



CONSEJO NACIONAL
DE RECTORES



CeNAT

Centro Nacional de Alta Tecnología

20



INSTITUTIONAL
REPORT

CENTRO NACIONAL DE ALTA TECNOLOGÍA

21

Transforming knowledge
into development



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Centro Nacional de Alta Tecnología

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Acronyms

CONARE	National Council of University Deans
CeNAT	Centro Nacional de Alta Tecnología
PRIAS	PRIAS Laboratory
LANOTEC	National Nanotechnology Laboratory
CNCA	National Advanced Computing Collaboratory
CENIBiot	CENIBiot Laboratory
CREATEC	Program for Creativity and Entrepreneurship in High Technology
TEC	Costa Rica Institute of Technology
UCR	University of Costa Rica
UNA	National University
UNED	Distance State University
UTN	National Technical University
Education-Roam	Education Roaming
LACOMET	Costa Rican Metrology Laboratory
AID	Agency for International Development
BCCR	Central Bank of Costa Rica
CCSS	Costa Rica Social Security Fund
CONICIT	National Council for Scientific and Technological Research
ICE	Costa Rican Institute of Electricity
INA	National Institute for Learning (INA)
INEC	National Institute of Statistics and Census
MAG	Ministry of Agriculture and Livestock
MICITT	Ministry of Science, Technology, and Telecommunications
MINAE	Ministry of Environment and Energy
RREE	Ministry of Foreign Affairs and Culture
FEES	Special Fund for Higher Education
SAF	Agroforestry Systems
PILA	La Amistad International Park
Udelar	University of the Republic of Uruguay
CONICET	National Council for Scientific and Technical Research
UBA	University of Buenos Aires
CNEA	National Atomic Energy Commission
Univalle	Universidad del Valle, Colombia
UNI	National University of Engineering, Peru
CNRS	Centre National de la Recherche Scientifique, France
UGA	University of Grenoble Alpes, France
TGA	Thermogravimetry
FTIR	Fourier Transform Infrared
SEM	Scanning Electron Microscopy
TEM	Transmission Electron Microscopy
CANAPEP	National Chamber of Pineapple Producers and Exporters
IJSO	International Junior Science Olympiad
COLAEIQ	Latin American Congress of Students of Chemical Engineering and Related Majors
ACOMET	ACOMET Metals and Minerals S.L.
INS	National Insurance Institute
AFM	Atomic Force Microscopy
QUIMICAM	Chemistry Camp

ECMAR	National Marine-Coastal Science Station
ICHO	International Chemistry Olympiad
NAVAL	NAVAL United States Geological Survey
INALVE	Inalve Food Industries
FIFCO	Florida Ice and Farm Company
ULEAD	LEAD University
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
USGS	United States Geological Survey
ESA	European Space Agency
DLR	German Space Agency
ILSI Mesoamérica	ILSI Mesoamerica Association
STEAM	Science, Technology, Engineering, Art, and Mathematics
ALLBIOTECH	Latin American Network of Young Leaders in Biotechnology
DOS PINOS	Cooperativa de Productores de Leche Dos Pinos R.L.
PINN	Innovation and Human Capital Program for Competitiveness
CITA	National Center for Food Science and Technology
INTA	National Institute of Innovation and Transfer in Agricultural Technology
AECID	Spanish Agency for International Development Cooperation
TUHH	Hamburg University of Technology, Germany
CORBANA	National Banana Corporation
BIOTECH	Biotechnology
SEVRI	Specific Institutional Risk Assessment System
PAO	Annual Operational Plan
CIPRONA	Natural Products Research Center
FIDA	International Fund for Agricultural Development
COOPETARRAZU	Cooperativa de Caficultores y Servicios Múltiples de Tarrazú R.L.
PRISLAB	Pattern Recognition and Intelligent Systems Laboratory
TIC	Information and Communications Technology
SUTEL	Superintendency of Telecommunications of Costa Rica
Zii	Wireless Internet Zones
MOCUPP	Change in Use of Productive Landscape Monitoring
GIZ	German Corporation for International Cooperation
CNFL	National Power and Light Company
SIMOCUTE	National Monitoring System for Land Cover and Use and Ecosystems
SFE	State Phytosanitary Service
IGN	National Geographic Institute

