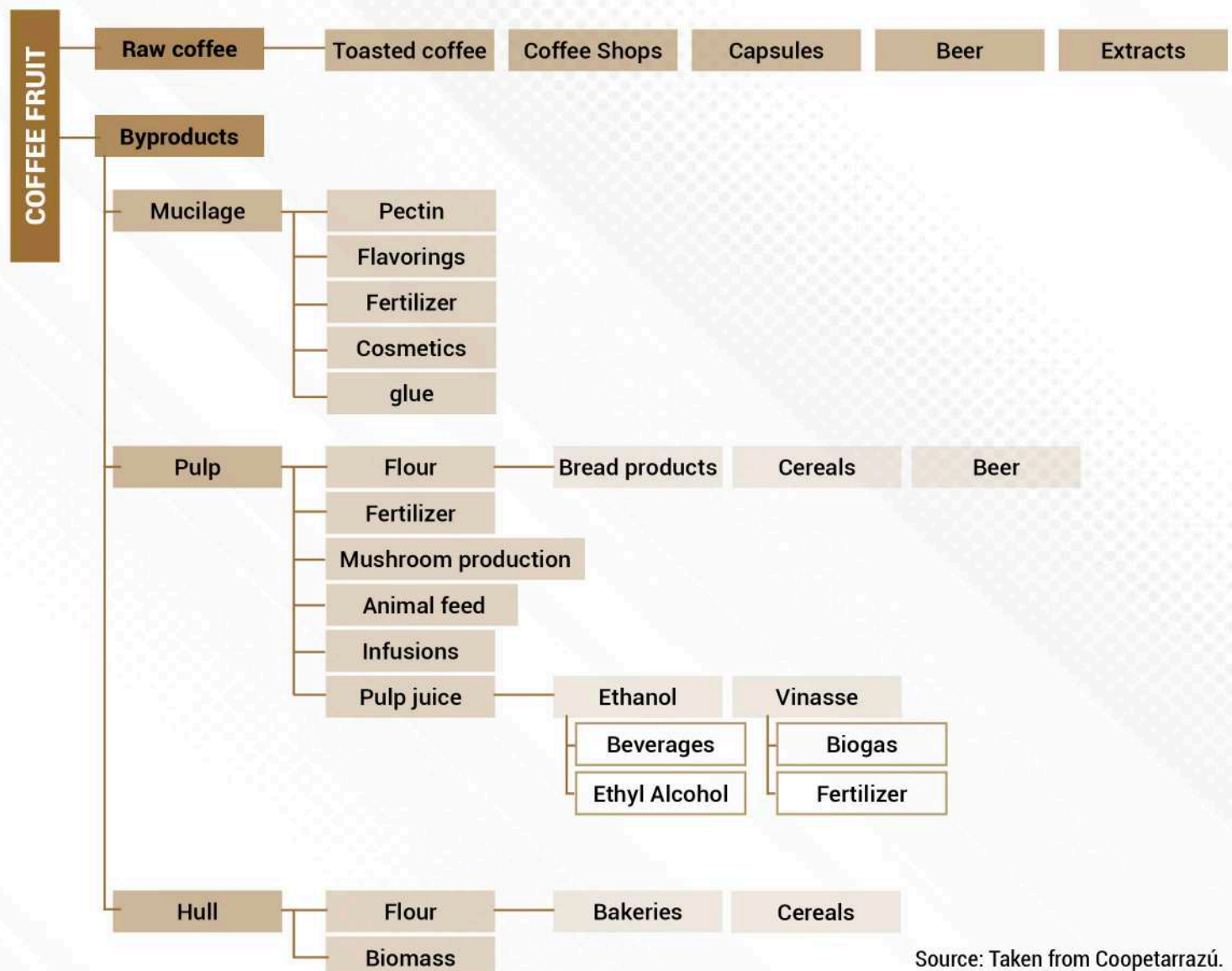


Fostering entrepreneurship and good practices

Public and private coffee chain stakeholders in Latin America and the Caribbean (LAC) must continue to make progress in discovering and recognizing the potential afforded by the bioeconomy for production and processing activities. This, in turn, will foster more competitive, inclusive and sustainable businesses that capitalize on biological resources and principles in a more efficient and sustainable manner.

"Progress must also be achieved in developing, broadening access to and utilizing bioeconomy technologies and innovations; in strengthening organizational and business capacities; and in developing standards and regulations that not only make new bioeconomy businesses viable, but also ensure that they are established within a framework of sustainability and security", says Hugo Chavarría, manager of IICA's Innovation and Bioeconomy Program.

Uses of the coffee byproducts



Source: Taken from Coopetarrazú.



Challenges and opportunities

Several countries throughout the region lack specific environmental regulations for the chain, as well as technologies, innovations and incentives for capitalizing on residual biomass. This hinders the efficient and sustainable use of biomass through new bioeconomy advances and businesses. In some cases, residual biomass is wasted and even becomes a major source of water and soil pollution.

With a view to supporting new bioeconomy businesses in the coffee chain and other agro-industrial chains in the region, the Institute is working together with several partners to develop a platform for the incubation and promotion of biobusinesses. The platform will connect initiatives to various regional and global institutions that offer support services for ideas and projects aimed at driving the bioeconomy in LAC's agriculture sector and agrifood systems.

Waste and residues—which previously generated environmental issues and high management costs—now represent an opportunity for the coffee industry to improve and diversify its income, reduce its carbon footprint and contribute to mitigating the effects of climate change.



The bioeconomy and the challenges of the coffee chain

Challenges

Opportunities

- Decline in productivity, low yields
- Problems with pests and diseases

- Improved materials: better yields and greater resistance to water stress and pests and diseases
- Greater business efficiency and sustainability.
- Diversified production
- Lower costs and less vulnerability
- Use of the entire product

- Low prices in international markets

- Value adding and differentiation, thereby enabling differential pricing and better market growth prospects
- The use of byproducts that were previously considered to be waste creates new productive and profitable options

- Significant amount of waste and residue that affect the environment

- Generation of bioenergy and bioproducts for the food, cosmetic and chemical industries
- Lower generation of non-usable waste
- Lower volumes of transported products
- Substitution of chemical inputs for use in farming operations (bioinputs)

- Unemployment and migration in coffee regions

- Generation of new job opportunities in rural areas in the new chains
- Generation of job opportunities

Source: IICA.

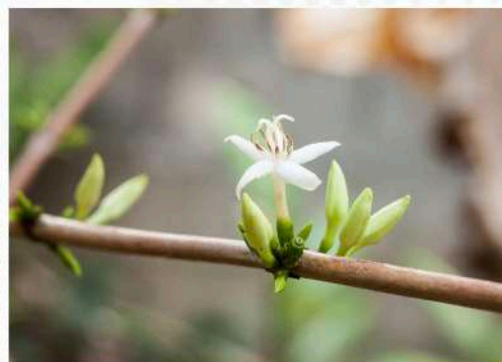


Applying bioeconomy concepts to capitalize on coffee byproducts

Coffee production in Central America (2018-2019)

	Production (100 lb or 46 kg-bags)	Number of producers	Area (ha)	Bags/ha
Honduras	9,558,104.74	120,000	350,000	27
Guatemala	5,226,175.17	125,000	305,000	17
Nicaragua	3,274,277.61	44,519	145,000	23
Costa Rica	1,860,856.7	45,449	84,133	22
El Salvador	976,800	21,704	136,673	7
	20,896,214	356,672	1,020,806	

Source: Prepared based on PROMECAFE and ICAFE.



"More than 70% of Costa Rica's coffee is produced under adaptation and greenhouse gas mitigation actions." ICAFE.

"By means of a network, IICA will seek to attract capital to assess the Central American ecosystem: what is being done, who is doing it and how they are doing it. This network will serve as a bridge, enabling us to work with strategic partners and support the opening of new markets in the region." Hugo Chavarría, IICA.

"More than one million Central American farmers produced 33 million 100 lb-bags during the 2018-2019 coffee harvest." IICA.



Policies and strategies to foster the bioeconomy and guarantee sustainability



Awareness raising

Recognizing the economic, social and environmental potential of the bioeconomy



Regulatory frameworks

Environmental, sanitary, agricultural and health regulations



Fostering RDI

Innovation programs, clusters, pilot initiatives, generation of enabling technologies, etc.



Technical/scientific capabilities

Building up the capacity to innovate of professionals and technical/management teams



Financial and tax incentives

Funding, differentiated taxes, investment funds, assistance, etc.



Market promotion tools

Public procurement, labelling standards, regulations, market transparency



Industrial localization policies

Fostering clusters, training, FDI, technology transfer, etc.

Source: Hugo Chavarría, Innovation and Bioeconomy Manager IICA



2022. Inter-American Institute for Cooperation on Agriculture (IICA)

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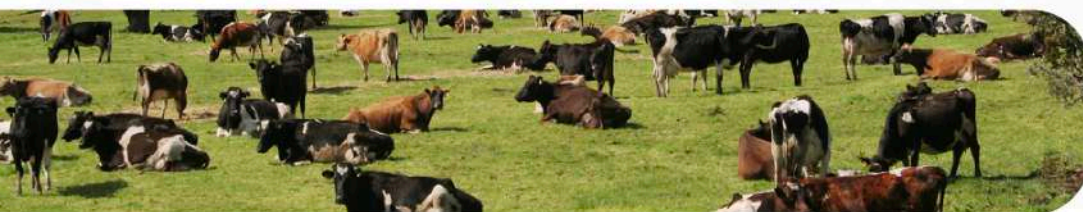
Design and layout: Agencia La Ola

Sustainable livestock: a stronghold against climate change and in favor of the preservation of ecosystems in Latin America

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources





Sustainable livestock: a stronghold against climate change and in favor of the preservation of ecosystems in Latin America

Through strategic alliances and different sustainable livestock programs, the countries of the Americas promote practices that mitigate the emission of greenhouse gases (GHGs), promote animal welfare, favor the settlement of families, and strengthen the family economy.

Latin America is the largest exporter of beef in the world. This activity represents around 46% of the region's agricultural GDP. The region exports 40% of the total beef sold on the international market and is the largest exporter of poultry meat in the world and the third largest exporter of pork. Livestock also plays a social role in the region that cannot be ignored.

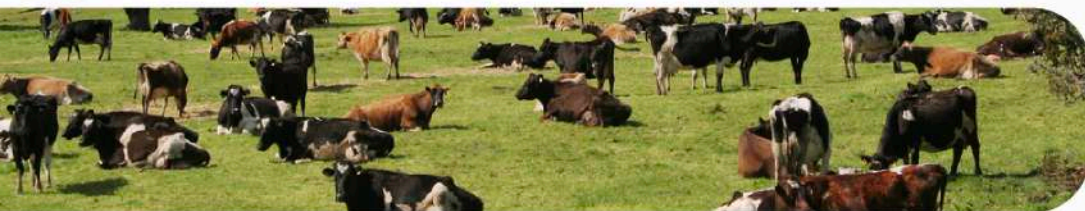
Small livestock producers generate more than 60% of total beef, poultry, and pork production. In Central America, for example, about 86% of livestock farms are small-scale farms of less than 18 hectares, which have between four and twenty animals and have an average stocking rate of 1.5 animals per hectare. The animals even serve as

collateral support for obtaining credits and constitute a source of food for small livestock producers to diversify their diet, traditionally based on basic grains.

In this context, sustainable livestock plays a fundamental role, both in terms of adaptation to and mitigation of climate change. Together with the conservation of ecosystems, it rationalizes the use of natural resources, in a region with an extraordinary environmental wealth: Latin America and the Caribbean concentrates 16% of agricultural land, 50% of biodiversity, 23% of the forest surface and 30% of the fresh water of the planet.

Thanks to significant public-private efforts, livestock farming in the Americas has made great strides in the 21st century to reduce its environmental impact and maintain or increase profitability. Today the hemisphere seeks to advance further along this path, in order to continue strengthening its competitiveness and consolidate its position in international trade.





Cooperation initiative

There is a huge difference between the cattle ranching practiced in the region and that of the rest of the world. In the Americas, the activity is primarily based on grazing systems that do not generate deforestation, do not compete with crops, do not burn grasslands, and do not put the biomes of the countries at risk. Overall, livestock farming takes place in marginal areas from a productive point of view, because they suffer from water scarcity, have poor soils, and do not have transportation infrastructure.

Regarding GHGs, although animals release methane into the atmosphere, this is offset in Latin America by capturing carbon from grasslands. In the case of Argentina particularly, pastoral farming sequesters 12 times more carbon than it emits, according to a study by renowned researcher Ernesto Viglizzo, who is part of the Intergovernmental Panel of Experts on Climate Change (IPCC).

On the other hand, the methane emitted by cows has the shortest life among GHGs. While carbon dioxide has the potential to exist in the atmosphere for hundreds or even thousands of years, methane only remains for only a decade before becoming part of the carbon cycle. It transforms into carbon dioxide and is absorbed by plants through photosynthesis. The cattle then eat the plants, releasing methane that stays in the atmosphere for a short time before turning into carbon dioxide, at which point the cycle restarts.

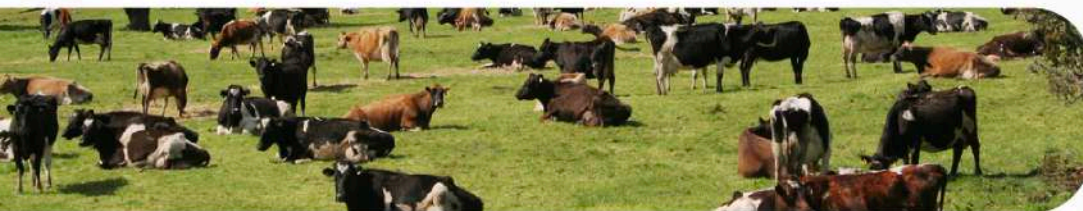
The Global Roundtable for Sustainable Beef (GRSB) and the Inter-American Institute for Cooperation on Agriculture (IICA) have been developing joint projects on the subject. Specifically, Josefina Eisele, Regional Director of the GRSB for Latin America, explains that both organizations share the vision of the importance of producing beef in a sustainable, environmentally friendly, socially responsible, and economically viable manner.



In order to strengthen sustainable livestock in Latin America, spaces have been created where producers can share experiences that improve social, economic, and environmental aspects of the beef value chain.

For his part, Abel Argüelles, Executive Director of the Argentine Roundtable for Sustainable Beef, explains that their organization works together with various institutions to develop sustainability indicators, which help improve production protocols.





In this sense, Sergio Schuler, from the Brazilian Roundtable, points out that there are three main lines of work: increasing traceability throughout the chain, achieving carbon neutrality, and improving the use of soil resources. The organization also seeks to communicate its achievements to society, with a view to changing consumers' perception of the livestock chain.

"We are disseminating the concept of sustainable meat and social recognition among national and international actors; in addition, we have developed software to identify areas for improvement in sustainable production", said Hugo Sánchez, representative from Paraguay.

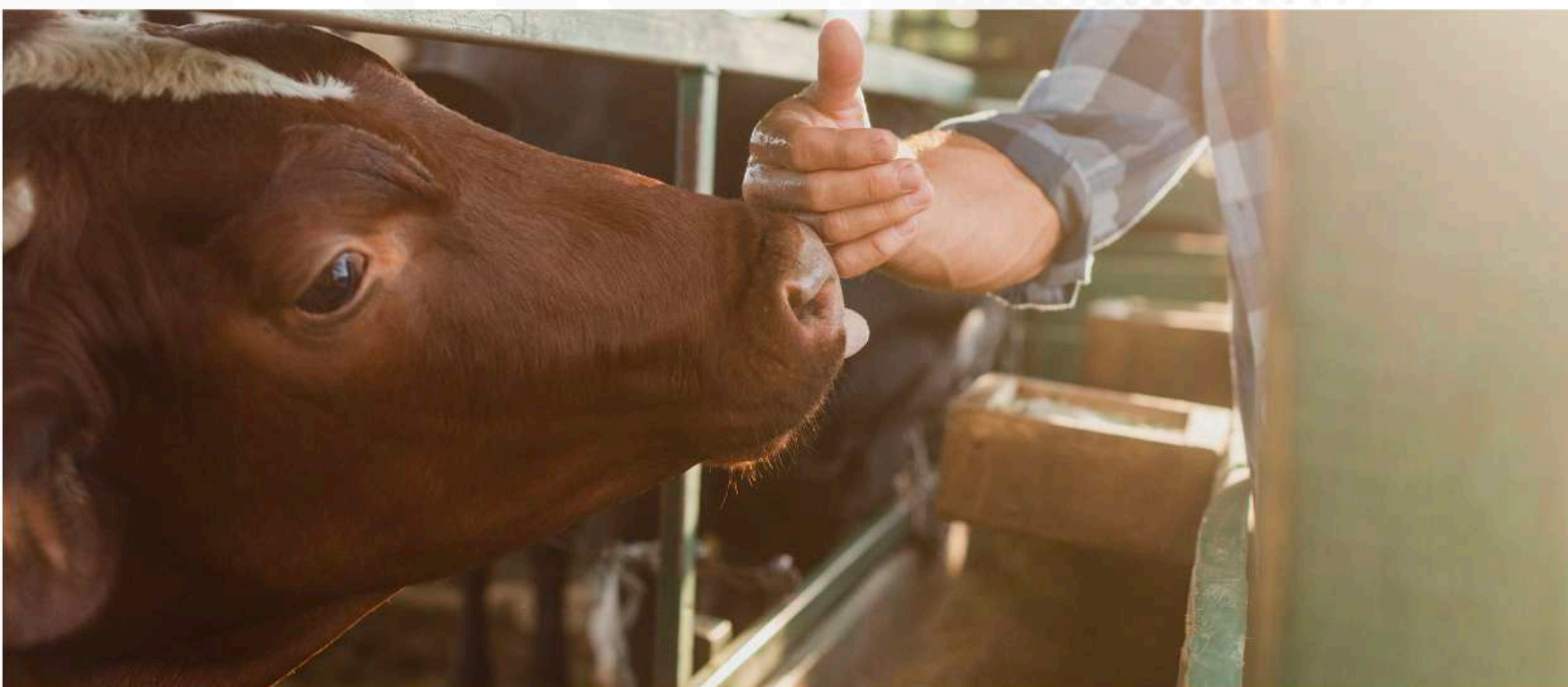
From Mexico, Eduardo Rendon explains that the roundtable in his country includes beef, goat, and pork production: "We work on traceability, by developing sustainability standards for pigs. We hope that this will be the spearhead for other productions".

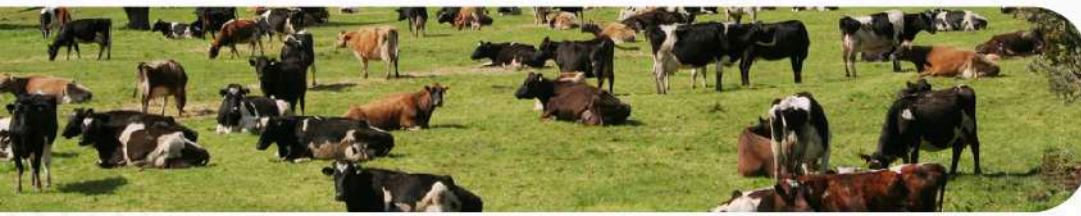
Germán Serrano, from Colombia, explained that his country has established a national framework for sustainable livestock production that has been included in the national policy.

In the case of dairy cattle farmers, the Net Zero Initiative in the United States supports dairy producers in reducing the environmental impact of the industry. This initiative is coordinated through the Innovation Center for U.S. Dairy, a voluntary organization that collaborates with leaders from across the dairy value chain.

For its part, the Alianza del Pastizal, an initiative for sustainable livestock led by the environmental organization BirdLife International, brings together Argentina, Brazil, Paraguay and Uruguay, and awards a seal to meat whose production process contributes to the conservation of natural grasslands and biodiversity. In order to obtain this certificate, ranchers must implement practices that mitigate GHG emissions, promote animal welfare, strengthen adaptation, and improve the economy of rural families.

Currently, there are several successful examples of sustainable livestock throughout the entire American continent.





Canada

Recovering native grasslands to increase biodiversity

For many people, Canadian prairies are a vast ocean of grass; however, this reality has changed. Today, in some areas of Canada, less than 20% of native grasslands remain. This situation is worrying, due to the cultural importance of these grasslands for the indigenous peoples and for all the inhabitants of rural areas.

For this reason, Ducks Unlimited Canada, the Nature Conservancy, and the United States Roundtable for Sustainable Beef (USRSB), in cooperation with the Waldron Ranch, implemented a project in 2013 for sustainable practices to preserve native grasslands.

Waldron Ranch has 65,000 acres and currently sequesters around two million tons of carbon, equivalent to the emissions of more than 100,000 Canadians for a year. These levels remain stable in the long term and stay in the soil as long as the ecosystem and livestock grazing on the land are maintained, explained Ben Campbell of the Black Diamond Ranch in Alberta.

United States

Sustainable beef from start to finish

Since its founding in 2015, the USRSB has brought together individuals and businesses to reflect on how they raise, buy and distribute beef, and to find opportunities to help consumers understand the history of sustainability in the beef community.

More than 100 USRSB diverse stakeholders, from ranchers to restaurants and others in between, have come together to address environmental, social, and economic concerns and identify ways to continually improve the sustainability of the meat value chain. In most developed countries, more than 80% of all GHG

emissions come from fossil fuels, while less than 3% comes from livestock production.

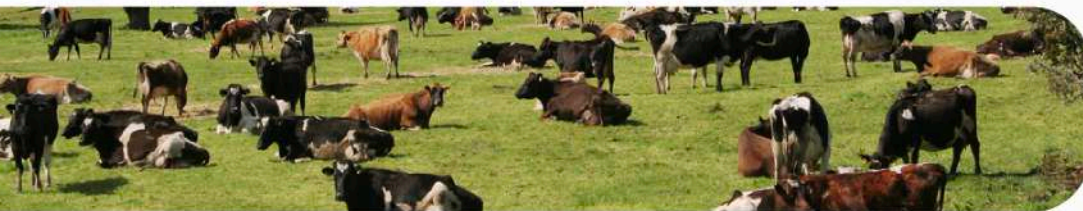
To approve standards, guidelines, and methods to measure sustainability, the USRSB developed a two-year meat sustainability pilot project, which brought together participants from each phase of production to share data and best practices in the value chain. The objectives were multiple: increasing efficiency, improving management practices, self-assessing and documenting sustainability efforts, exploring third-party verification of sustainability, and evaluating a chain-wide track-and-trace program.



Uruguay

Livestock and Climate Project, more sustainable meat per hectare

Uruguay is a livestock, and especially cattle, country, with great wealth in terms of natural grasslands. Of the country's 17 million hectares, more than 10 million are dedicated to livestock with direct grazing.



Extensive pastoralism is carried out with little use of external inputs and capital; rather, it is based on what the ecosystem offers and the growth of native biodiverse grasslands with very high forage production potential, explained Walter Oyhantcabal, an expert on Sustainable Livestock at IICA.

Between 2010 and 2019, the Uruguayan Ministry of Livestock promoted a strategy aimed at improving efficiency and productivity, increasing the net income of producers, obtaining greater resilience, contributing to mitigation, and adopting management practices that generate conditions to recover organic matter in the soil and capture carbon, added Mr. Oyhantcabal.

One of the initiatives of the Livestock and Climate project was the creation of the Adaptation Fund of the Climate Change Commission, aimed at some 1,500 producers with very shallow soils who, as a result, are highly vulnerable to droughts. The initiative focused on the vulnerability of livestock, given that the grasslands of the Uruguayan pampas usually produce a lot of grass, but problems arise when there are droughts.

Currently, a training program is being developed for farmers on how to produce more with fewer resources. Around 10% of the Uruguayan livestock area is managed based on criteria of high environmental ecological efficiency. Despite these initiatives, there is still much room for improvement.

Colombia

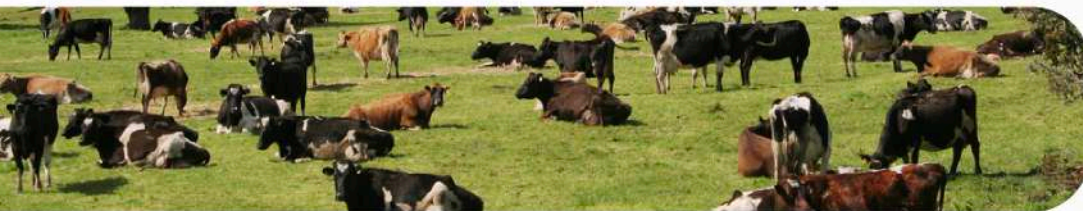
Recovering natural grasslands to improve economic, social, and environmental sustainability

In the province of Atlántico, on the north coast of Colombia, is the farm of Ana Hernández, which is part of 270 hectares that were bought from a landowner and distributed among 43 displaced families. It is also part of a national initiative to improve the economic, environmental, and social sustainability of cattle ranching in Colombia.