PEN	State of the Nation Program
IMN	National Meteorological Institute
FONAFIFO	National Forest Financing Fund
OCDE	Organization for Cooperation and Development
GPSDD	Global Partnership for Sustainable Development Data
BM	World Bank
SICA	Central American Integration System
GEF	Global Environment Fund
USAIG	United States Aircraft Insurance Group
SERVIR	National Civil Service Authority
FAO	Food and Agriculture Organization of the United Nations
CEPAL	Economic Commission for Latin America and the Caribbean
PIACT	Interactive Platform for Tropical Climate Application
LAICA	Cane Chamber
CAPROSA	Guild of Health Professionals
CASAGRI	Farmers House
OAS	Organization of American States
ANAGAN	National Association of Cattle Breeders
MEP	Ministry of Public Education
UNESCO	United Nations Educational, Scientific and Cultural Organization





Eduardo Sibaja Arias

Director

Centro Nacional de Alta Tecnología

The year 2021 has continued to be marked by the COVID-19 pandemic. This situation has led to making decisions and taking measures that ensure the safety of the personnel and the fulfillment of the institutional objectives, including establishing capacity limits in the laboratories, development of teleworking activities, implementation of preventive health measures, the definition of protocols, and use of technology tools for the execution of the work, among other actions.

The year 2021 was a very productive year for the Centro Nacional de Alta Tecnología (CeNAT) in terms of publications, research, and knowledge

transfer, among others, thus contributing to national development under its slogan: "Transforming knowledge into development."

Science and technology are a fundamental pillar for cultural, social, economic, and environmental development, and for life in modern society, which is why the Centro Nacional de Alta Tecnología in its twenty-three years of existence has contributed to strengthening this pillar through projects, knowledge, experience, and multidisciplinary teams of young talent in the scientific and technological fields.

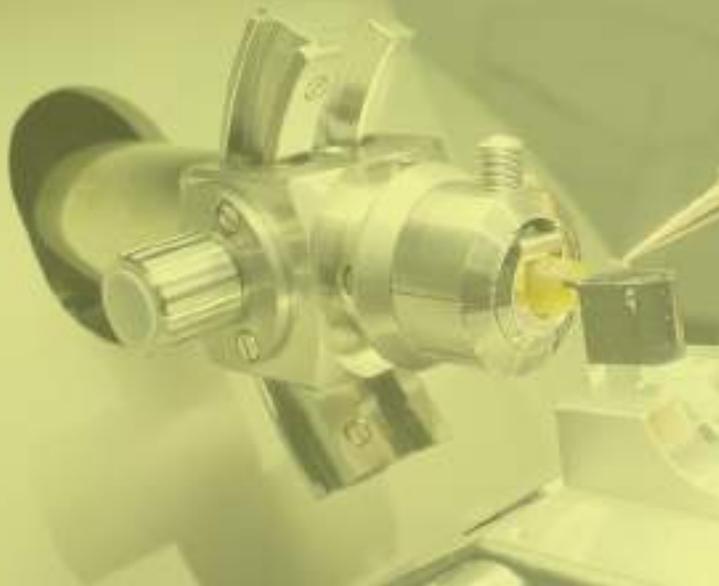
To this end, the academic support of public universities is key to CeNAT, as it is one of the strategic programs of the Consejo Nacional de Rectores, which seeks to promote scientific and technological development as drivers of change and progress. This is pursued by linking the academic, government, and private sectors, fostering collaboration spaces to generate and facilitate knowledge transfer through the development of socio-productive projects and training programs.

Within the framework of institutional accountability and transparency, we present the 2021 Annual Report as a compendium of the entity's multidisciplinary management, which includes the work of the areas, laboratories, and programs of CeNAT, with the administrative management support of the Centro de Alta Tecnología Foundation (FunCeNAT).

This Report synthesizes the data, information, and results of the actions carried out in materials science and engineering, biotechnology, advanced computing, environmental management, and culture and society.

During these two years of the pandemic, it is essential to highlight the work of the personnel who maintained their commitment to quality and compliance with the different processes, while generating knowledge about science and technology at the service of the country.

The achieved goals drive us to set challenging objectives that continue to support the national development path by strengthening the population's well-being and its economic, social, and environmental sustainability.





Background of CeNAT

During the Figueres-Olsen national presidency, the initiative for the creation of a National High Technology Center in Costa Rica was raised, with the support of state universities to attract investment in high technology; this is due to the role that the academy plays, as the main generator of research in Costa Rica.

In October 1997, the Government of the Republic presented to the Consejo Nacional de Rectores (CONARE) an initiative to use the formerly used building by the U.S. Agency for International Development (AID) for the establishment of a national center in high technology, through which the academia would be linked with the Government and the productive sector, in areas of high impact related to the attraction of foreign investment, for the benefit of national development.

The proposal used countries such as Korea, Singapore, and Israel -the latter with the Technion or Israeli Technological Institute, located in Haifa- as reference.