The *Mainstreaming Sustainable Cattle Ranching* project has helped 4,100 family farms in five different areas of Colombia to adopt silvopastoral techniques that mix trees with grass, in a beneficial combination for farmers, their cows, and the environment. Shade cows are more productive and sustainable than those raised in open fields. Shade reduces heat stress for animals; as a result, they emit less methane, while diversified vegetation improves their diet and productivity.

To date, around 32,000 hectares have been converted to the silvopastoral system, which has increased incomes by up to USD 523 per hectare/per year and has boosted milk productivity by an average of 36.2%. By rewarding farmers through payments for environmental services and encouraging natural regeneration, the project has also contributed to the conservation and enrichment of an additional 21,000 hectares of ecosystems, key to global biodiversity. The project has helped farmers plant more than 2.6 million trees of 80 different species and has sequestered more than 1.2 million tons of carbon.





The project, which is supported by the World Bank, is implemented by the Federation of Livestock Farmers of Colombia (FEDEGAN) in association with The Nature Conservancy, CIPAV and Fondo Acción, with financial support from the Global Environment Facility and the Government of the United Kingdom. Participating ranchers also contributed a significant amount of physical labor, time, fencing, and composting material successfully change the landscape.

For Ana Hernández, planting edible trees and shrubs in an area threatened by extreme weather has been difficult but worth it: her cows' milk production has increased from about 2 liters of milk per cow per day to 4.5 liters today. "My cows would produce much less milk if it weren't for the trees," she explained with conviction.

Raising the same number of animals on a smaller surface is essential to increase the sustainability of livestock farming and make room for forest restoration, said Hernández, who, along with the 43 displaced families, found a new life full of hope and opportunities on the north coast of Colombia.

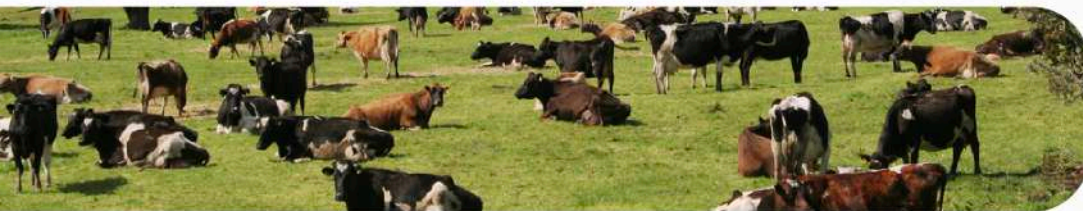
Brazil

Sustainable pasture-based farming for sustainability

Currently, there are more than 200 million head of cattle in Brazil and the industry is in all the municipalities of the country. An opportunity to intensify the use of the land are the integration systems between livestock production, agriculture, and forests. An example of this integration is that of a farmer who first uses the land to produce soybeans, followed by a corn crop. The same land is then planted with a grass that the cattle use as pasture. Although this type of integration system is complex to manage, the benefits are numerous when successfully implemented and producers see increased productivity and a positive financial impact.

The Brazilian government created a low-carbon agriculture plan that finances technologies to reduce carbon emissions. This plan includes the integration and restoration of pastures, no-till farming, forest plantation, nitrogen fixation and the use of animal by-products.





Other initiatives exist to combine the efforts of government, the private sector and civil society. Produce Conserve Include (PCI) in Mato Grosso, Brazil, works to achieve sustainable production in all industries in this territory, managing future agricultural growth within the existing productive areas, while restoring forests and involving all farmers, regardless of the scale of their production.

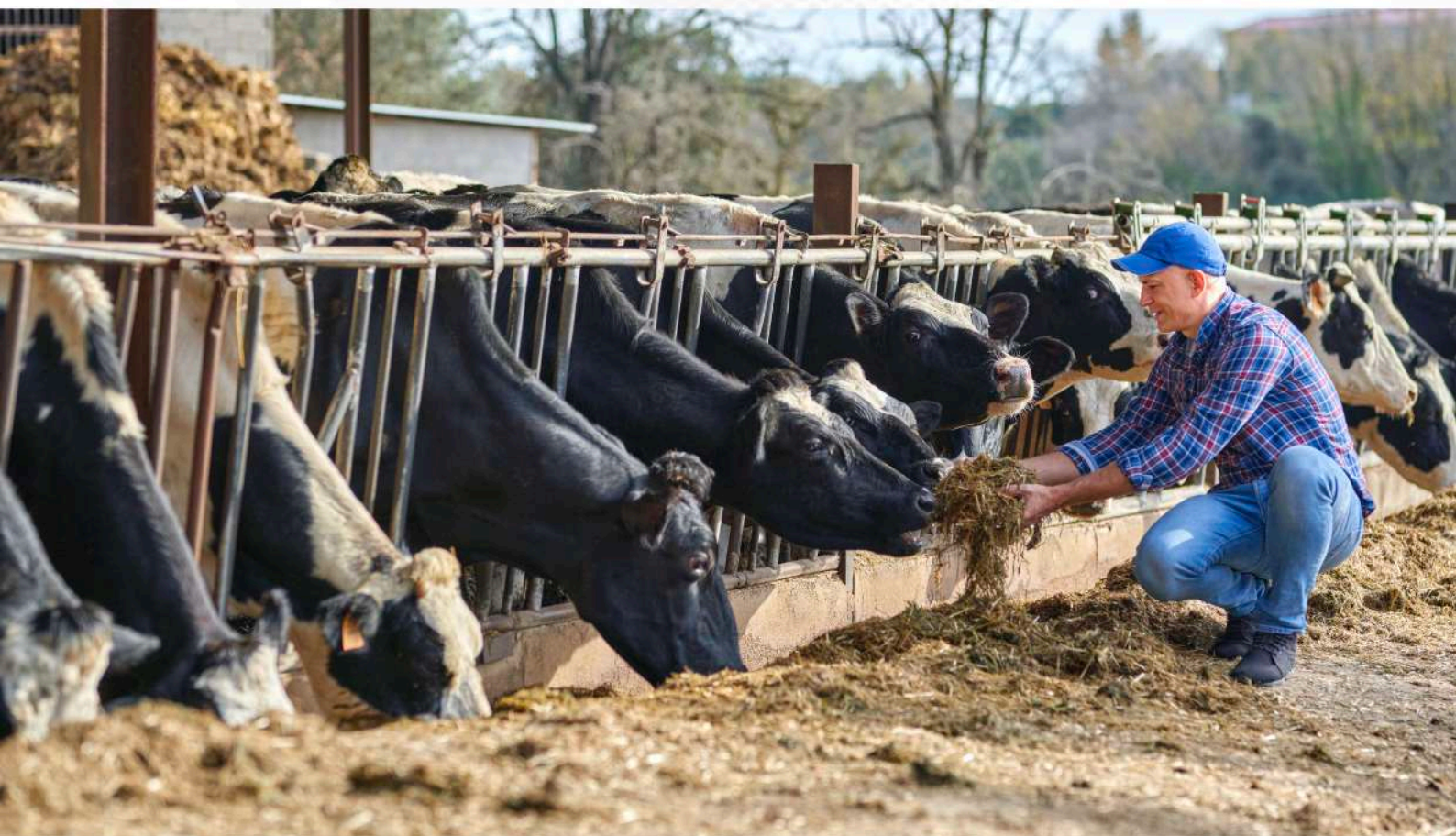
Mexico

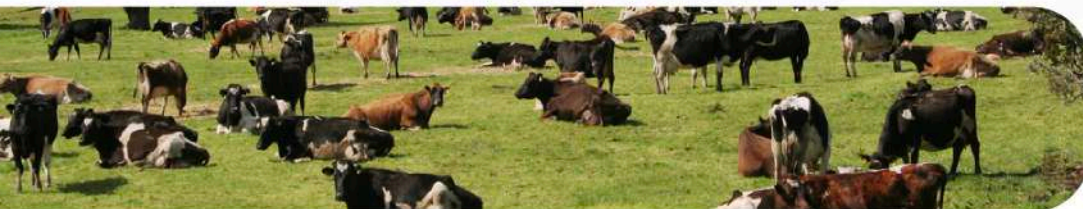
Sustainability of holistic and conventional livestock in the tropic of Chiapas

Conventional cattle ranching in the lowlands of Chiapas, Mexico, typically employs extensive grazing, annual burning of grass, and frequent applications of agrochemicals, thus threatening biodiversity and long-term productivity.

To remedy this situation, a small group of innovative ranchers in the Central Valleys region have shifted towards a more holistic management through careful land-use planning, rotational grazing, diversified forage, and reduced use of purchased inputs. To do so, they compared the sustainability of 18 conventional ranches and seven dual-purpose holistic ranches, using three sets of sustainability metrics.

As part of the project, vegetation and soil samples were taken at seven holistic ranches and seven conventional ones. Holistic ranches had greater soil respiration, a deeper topsoil, higher presence of earthworms in the soil, and canopies that were closer together when compared to conventional ranches. This suggests that holistic management strategies lead to greater ecological and economic sustainability.





Argentina

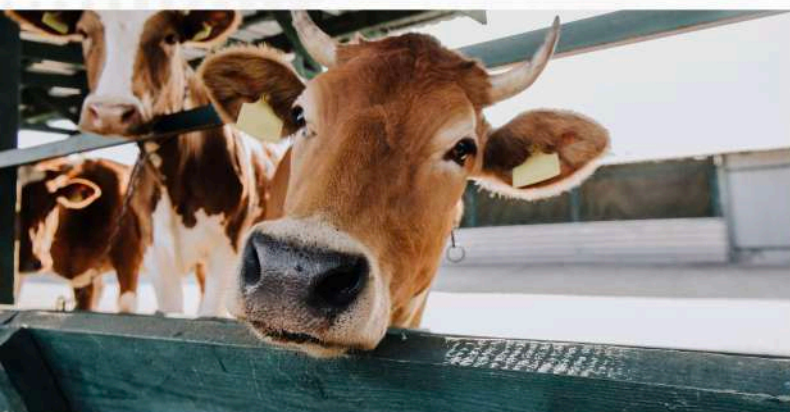
Forest management with integrated livestock to tackle climate change

The Forest Management with Integrated Livestock (MBGI) Plan promotes the conservation of the native forest and its biodiversity based on the adoption of low environmental impact technologies. This initiative by the Argentine government seeks to mitigate GHG emissions and strengthen sustainable livestock farming.

The MBGI, created in 2015 by the National Institute of Agricultural Technology (INTA), applies a comprehensive vision of the environment that seeks to strike a balance between productive capacity, environmental integrity, and ecosystem services to maintain and improve the well-being of farmers and the associated communities.

The plan, endorsed by the Ministry of Environment and Sustainable Development, responds to clear strategic objectives, which contribute to the sustainable use of native forests as a development tool in the face of land use change.

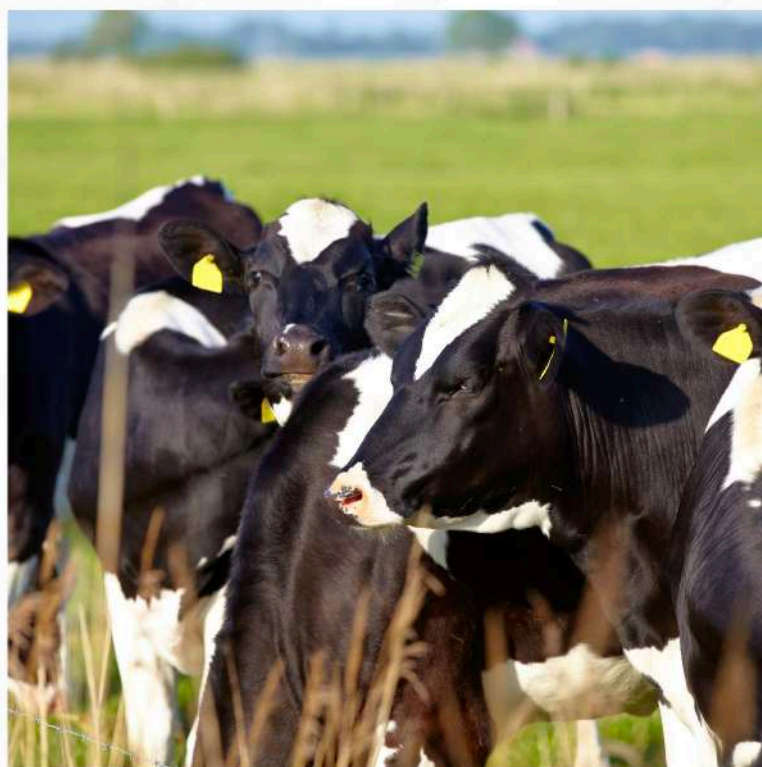
Estancia Puma, in the town of Quimilí, Santiago del Estero, produces soybeans, corn and sorghum, together with a full cycle of livestock. Although they carry out rearing and fattening of animals, their workload is moderate. This helps overcome the challenges of dry years by increasing supplementation instead of eliminating categories altogether.