On May 25, 1998, the Legislative Assembly enacted Law 7806, authorizing the transfer of the building to CONARE to create the Centro Nacional de Alta Tecnología and call it after Dr. Franklin Chang Díaz.

Furthermore, article 3 of this law provided for the creation of the Centro, de Alta Tecnología Foundation (FunCeNAT), whose purpose is to fulfill the legal duty of managing the resources required for the execution of the projects developed through CeNAT.

Subsequently, the Consejo Nacional de Rectores, under the Coordination Agreement of State Higher Education, in session number 5-99, on March 2, 1999, created the Centro Nacional de Alta Tecnología (CeNAT).



At the time, CONARE was made up of Dr. Gabriel Macaya Trejos, Chancellor at the University of Costa Rica, Alejandro Cruz Molina, Eng., Chancellor at the Costa Rica Institute of Technology, Dr. Jorge Mora Alfaro, Chancellor at the National University, and, Dr. Celedonio Ramírez Ramírez, Chancellor at the State University for Distance Education, who supported the proposal to create a center for scientific and technological development, which would enhance the research efforts of the universities. The first administrative board of FunCeNAT was formed by them and by Marielos Aldí Villalobos, as representative of the Municipality of San José.

In this succession of events, CeNAT is formed as an inter-university encountering instance for the academy, the

Government, and the productive sectors of the country, in different high technology fields, thus joining forces to enhance the potential of the country and to take advantage of the opportunities that technological development offers to countries that, like Costa Rica, have invested significantly in the education of their population at all levels.

Following the years after its inception, the Center has consolidated a work platform based on the high technical-professional capacity of the personnel in its areas and laboratories, and its equipment and facilities, thus allowing it to promote various research and knowledge transfer projects, focused on the vision to transform knowledge into development.



Strategic Planning

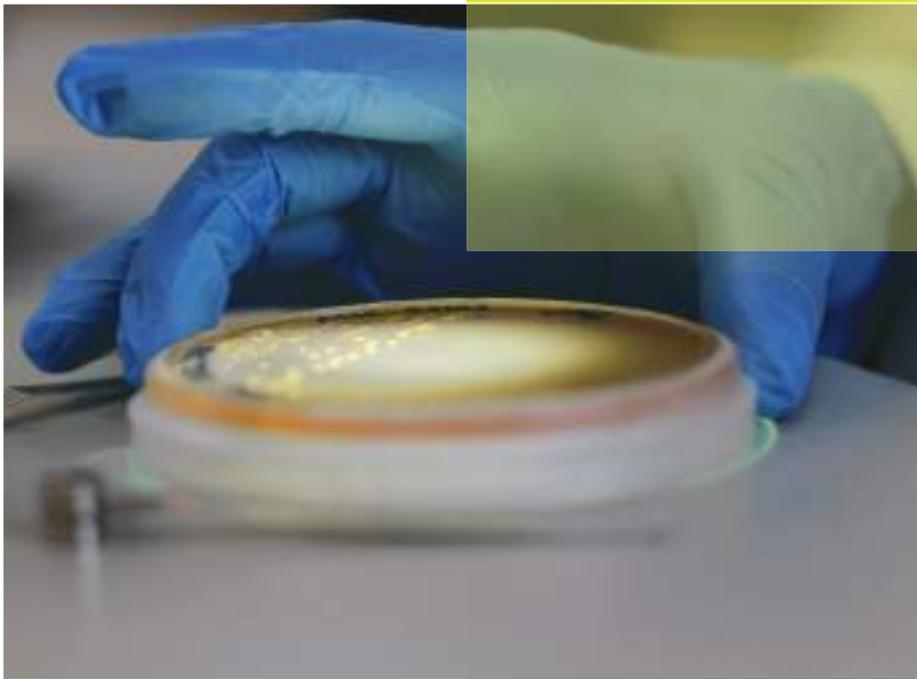
One of CeNAT's essential characteristics is its capacity for continuous improvement and reinvention in the new contexts and challenges that society has faced throughout its 23 years of existence. The year 2021 continued to be hard to face due to the multiple economic and social problems caused by the COVID-19 pandemic.

Facing this scenario, the different operational units of CeNAT and FunCeNAT carried out a process of re-formulation and definition of new operational actions, taking advantage of the capacity and ability of their personnel for innovation, in addition to the strength of the physical, instrumental, computational, and telematic infrastructure with which it counts.

New lines of virtual and face-to-face work were adopted, while ensuring the safety and efficiency of both its collaborators and their research work. Fieldwork processes were generated, which were defined as virtual tours. Training sessions, talks, workshops, and virtual seminars were developed, as well as webinars, television, and radio information capsules, based on different platforms of great scope and impact, oriented to the different levels of society and productive sectors.