The large scale of this farm has demonstrated that it is possible to apply the MBGI technology in small, medium, and large production units. Farmers can adopt this system on a voluntary basis, which provides an opportunity for sustainable production. Thus, it has become an alternative to production models that involve replacing forests with pastures that generate land use changes and have major environmental consequences.

As Ernesto Viglizzo has pointed out, grazing lands have great carbon sequestration potential, especially in the Southern Common Market (MERCOSUR) countries. However, there is still a lack of scientific research on carbon sequestration in livestock in the Americas, particularly because the modality is very different from other practices in other parts of the world.

Although the contribution to climate change mitigation through carbon sequestration has yet to be recognized as a significant option to offset methane release, it is certain that livestock, when properly managed, is part of the solution, which currently constitutes a global challenge.





2022. Inter-American Institute for Cooperation on Agriculture (IICA)

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Natural grasslands

Sustainable Agriculture Milestones in the Americas
Successful experiences in the region to address climate change and care for the environment and natural resources



Conservation of natural grasslands in Latin America: a pillar for sustainable livestock production and ecosystem conservation

Livestock producers in some countries in the Americas are practicing a significant amount of natural grassland management, which is making a substantial contribution, by helping to preserve vast ecosystems that are home to extensive biodiversity and by mitigating climate change. This has allowed the region to engage in sustainable livestock production.

Not only do grasslands provide several environmental services, most notably carbon sequestration and the production of forage for wild animals, but they are also the basis for the grazing systems of various countries in the hemisphere, enabling efficient production of meat, milk, and wool for domestic and global use.

Approximately 40% of the world's land surface is covered by natural grasslands, which recent research has shown are currently threatened by changes in soil use and the effects of climate change¹.

Nonetheless, despite the environmental and economic importance of grasslands, many people living in the city are unfamiliar with them and are unaware of their value. These assets remain practically invisible to societies, which tend to be more aware of the ecological and economic value of forests. Therefore, the work of agricultural research centers in Latin American countries has been decisive in developing the ecological and technological bases to improve grassland conservation.

Grasslands are not simply land areas without trees, as some may believe. They are ecosystems that produce rich vegetation that is consumed and transformed by wild and domestic animals, which then yields enormous benefits for people and the planet.

One of the most valuable examples of this ecosystem in the world is the area known as the Rio de la Plata Grasslands, which covers 750,000 km²



¹ Gibson, DJ. 2009. Grasses and Grassland Ecology. Oxford, United Kingdom, Oxford University Press. p. 313.

and spans three countries: more than 7% of the land area of Uruguay; central and northeastern Argentina; and the southern state of Rio Grande do Sul, Brazil. This is one of the most extensive grassland ecosystems on the planet, although it is far from being the only one in the Americas, given that countries such as Venezuela, Colombia, Mexico, the United States and Canada also possess vast grasslands with grasses that are rich in biodiversity.

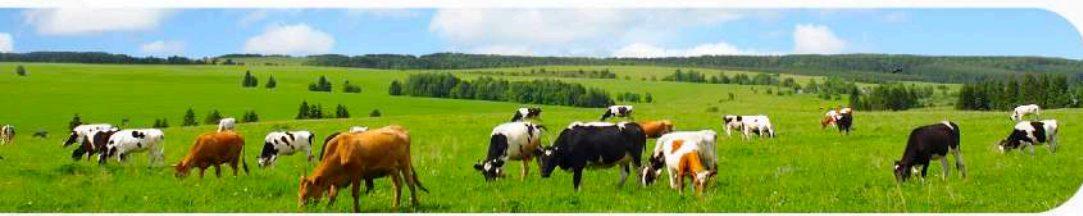
Grasslands cover more than 900 million hectares throughout the hemisphere, with most of them used for grazing in North and South America, and to a lesser extent, Central America and the Caribbean.

Although European colonization transformed the grasslands of the hemisphere into one of the world's most important agricultural production

regions, the many years of production activity have significantly changed the landscape and resulted in the loss of habitats. However, in recent years, there has been gradual recovery thanks to the work of research centers, which have been at the cutting edge of agricultural modernization.

There are some sustainable practices that have been implemented in the hemisphere and still have the potential to grow, including the preservation of iconic sites that are in danger of extinction; grazing management; production of organic amendments (manure, agroindustrial waste and biocarbon) and cover crops; fertility management; integrated agricultural systems (agroforestry, silvopastoral systems and crop-livestock-forestry systems); and water management, among others.





The environment and food security

Livestock production is an extremely valuable economic activity for Argentina, Brazil, Uruguay, Paraguay, and other countries in the hemisphere. There is a longstanding tradition of cattle production in the Americas and the beef value chain is one of the most important in the region, in terms of production and exports to the rest of the world. It is essential for food security and has deep cultural roots.

Cattle production systems are central to the economic, social, and environmental sustainability of South American countries, and as mentioned before are essential to global food security, given the Southern Cone's vast capacity to produce and export animal-based proteins that are an essential component for the proper nutrition of the population.

Martín Jaurena, researcher from Uruguay's National Agricultural Research Institute (INIA), points out that grasslands, which in Uruguay are referred to as "campo natural", occupy 64% of the country's land

area and have been the mainstay of one of the country's primary economic activities: livestock farming.

INIA, a government entity that develops projects based on state-of-the-art technology, is contributing to natural grassland enhancement through a series of best practices undertaken in collaboration with the private sector, to improve grassland use and promote increased conservation.

"The practices ensure better farm management and allow us to produce more nutritious grass for the cattle. We in turn take care of these resources so that they can remain in good condition over a longer period", said the INIA researcher.

Jaurena also pointed out that, "In order to improve natural grassland production and conservation, producers must have more grass at their disposal, in other words, they must operate on pastures that produce a lot of fodder, thereby maximizing productivity and sustainability. They must be aware



of the various plant communities in the pastures, which have very diverse characteristics. Sometimes a one-by-one-meter plot may contain more than 50 different species. Likewise, a native ecosystem of South America is very different to a tropical ecosystem. This knowledge will allow the livestock farmer to improve productivity".

In Uruguay, livestock farming is the main activity of family farmers. Official statistics indicate that of the country's 44,000 agricultural establishments, 25,000 are family farms and 20,000 of these small-scale operations are devoted to livestock farming, particularly of cows and sheep.

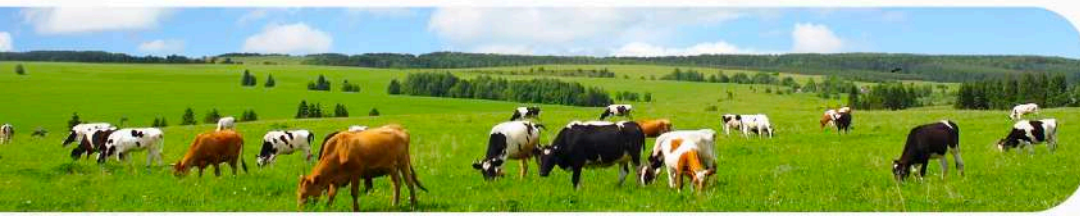
Most of the grasslands are used for cattle rearing and are a source of food, fiber and fuel, while contributing to climate regulation, pollination, purification and recharging of aquifers, control of invasive species and carbon sequestration.

Moreover, healthy pastures are huge carbon sinks and are therefore a key tool for climate mitigation. The soil is the most important carbon reserve in the biosphere, as it contains three times more carbon than the vegetation and the atmosphere. Proper environmental management enables pastures to operate as net carbon sinks.

Several countries of the Americas—such as Brazil, Canada, Colombia, Chile, El Salvador, Paraguay, Peru, and Uruguay—have made headway in improving soil health, through the "Living Soils of the Americas" initiative. The initiative was launched by the Inter-American Institute for Cooperation on Agriculture (IICA) in 2020, in partnership with the prestigious scientist, Rattan Lal, who is considered the world's leading authority on soil sciences. The project has brought together stakeholders from the public and private sector, universities, as well as international and civil society organizations in the hemisphere, in a common restoration effort aimed at tackling soil degradation, which is threatening to undermine food production.

For example, research undertaken by renowned scientists and coordinated by Professor Lal, within the framework of "Living Soils of the Americas", determined that the adoption of two large-scale sustainable management practices (pasture reclamation and conservation tillage) in the Americas would have a potential soil carbon accumulation of 9.81 Pg of carbon dioxide equivalent over 20 years. Thus, with the full implementation of sustainable management practices promoted throughout the region, the soils of the Americas could reduce total global greenhouse gas emissions generated by agriculture by almost 8%

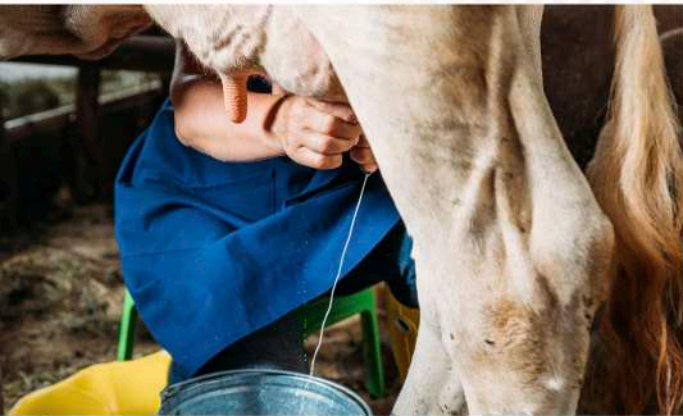




Emphasis on conservation

Although the practice of replacing natural vegetation to feed cattle has been gaining ground in recent years, grassland livestock production comes closest to achieving the desired balance between food production and biodiversity conservation. Thus, livestock production on natural grasslands, as practiced mainly in South America, is an example to the world of sustainable production.

The productivity of ecosystems will increase as more producers use natural pastures. The challenge is to maintain the health of soils and native vegetation. Another benefit is the fact that farmers in the Americas utilize organic rather than chemical fertilizers on most natural grasslands. In all cases, the cattle are also contributing to the fertilization of these grasslands through the biogeochemical cycle



Fewer net GHG emissions

Livestock farming has been identified as an important source of greenhouse gas (GHG) emissions worldwide, thereby contributing to climate change.

However, these emissions are calculated based on international equations that do not necessarily reflect the reality of the Americas, particularly of countries in the Southern Cone, and fail to take into account the heterogeneity of different production systems.

It has already been determined that extensive livestock farming on natural grasslands generates

fewer GHG emissions than intensive production. However, one must also calculate the potential carbon capture and sequestration of the pastoral systems used in the Southern countries.

Although there is a need for more research that accurately reflects the impact of the various systems, there are scientific studies today that indicate that grazing lands in countries in the Southern Cone produce excess carbon. In other words, the carbon sequestration by the grasslands more than compensates for the emissions produced by the animals, under conditions of extensive grazing.

Studies on this issue undertaken by a group of researchers headed by renowned Argentinian scientist, Ernesto Viglizzo, reveal that grazing lands in Argentina, Brazil, Uruguay, and Paraguay play a fundamental role in carbon capture, which offsets methane emissions generated by the cattle.

Viglizzo's studies maintain that the sole focus should not be emissions from animal production, but also the net carbon balance, which favorably

impacts the environment, particularly with the practices adopted in the Southern region.

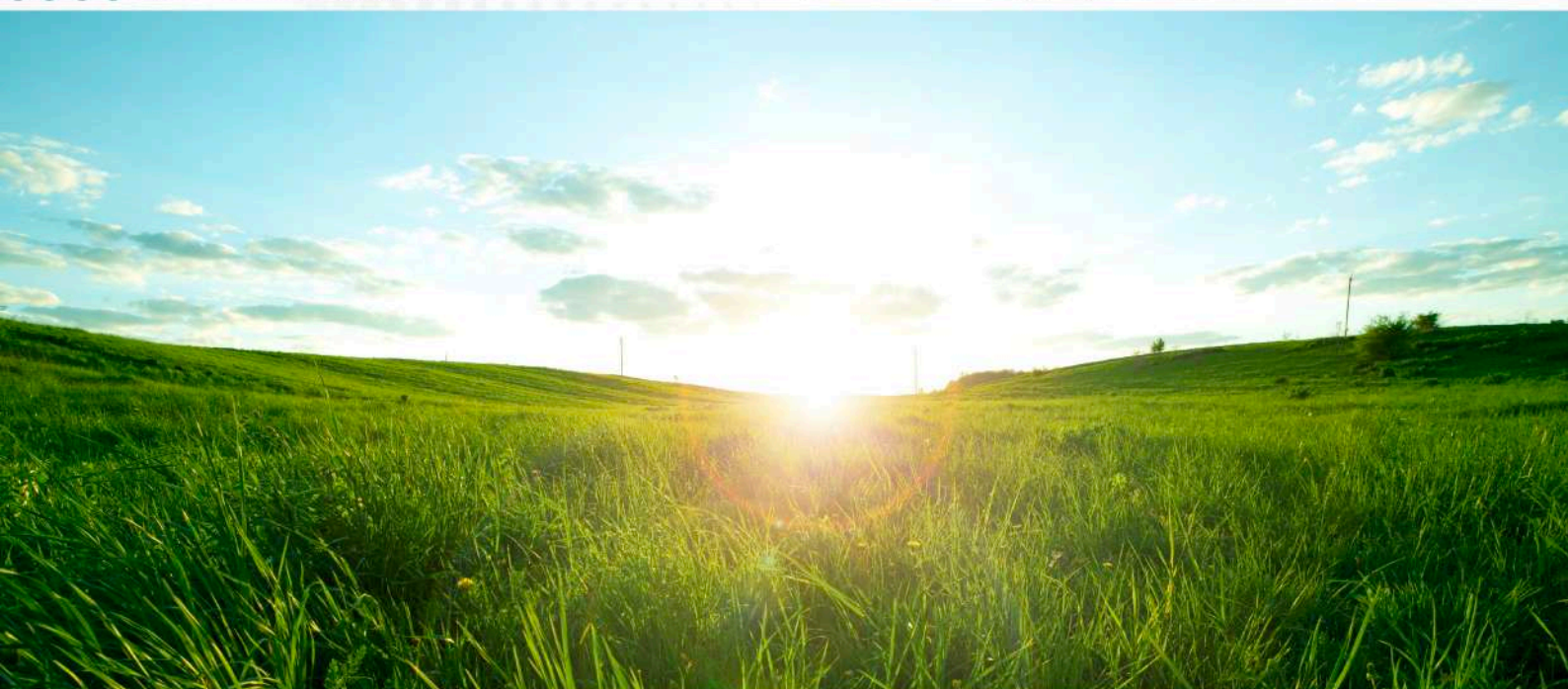
Thus, Latin American countries have made significant headway in reducing the carbon footprint of meat production and they intend to continue on this path, by strengthening initiatives that contribute to the increased adoption of technology and agricultural practices that mitigate GHG emissions.

The benefits of natural grassland conservation in the region can be summarized as follows:

- Natural grasslands offer producers increased resistance and resilience to drought.
- Natural grasslands contribute to national economies, culture, and ecosystem health.
- The ecosystem services approach establishes a more explicit link between human well-being and the functioning of ecosystems.
- Natural grasslands not only generate forage for cattle, but also provide the population with important ecosystem services, such as erosion control, biodiversity, and water quality conservation, as well as climate mitigation, among others.
- Natural grasslands provide the population with much more than meat production services. This ecosystem is important for the sustainable development of the country.



Natural Grasslands



Next steps

Currently, INIA in Uruguay is working on joint projects with researchers in Argentina and Brazil and exchanging best practices to improve natural grasslands. There are also initiatives with professionals in Costa Rica and Colombia, using satellite information to identify the amount of pasture involved in production systems in these countries. Work is also being undertaken with remote sensors that take aerial photographs in the

fields. The results of these projects will facilitate better decision-making about grassland management.

Also underway is the development of mobile apps that can identify the different types of fields in a cattle farm, in order to develop precision practices and optimize production



New challenges

The main challenges in promoting the use of natural grasslands in a bid to address the climate crisis are undoubtedly the need to improve the efficiency of their use and to increase the carbon sequestration of production systems. However, there are other actions that can contribute to climate change mitigation, in particular by:

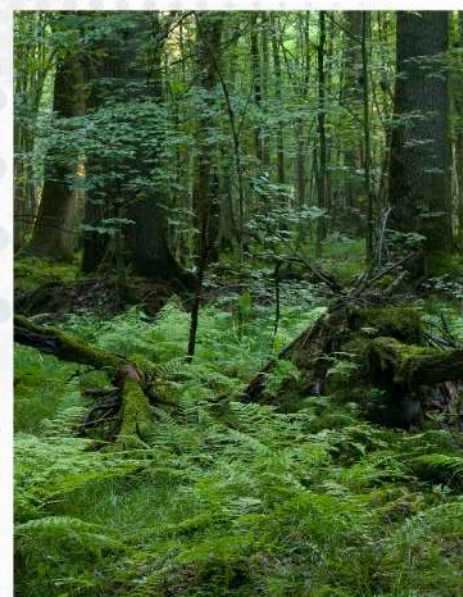
- Strengthening the connection between grasslands and native forests. Most of these forest areas exist naturally on the farms, but in some cases, there are small, cultivated forests. The aim is to ensure the coexistence of pastures and trees.

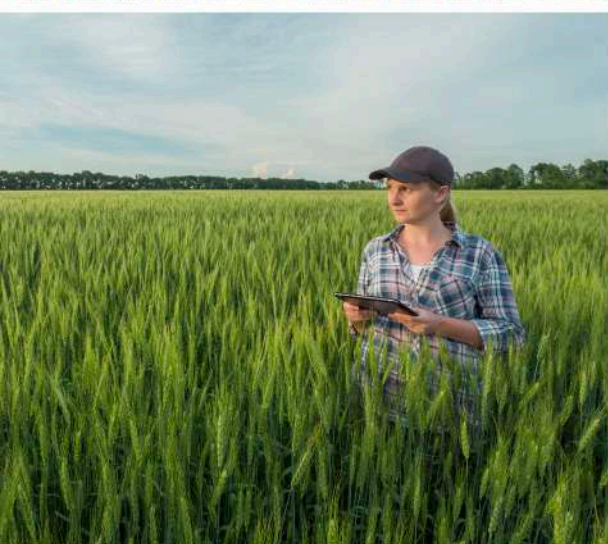
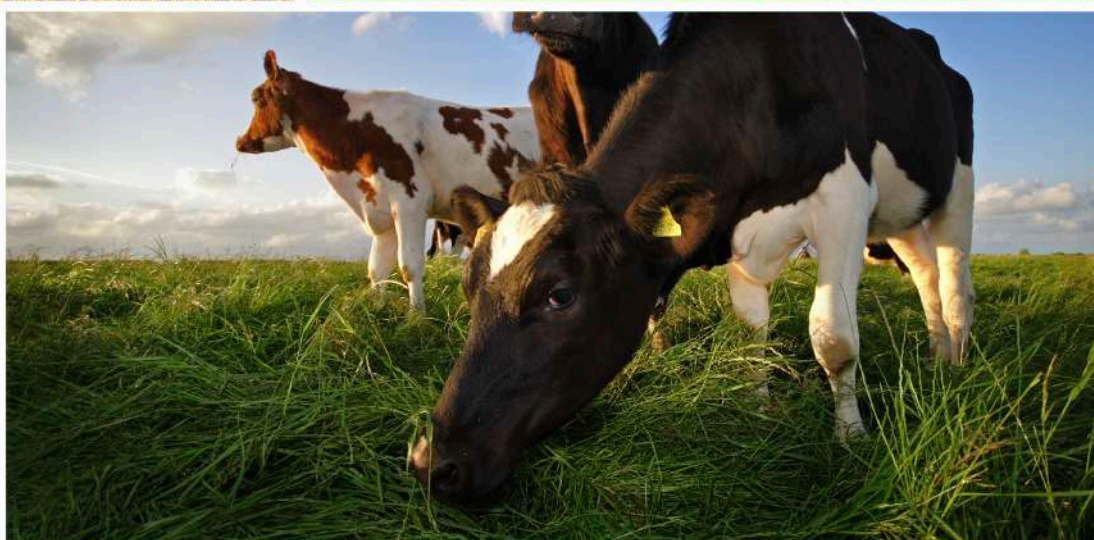
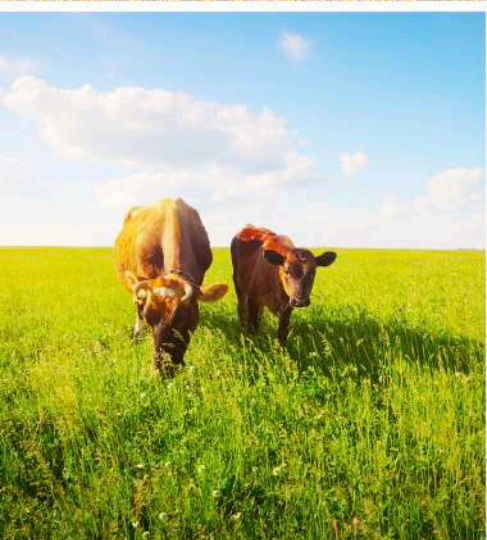
- Placing greater emphasis on projects aimed at training and knowledge transfer about natural grasslands in all countries of the region.

The region's large expanse of natural grasslands demonstrates the importance of protecting them to address the climate crisis and protect biodiversity.

"Investing in natural pasture management is a good business venture today, tomorrow and always", Martín Jaurena, INIA.

"Natural grassland: land area dominated by herbaceous species, many of which are palatable to livestock, and which are considered spontaneous and grow naturally in that area, with no introduced species", INIA Uruguay.





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Direct seeding: Encompassing Principles of Conservation Agriculture

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources



The compelling results of agriculture in the Americas in support of environmental conservation

The introduction of direct seeding in different countries around the world has yielded a wide range of benefits, contributing to environmental conservation and transforming agriculture in a positive manner. The profound and rapid revolution it has triggered in the Americas, particularly in Southern Cone countries, is especially noteworthy. Direct seeding is based on the principles of conservation agriculture: using no tillage, retaining crop residue mulch, and adopting complex rotations including cover cropping.

In Argentina, Brazil, Paraguay and Uruguay, which comprise one of the leading grain-producing regions in the world and, as such, play a key role in guaranteeing global food security, farmers turned to direct seeding en masse. They realized that modifying their work practices under this technique would yield significant results in terms of farming sustainability and natural resource preservation. As a result, food production in these countries is not only more environmentally friendly, but also more profitable.

Direct seeding has enabled the Southern Cone region of the Americas to reduce soil erosion by more than 90%, improve water use efficiency, lower the consumption of fossil fuels and reduce

greenhouse gas (GHG) emissions, which contribute to climate change. These concrete achievements have strengthened the region's standing as a global benchmark for sustainable agricultural production.

According to data from the Rosario Stock Exchange, a private entity that is a benchmark for agricultural monitoring, direct seeding has been carried out in more than 90% of Argentina's farming area for several years now.

In Brazil, where the system was first applied in the southern state of Paraná more than 50 years ago, direct seeding has grown exponentially in recent years. According to private-sector estimates, the technique is now applied on 35 million hectares – a significant portion of the total area dedicated to grain production. The application of direct seeding in Uruguay is also significant.

In Paraguay, which shares a border with the Brazilian state of Paraná, the expansion of direct seeding was facilitated by the two countries' geographical proximity and ecological similarities.





Direct seeding



Preservation of natural resources

Direct seeding essentially involves planting a crop without prior soil tillage, a technique that has been used in agriculture for thousands of years. It is unique in that it avoids soil removal, thereby improving contact between the soil and the seed.

However, the direct seeding system that is extensively applied in agriculture in the Southern Cone region of the Americas is much more than that. It is complemented by a series of good agricultural practices, including maintaining a permanent soil cover with crop residues.

Additionally, integrated pest management and more effective retention of organic matter contribute to improving soil health from a biological, physical and chemical standpoint. By avoiding disturbing the soil, this system fosters more efficient water capture and storage, which is one of the most important challenges facing global agriculture amid the current environmental and climate crisis.



A new paradigm

Although the first trials of no-till farming were carried out in Great Britain, direct seeding began to be developed in the United States between 1940 and 1950.

In the mid-1970s, the system attracted the attention of agricultural technical specialists in Argentina, who were looking for less invasive and more productive planting techniques. At that time, producers in the pampa region, whose plains and mild climate made it one of the most fertile agricultural areas in the world, were beginning to experience soil erosion issues due to poor water management. Farmers who tilled the land began to notice that the soil would crack when the rain came.

Direct seeding began to emerge as a more sustainable farming option for Argentine farmers, who finally adopted it on a massive scale in the 1990s. The consequences of soil erosion on production had become evident in many parts of the country and rising production costs led many farmers to find ways to utilize fewer inputs. Such was the case in Brazil, where direct seeding experienced a boom in the last decade of the 20th century.

Direct seeding translates into more water for crops. According to data from the National Institute of Agricultural Technology (INTA) of Argentina, a national public organization considered a regional benchmark for research and innovation, direct seeding in Argentina yields up to 100 millimeters of useful water per year, as opposed to conventional tillage. INTA has estimated that the resulting water use efficiency of each crop represents a production increase of 1,700 kilos of corn, 1,400 kilos of sorghum and 800 kilos of wheat per hectare per year.





No tillage and healthier ecosystems

"Direct seeding prevents farmland erosion and the presence of organisms that cause pests. It also maintains the soil's ecological balance by protecting disease-counteracting organisms", explains David Roggero, President of the Argentine Association of Direct Seeding Producers (AAPRESID).

AAPRESID is an organization established in 1989 by a group of innovative producers who were not afraid to make a change and sought to develop an agriculture sector that could optimize the use of natural resources through greater knowledge, research and the introduction of modern technologies.

The organization, which has widespread presence in Argentina and a subsidiary office in Brazil, has become a benchmark institution for sustainable and advanced agriculture in the region and the world.

To address the global challenge of striking a balance between production and sustainability, Southern Cone farmers are relying on this methodology which, in addition to avoiding tillage, provides for crop rotation, balanced nutrition, optimal and efficient application of different phytosanitary products and other types of inputs, as well as integrated management of weeds, insects and diseases.

The system is therefore beneficial in preserving soil, agriculture's most important resource and the mainstay of global food security.

"The sustainability of direct seeding is dependent on the comprehensive application of all of its concepts. If we fail to return nutrients to the soil or rotate crops, we are providing all of the microflora and microfauna in the soil with only one type of food. It is crucial to apply various micronutrients", explains the President of AAPRESID.

Roggero notes that science has demonstrated that crop rotation results in better soil health than monoculture farming. Just like a human being, the soil is a living organism that requires a balanced and diverse diet.

As is done in the Southern Cone, this system can be employed with different crops and on small, medium or large farming areas. At present, direct seeding is used extensively to grow soybean, corn, cotton, wheat, sunflower, sorghum and barley, among other crops.

However, a long road has been traveled to reach the current situation. Although direct seeding has many advantages, South American farmers were initially





Direct seeding

hesitant. Their first concern was how to control weeds. Seeding machines posed another challenge, given that conventional models were made for use on tilled soils, so different machines would be required for non-tilled soils, characterized by abundant agricultural residues – such as those from corn harvesting – and uneven terrains.

The widespread growth of this technique spurred the continuous progress achieved by Southern Cone countries in developing agricultural machinery with the most innovative technology for use in no-till farming. Industry research and advances in countries like Argentina and Brazil has provided these countries with access to the best technology and even enabled them to export agricultural machinery to leading food producing nations.



Benefits

With respect to productivity, there are substantial differences between conventional tillage farming and no-till farming. Over the past 20 years, thanks to the implementation of direct seeding, in addition to advances in agricultural machinery and

biotechnology, Argentina, Brazil, Uruguay and Paraguay have experienced considerable growth, enabling their grain production to reach record-breaking figures.

Some of the benefits that have been documented in the Southern Cone include:

- Better use of staff time.
- Fuel savings.
- Optimal use of rainwater (both in harvesting and subsequent phases).
- Higher yields compared to conventional tillage farming.
- Reduction in greenhouse gas emissions.
- Better infiltration of water in soil, reduced evaporation from the surface and improved accumulation and conservation of water in the soil profile.
- Better conditions for carbon sequestration in soil, through the frequent rotation of crops and grasses as well as balanced fertilization.
- Higher yields for cash crops, primarily due to improved water conditions in soil.
- Better adaptation to changing and uncertain climate.
- Saving of time in performing farm operations such as seeding a crop.
- More farm profit.



Direct seeding



Application of direct seeding

Direct seeding can be applied anywhere on the planet, but it is important to bear in mind that soils and climate vary in each territory. Consequently, practices must be adjusted based on the chemical, physical and biological characteristics of the soil, as well as the corresponding climate. Farmers have been tilling the land for 10,000 years, so transitioning to a different system is not easy. It is a gradual process, and progress achieved will depend on the advice, machinery and economic resources with which farmers are provided.

“The use of phytosanitary products is lower from day one, because the crop residues left on the soil help us control what we used to control with tillage”, says Roggero.

Direct seeding works for small, medium and large-scale producers who use manual seeding methods, animal traction or mechanized seeding. It is less costly than tillage farming and results in less degraded soil.

Prior to applying direct seeding, Roggero recommends identifying dense layers in order to adequately manage them, using cover crops to break up hardened layers of the soil profile. No-tillage farming allows for drastically reducing the oxidation of soil organic matter, which, in turn, allows for storing atmospheric carbon in the soil and contributing to climate change mitigation.





Direct seeding



Dissemination of the system



The direct seeding system is spreading across the world, especially in Latin America and the Southern Cone region. Nearly half of the global surface area that has been cultivated with direct seeding is located in Latin America.

A study by the Cooperative Program for Agrifood and Agroindustrial Technology Development in the Southern Cone (PROCISUR) notes that "there has been a dramatic shift, given that only a few years ago, virtually all agriculture was carried out in the conventional manner, with tillage".

Argentina, Australia, Brazil, Chile, the United States, Uruguay and Paraguay are the countries with the largest no-tillage farming areas in the world. In the case of Central America and the Caribbean, no data is available on the number of hectares cultivated with direct seeding.

According to David Roggero, President of AAPRESID, "the adoption of this system in countries with no experience should be fostered through public policies that integrate institutions, training programs, access to technological knowledge and credit opportunities, as well as the creation of practical tools".

"Each time we till the soil, we are accelerating the decomposition process of organic matter. Part of it stays in the soil, but the other part is lost. That is why we want to establish strategic partnerships to implement direct seeding all over the world, because no-tillage farming is the way forward", concludes the president of AAPRESID.





Direct seeding

"The development of innovation, science and technology in the agriculture sector is the way to make agrifood systems increasingly productive, sustainable and inclusive".

IICA.



"The way to save the planet is to recapture carbon from the atmosphere through living crops".

David Roggero, President of AAPRESID.



"In recent years, direct seeding has revolutionized farming around the world; however, the Southern Cone of Latin America is the region in which this technological change has been implemented with greater speed and intensity, yielding excellent results".

PROCISUR



General Benefits

- Reduces soil erosion by more than 90%.
 - Reduces water evaporation by 70% and improves water use efficiency.
 - Reduces the use of fossil fuels by more than 60%, significantly reducing greenhouse gas emissions.
 - Facilitates soil carbon sequestration and improves chemical, physical and biological fertility.
 - Fosters greater biodiversity and biological activity.
 - Increases nutrient circulation.
 - Reduces operating costs and working hours, which allows for using extra time to improve planning and production strategies.
 - Drives the accumulation of stubble on soil year after year, contributing to better soil care by increasing the surface layer of organic matter.
 - Improves soil permeability and aeration and reduces soil erosion.
 - Addresses the reduction in the organic matter content of agricultural soils subjected to conventional tillage, by removing as little soil as possible.
 - Allows for accessing waterlogged soils shortly after rainfall in some humid areas.
- In extreme cases in which machines are unable to move in muddy areas, no-tillage farming has allowed for regenerating eroded soils.

Source: AAPRESID, Argentina





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System of Rice Intensification

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources



Latin American countries reduced water use in rice farming by up to 50%, making the crop more sustainable in a context of climate change

Thanks to a series of innovative practices promoted by the Inter-American Institute for Cooperation on Agriculture (IICA) to address the current scenarios of climate change and water scarcity, farmers in several Latin American countries have reduced water use in rice farming by up to 50%.

These efforts are being undertaken within the framework of the program "Producing more from less", which seeks to achieve a more productive, competitive and resilient rice sector that is low in greenhouse gas (GHG) emissions. The program is implemented in South American countries, such as Chile, Venezuela and Colombia; in Central American countries like Nicaragua, Costa Rica and Panama; and in Caribbean countries, such as the Dominican Republic.

The initiative has also enabled farmers to reduce the use of other resources besides water. For instance, seed use per hectare has decreased from 100-120 kilos to just 24 kilos, significantly reducing costs without affecting crop yields.

"People used to tell me the system wouldn't work because they thought it required a lot of water. However, I took the plunge and saw great results from the start", says Fabio Diosa, a small-scale farmer from the municipality of Santo Domingo Norte in the Dominican Republic. In that Caribbean country, the system began to be tested in 2011.



Panamá





A paradigm shift

Rice fields often evoke images of large floods, given that this grain is traditionally grown under water. Rice is the crop with the highest water footprint in the world, requiring 1,700 liters of water to produce half a kilo of rice. Flooded rice fields are a major source of atmospheric methane, one of the greenhouse gases that contribute the most to climate change.

However, rice is also one of the main sources of food security in different parts of the world, including Latin America and the Caribbean. A staple food used in traditional dishes in many countries of that region, rice is a crop of key economic, social and cultural importance.

Rice is the fourth most consumed food in the region and is estimated to account for 11% of a person's average calorie intake. It is also the main source of income and food for millions of small-scale farmers, who are the main producers of this grain.

It is therefore crucial to reduce the environmental impact and ensure the sustainability of rice farming, which covers 5.3 million hectares in Latin America and the Caribbean.



Based on the conviction that more efficient and environmentally friendly rice production systems are required to guarantee competitiveness and sustainability in the face of climate change, efforts were undertaken in Latin America to promote, adapt and validate the SRI (System of Rice Intensification) methodology, which has been applied by more than 10 million farmers in 60 countries around the world. Developed in Madagascar, the system has been improved based on research conducted by Cornell University and other institutions.

On that island off the coast of Africa, the system began to be tested in the 1980s by French agronomist and Jesuit Catholic priest Henri de Laulanié, with the aim of improving the situation of poor farmers, who were dealing with falling rice yields due to soil degradation and environmentally harmful practices.

De Laulanié was able to prove that reducing plant competition, using fewer seeds, and applying intermittent irrigation instead of flooding, generated more positive results while protecting the environment.



Starting in the 1990s, Cornell University in the United States began to take interest in and undertake research on SRI. As a result, the system became more widely known and applied in other countries around the world besides the island of Madagascar. At present, SRI enables millions of farmers around the world to increase rice



productivity through changes in plant, soil, water and nutrient management, while reducing the use of external inputs. It is a cost-effective and climate-smart system.

In more than 60 countries, SRI has been proven to enhance the environmental and social sustainability of rice farming, while caring for soil health, generating greater resistance to extreme weather events such as strong winds and droughts, and reducing the use of agrochemicals. This translates into higher yields that improve the income of small-scale farmers.

Forestry Research Council (CONIAF), the National Rice Growers' Federation of Colombia (Fedearroz) and IICA, with financial support from the Regional Agricultural Technology Fund (FONTAGRO).



Under the SRI system, farmers irrigate intermittently and without flooding until plants begin their flowering and continuous grain filling, with a thin layer of water of 1 to 2 cm. On the contrary, the conventional system provides for continuous flooding throughout the entire crop cycle (with a layer of 10 centimeters of water in most cases).

Although the crop's water footprint (which measures the amount of water used to obtain the final product) varies between countries and regions, SRI has allowed for significantly decreasing it in all cases.

"In the Dominican Republic, a group of small-scale producers who joined forces and planted around 60 hectares achieved yields ranging from 10 to 12 tons, compared to the 4 or 5 tons obtained through the conventional method", explains Juan Arthur, Food Security and Agricultural Specialist at the IICA Delegation in that country.

In the Dominican Republic, the project was carried out by a group of partners comprised of the Dominican Agricultural and Forestry Research Institute (IDIAF), the National Agricultural and





Unlike conventional farming practices, which involve the extensive use of synthetic fertilizers, SRI fosters a greater use of organic fertilizers and microorganisms. This innovative method also provides for the use of mechanical weeding and integrated pest and disease management, while the conventional system is highly dependent on agrochemicals and flooding of the land to control weeds, insects and diseases.

"SRI is a concrete and sustainable solution for rice producers, which allows for intensive cultivation of the crop, using intermittent irrigation (alternating wet and dry soil conditions during the vegetative phase of the crop), thereby reducing water use by up to 50%", explains researcher Karla Cordero, who

leads the Program for the Genetic Improvement of Rice of the Chilean Agricultural Research Institute (INIA), a state entity dedicated to development and innovation that forms part of the Ministry of Agriculture of that South American country.





Producing more from less

Latin America and the Caribbean is one of the regions that is most vulnerable to climate change, with its agriculture sector facing significant impacts. Greater climate variability affects water availability and, in turn, rice production.

Thus, it became necessary to implement the SRI methodology to facilitate intensified rice production, with less water use and without the need for improved or new varieties. It also reduces producers' traditional dependence on synthetic fertilizers and the excessive use of agrochemicals to protect their crops, ultimately resulting in a higher crop yield.

Between 2014 and 2015, pilot projects were implemented in different countries to observe the behavior of this methodology and its yields. The results were very promising. Consumption of water and inputs decreased by more than 50% and the required number of seedlings per hectare decreased from 120 kilos to 8 -10 kilos, in the case of manual transplanting, and to 24 kilos/ ha when using mechanical transplanters. However, mechanized transplanting was introduced with a view to incorporating medium and large-scale producers into the process in countries like Costa Rica where manpower is expensive, explains SRI specialist Didier Moreira.

This technique enabled producers in the above-mentioned countries to decrease production costs per harvest by 30% to 40%, adds the specialist.

The system is based on four basic principles that interact with each other:



- Fostering early, quick and healthy plant establishment, (when the plant reaches the two-leaf stage).
- Minimizing root competition (low plant density in a square pattern)
- Maintaining healthy, aerated soils enriched with organic matter, and fostering the development of beneficial microorganisms
- Improving water management by alternating wetting and drying of soils, through reduced and controlled irrigation



República Dominicana



Adapting to change

Implementation of the SRI system in Latin American and Caribbean countries was a gradual process. IICA began by disseminating information, providing training and setting up demonstration plots, given that most of the region's rice farmers were planting under the conventional system. Farmers participating in the trials found the system to be efficient, economic, sustainable and profitable.

Some farmers have adapted quickly. This was the experience of farmers in Nicoya, Costa Rica, who cultivated a 250-hectare plot and reduced the density of the crop. They went from planting 3 and 4 quintals (one quintal= 100 kg) of rice seedlings per hectare (conventional system) to 1 and 2 quintals of seedlings, producing savings of up to US\$ 100/ha, given that the cost for a quintal of seedlings was US\$ 50. Yields were very acceptable despite the fact that no evaluations of this type had been carried out in any other country, explains Moreira.



The specialist adds that Colombia, Chile, the Dominican Republic and Venezuela are working with mechanized transplanting. In some cases, they have established certified genetic seed companies to support other farmers. "The current situation has forced producers to use bio-inputs and organic matter; save water and seeds; and use rainwater to irrigate. This has lowered the chemical load and decreased the carbon footprint".

The SRI system has demonstrated that there are more sustainable ways to grow rice. On the other hand, the global chemical fertilizer crisis triggered by the war in Eastern Europe in 2022, in addition to the ongoing environmental crisis involving climate change, a water deficit and the need to use less land for farming, make SRI an efficient and sustainable alternative.

SRI has also demonstrated the tremendous potential of the rice genome. Learning how to "produce more with less" will be crucial to achieve a sustainable agriculture sector in the 21st century.



Nicaragua



Benefits of the System of Rice Intensification (SRI) that is being implemented in Latin American and Caribbean countries

- Greater productivity
- Reduced use of inputs (water, seeds, agrochemicals)
- Greater resilience to droughts
- Lower greenhouse gas (GHG) emissions
- Greater profitability
- Higher yields with the land, manpower and resources available
- Increased profitability and competitiveness
- Lower dependence on agrochemicals
- Lower manpower costs



Comparison of the System of Rice Intensification (SRI) and conventional production

SRI PRACTICES	CONVENTIONAL PRACTICES
Transplant young seedlings, preferably 8 to 12 days after the second leaf grows on the plant.	Directly plant or transplant seedlings within a period of 21 to 40 days.
Space out seedlings in a square pattern of at least 25 x 25 cm and up to 50 cm.	Plant seedlings very close to one another, randomly spaced out.
Plant only one seedling per hill.	Plant multiple seedlings per hill.
Intermittent irrigation and no flooding until the flowering and grain-filling stage, applying a film of water at a depth of between 1 to 2cm.	Continuous flooding during the entire crop cycle (water at a depth of 10cm or more in most cases).
Make greater use of organic fertilizers and microorganisms. Apply chemical fertilizers only when necessary.	Use synthetic fertilizers extensively.
Use mechanical weeders and integrated pest and disease management.	Depend heavily on agrochemicals and flooding to control weeds, insects and diseases.



"We went from using between 100 and 120 kilos of rice seeds per hectare to 24 kilos, and reduced water use by up to 30%. Now we have more vigorous, clean and healthy plants free of diseases or bacteria, with thicker stalks, more developed sprigs and more grains".

Israel Araya, Costa Rican farmer.





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Agrosilvopastoral systems

Sustainable Agriculture Milestones in the Americas

Relevant experiences in the region to address climate change and care for the environment and natural resources



Agrosilvopastoral systems in the Americas combine natural resource conservation, climate change mitigation and production intensification

The continuous and simultaneous integration of trees, crops and livestock production on the same site, which fosters biological diversity and facilitates the rehabilitation of degraded areas, is an increasingly common practice among small- and medium-scale producers in the woodlands of the Americas, yielding significant environmental and production benefits.

Agrosilvopastoral systems are alternative models that increase production and sustainably use natural resources, by implementing an integrated management system that brings together trees, pastures and animals, as well as inputs appropriate to the characteristics, potential and needs of each specific site.

These systems also increase the potential of the land to store carbon, in comparison to conventional pastures, given the increased capacity of the tree biomass and soil to absorb carbon and greater

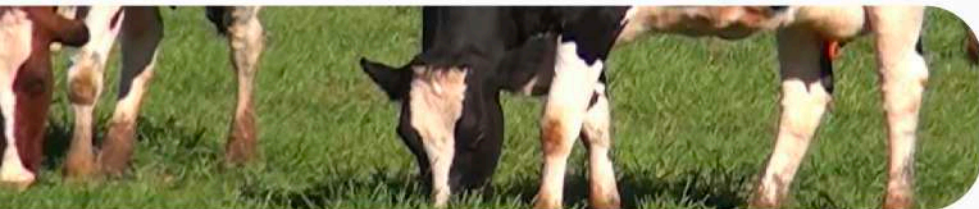
protection of the soil against erosion.

Given the fact that agrosilvopastoral systems are currently gaining importance in the region's beef cattle and sheep production chains and in the timber industry, the sectors must promote the sharing of positive experiences and best practices, as well as the generation of knowledge, through research.

In the Americas, in particular, agrosilvopastoral systems play a vital role in soil carbon sequestration, which mitigates the effects of climate change. Specialists in this field have acknowledged this fact, but also recognize that information on the true magnitude and more so the potential of this impact is still inadequate.

There are many countries in the hemisphere where this model has yielded successful results that should be disseminated.





Agrosilvopastoral systems



Relevant cases in Latin America and the Caribbean (LAC)

Brazil has introduced different combinations of the model, demonstrating the potential for forestry, livestock and agricultural development.

Celso Moretti, President of the Brazilian Agricultural Research Corporation (EMBRAPA), explained that, "Regions where natural resource conservation is under growing pressure from agriculture should implement effective land-use practices. These approaches usually provide an alternative to the ecological, economic and social problems experienced by a large sector of the country".

"Agrifood systems have been incorporated into food production practices in Brazil, with promising results. Notable examples of the research that has fueled this expansion are studies related to nitrogen fixation in soybean and the development of technologies for agricultural production in the natural habitat of El Cerrado, which is something that was considered impossible some 50 years ago", said Moretti.

In Brazil's Amazon region, where deforestation is exerting tremendous pressure, agrosilvopastoral systems are excellent land use alternatives that are economically and environmentally sustainable.

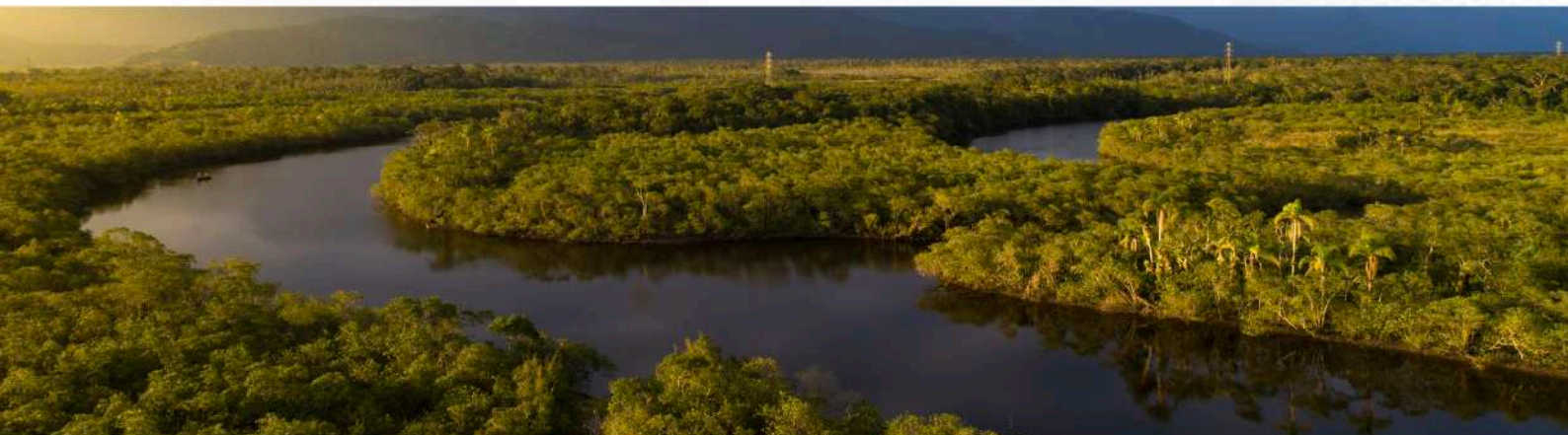
In Argentina, agrosilvopastoral systems have been able to offset the environmental impact of

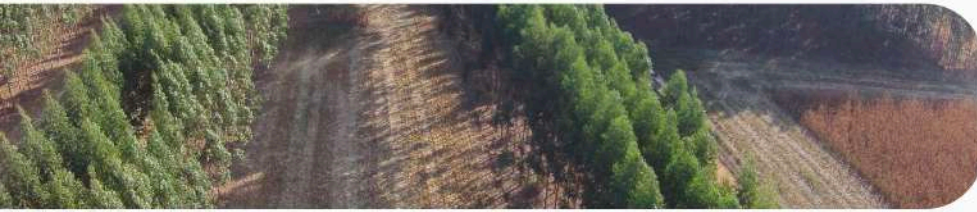
expanding livestock production on land originally covered by native forests, a fact that has been verified in recent decades, particularly in the Gran Chaco, the immense, forest-covered plain that also extends to Paraguay and Bolivia. Moreover, these systems offer a suitable alternative for the environment in provinces, such as Misiones, in the country's northeast region, where forestry plantations of exotic species have developed significantly.

The expansion of the agricultural frontier and the consequent encroachment of livestock production into forests inspired the creation of the Integrated Forest Management with Livestock (MBGI in Spanish) program by the National Agricultural Technology Institute (INTA), an Argentinian government institution of international renown.

In 80% of the country's forests, an environmental conservation law prohibits the clearing of trees and subsequent establishment of pastures. As such, the MBGI program is aiming to enhance production capacity, while also preserving native forests and biodiversity, through the adoption of technologies that have a low environmental impact.

The Inter-American Institute for Cooperation on Agriculture (IICA), with funding from the European Union, is undertaking the Adapted Agroforestry





Systems for the Central American Dry Corridor (AGRO-INNOVA) project, which is contributing to increasing climate resilience and food security in the extremely vulnerable households of small farmers.

In the district of El Paraíso, Honduras, there are efforts to promote the adoption of agricultural best practices in the production of basic grains and coffee, as well as small-scale livestock farming, to assist in climate change mitigation and adaptation.

Costa Rica is encouraging the implementation of agricultural and digital technologies associated with forestry best practices.

The project, which is taking place with technical assistance from the Tropical Agricultural Research and Higher Education Center (CATIE), is working with more than 3,000 small farmers in Central America – one of the regions in the world that is most vulnerable to climate change.

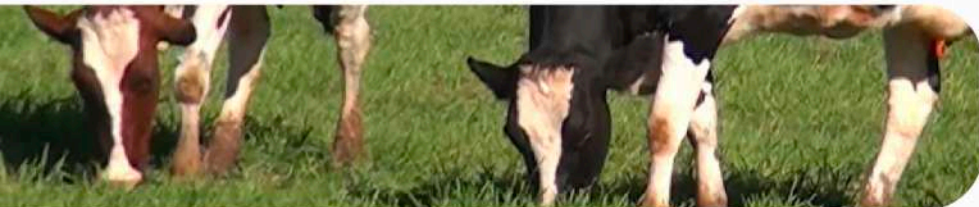
In Dominican Republic, where livestock production is extremely critical to the territorial development of the country, agrosilvopastoral systems have assisted in tackling problems such as prolonged droughts, limited surface and groundwater supplies and soil degradation.

These systems have also made great strides in Mexico. In 2017, CATIE and IICA launched the project Biodiversity and Sustainable Agrosilvopastoral Livestock Landscapes (BIOPASOS) in the states of Chiapas, Campeche and Jalisco, which was implemented in collaboration with the Secretariat of Agriculture and Rural Development (SADER) and the Mexican Commission for the Knowledge and Use of Biodiversity.

The initiative worked with 1,200 small- and medium-scale livestock farmers who adopted practices to reconcile production activity and ecosystem conservation. The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of Germany and the International Climate Initiative funded the project.

Paraguay, Uruguay, Colombia and Chile are other LAC countries where agrosilvopastoral systems have been increasingly incorporated into the agricultural reality





Agrosilvopastoral systems



Integration of production and conservation

Agrosilvopastoral systems are not new. They have been employed since ancient times with various types of plantations intercropping annual and perennial crops, or fruit crops and timber trees.

They can be implemented by small-, medium- or large-scale producers. The integration of production systems is a way to produce more without the need to incorporate new areas in the process, a characteristic known as the "land saving effect".

These systems provide multiple and varied results: improved quality of forage grasses in systems that include trees, greater drought tolerance of crops, increased fertilizer efficiency, increased output of grass-fed cattle, an improvement in soil quality indicators and a reduction in pests and diseases, among others.

Celso Moretti, President of EMBRAPA, maintained that, "The risks result from a lack of planning for implementation, the failure to conduct feasibility and marketing studies, limited qualified labor and climate adversities. The extent to which careful and systematized planning is done prior to implementation will determine the success or failure of the activity".

The planning process must include an assessment of soil and climate conditions, agricultural and forestry species, the species and category of animals, the management capacity (which is directly linked to the production objectives), marketing, transportation logistics for inputs and products, and the qualified labor force in the region.

The models are dynamic and complex, due to the interaction between cultures, animals and diverse practices. This creates the need for continuous research that is usually undertaken with long-term and region-specific experiments, which are necessary to ensure sustainability.



Benefits to farmers

These systems offer many benefits to farmers, which include the following:

- They enable greater diversification of the farm's production activities, thereby reducing the risk of an overall decline in income. Food of animal origin (milk and meat) can be produced in forests, without sacrificing the land area devoted to crops. Other benefits may be derived from producing firewood, wooden posts, timber and fodder.
- Livestock farming enables the use and control of pastures and weeds that can compete with the development of young trees. Moreover, the clearing of pastures by grazing cattle facilitates the production of fruit trees and palms.
- The grazing of cover vegetation reduces the risk of fires.
- When livestock farming is integrated with crops, between 60% and 70% of the plant biomass may be used to feed the livestock, without competing with crops for human consumption.



Requirements for the implementation of agrosilvopastoral systems

Prior to implementing these systems, each region or country must assess soil and climate conditions. In the case of Brazil, a large part of its land area is located in the tropical zone, where the distribution of rain is generally good. This means that

crops can be harvested two or three times per year and conditions are favorable for the implementation of more intensive production systems.

Given the above, Celso Moretti is of the view that the potential for use of these systems is promising in countries that do not experience severe winters and that have a mildly irregular landscape and soils that exhibit good physical and chemical characteristics.

Other factors to be considered include the availability of favorable soil; production infrastructure and storage; appropriate financing or access to credit; competence in the use of the technology used to produce the grains, cattle and timber; and access to technical assistance.

Moretti also referred to the need to strengthen lines of research, technology transfer and promotion to increase the contribution of knowledge and information to the adoption of agrosilvopastoral systems.

Agricultural research should be conducted in an integrated manner and introduced into production systems in a way that ensures an efficient transfer of the resulting technology in the shortest time possible.

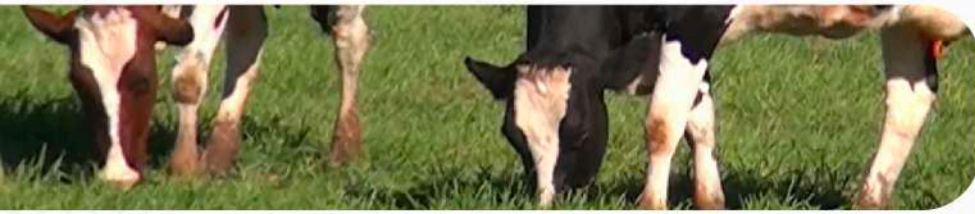
The EMBRAPA President also remarked that greater expansion of these systems will require alternative studies on crops and forestry species, focusing on the technical interrelationships, economic results and respective uses (production of food, grains, fiber, energy and timber and non-timber forestry products).

He felt that experiences over the last 30 years have demonstrated the need to develop new technical assistance and rural extension models.

Brazil appears to be blazing a trail in this area. The adoption of agrosilvopastoral systems has increased in that country, to the extent that the land area managed under these systems grew from approximately 11,500,000 ha in 2016 to 17,400,000 ha in 2021.

This growth was spurred by various research, development, innovation and public policy actions. Currently, 29% of livestock farmers and 17% of grain producers have adopted some kind of system. Of this group of primarily livestock producers, approximately 83% have adopted an agricultural integration system (crops-livestock); 9% have adopted an integrated crop-livestock-forestry system; 7% have introduced livestock-forestry integration and 1% are integrating crops and forests.

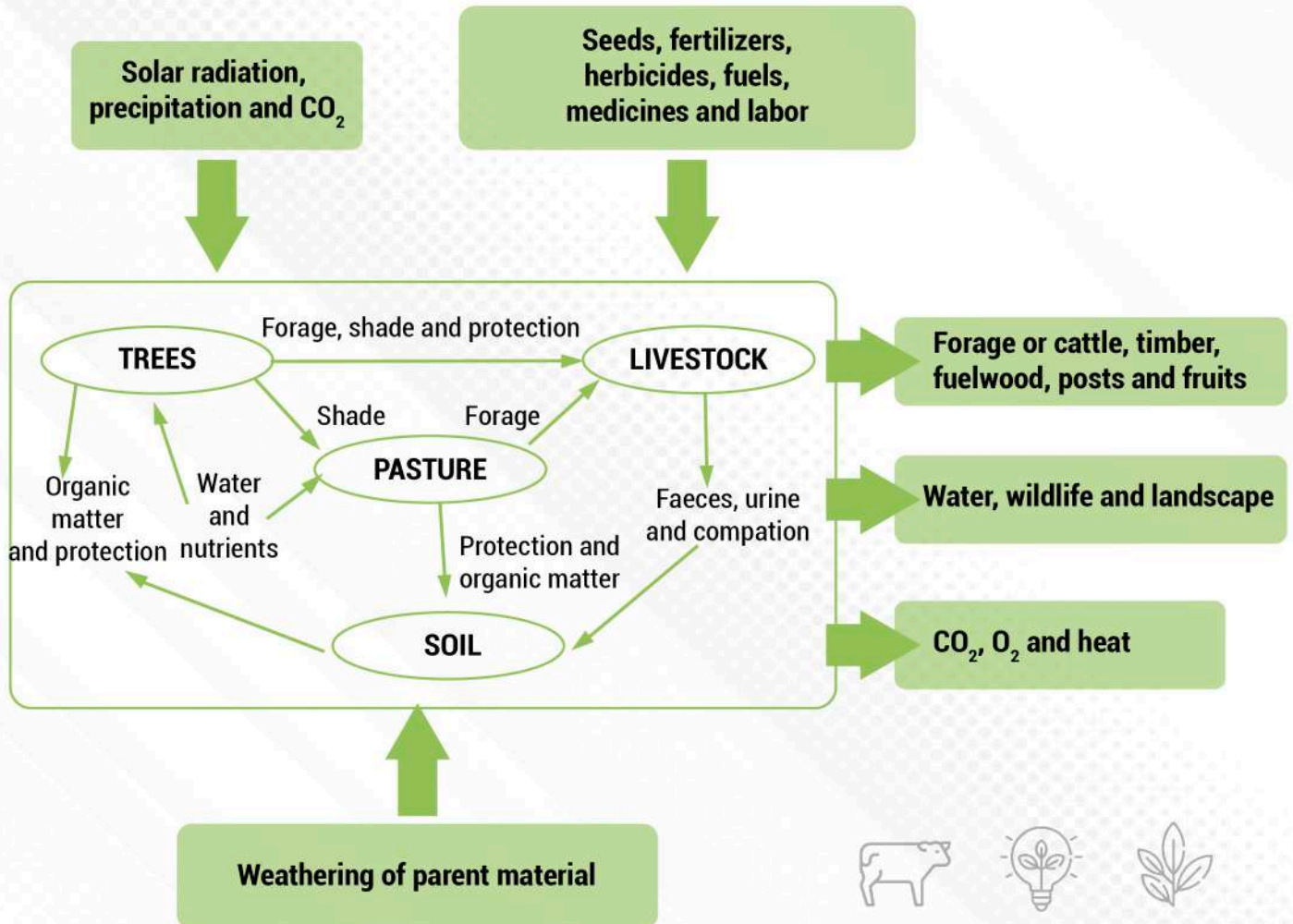




Agrosilvopastoral systems

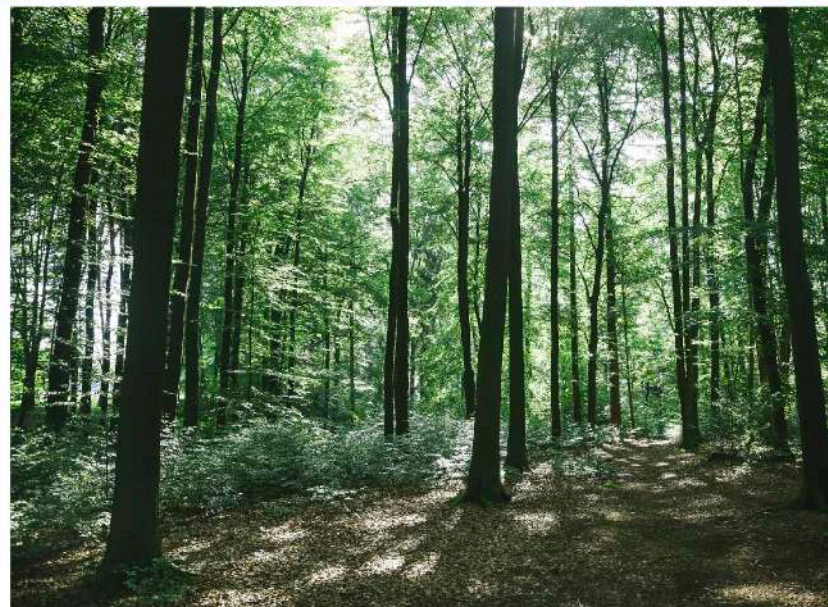


Interaction between components of the agrosilvopastoral system



Source: Adapted from Bronstein. Available at <http://usi.earth.ac.cr/glas/sp/90010027.pdf>, p. 2.

Agrosilvopastoral systems are already enabling thousands of small and medium-sized farms in Latin America to engage in more sustainable activity. However, in order to expand their growth, efforts must be undertaken in different spheres: research on traditional knowledge, improvement in farmers' perception of how agrosilvopastoral systems can facilitate their activities; and the development of the most suitable regulations and governmental policies.



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