All this has ensured not only the operational continuity of the Center, but also has promoted new lines and modern and innovative tactics for the development of institutional strategic objectives, while supporting social development, which is most necessary given the current situation.

In addition, in 2021, CeNAT had the philosophical framework of its Strategic Plan and the Strategic Plans of its high-tech laboratories, with a mission, vision, and development objective that guide the course of the 2019-2023 five-year period that is halfway already, which are aligned with the National Plan for Higher Education (PLANES).



Mission of **CeNAT**

"We are an inter-university coordination body that facilitates and promotes the proper functioning and systemic development of scientific research in higher education, in various areas of high scientific-technological content, oriented to research, linkage, environmental development, and extension, within an innovation framework with the government, civil society, and the private sector" (as inspired by the constitutive deed of CeNAT).



Vision of **CeNAT**

"To be a leading innovative center that generates high-technology knowledge, products and services for the promotion of high-impact scientific-technological collaboration, promoting learning spaces, strengthening competitive development, and knowledge exchange at the highest level, while enhancing the mechanisms that support inter-university and institutional coordination of excellence both at national and international levels."

In addition to its mission and vision statements, CeNAT incorporates the development goal into its philosophical framework as a contribution by the Center to the country's development.

Development Goal

To conduct research activities that provide the country with science, technology, innovation, and strategic entrepreneurship for competitiveness and economic, social, and environmental development (based on the constitutive deed of CeNAT).



Objectives of **CeNAT**

The objectives come from the constitutive act of CeNAT, which guides the institution's work, its contribution, and the areas that it should manage to address the impact of the scientific exercise.



Main Objective

To conduct training and research activities that would provide the country with the necessary, relevant, and strategic technology for the competitive development of the different sectors of society in the economic, social, and environmental areas.



Specific Objectives

The specific objectives describe the major categories that come from the constitutive act towards their orientation to collaborate to the country's scientific development.



Regarding Science
Promotion

To promote the development of research activities to provide the country with the necessary, relevant, and strategic technology, for the competitive development of the different sectors of society in the economic, social, and environmental areas.

To carry out anything that represents social, cultural, and scientific well-being according to Article 1 of the Law on Foundations.

Regarding
Information and
Training

To promote the creation and to provide contributions to support thinking spaces, as well as to coordinate actions that support scientific and technological development and conformation of multidisciplinary teams of researchers with a high level of training and experience (high level of critical mass), especially at the graduate level.

To promote technology extension, through exhibitions, conferences, seminars, technology markets, and training courses, among others.

Regarding Contribution
to Postgraduate
Specializations

To promote and support the implementation of academic research programs at the graduate level in coordination with state higher education university institutions.

Regarding
Inter-Sectoral
Articulation

To promote the coordination of public and private sectors involved in the generation, training, transfer, and application of high technology.

To encourage and promote the generation of businesses with high technological content and high added value for the country.

Regarding
Contribution to the
Country's
Development

To conduct -with research purposes- activities for development, licensing, utilization of resources (know-how), donation or purchase of patents, inventions, industrial or utility models.

To publicize and sell publications arising from research; to assign, sell, transfer and grant licenses for the use of its patents, industrial or utility models, and any other assets that belong to its intellectual property.



Values and Principles Enforced at CeNAT

Our values, which comprise those indicated by CONARE in addition to the values and principles that are enforced at CeNAT, are presented below.

Institutional Values of CONARE

- Teamwork
- Discipline
- Respect
- Communication
- Responsibility
- Tolerance
- Honesty and Loyalty
- Commitment



Values Enforced at **CeNAT**



Willingness to
excellence in the
work that is
undertaken



Transparency in
the exercise of
research



Ongoing learning
attitude



Tolerance and
flexibility in the
processes that
are developed



Critical and
self-critical
position to
address
improvements in
all research
processes



Continuous
personal
improvement
attitude at the
scientific level



Principles Enforced at **CeNAT**



- Collaborative and integrated work in all processes
- Scientific rigor in the studies undertaken
- Work conducted within interdisciplinary complexity
- Effective communication
- Accountability in goals and times set for each task
- Commitment to impact generation on the actions undertaken

CeNAT Strategic Lines

The strategic lines are present in the work of CeNAT. They are defined as cross-sectional lines of the substantive activities carried out by the laboratories and the Environmental Management Area.

These strategic lines highlight the importance of the collegiate work of each dependency that makes up the organization, where each action contributes to efficiency and projection.

The strategic lines and their definitions are identified below.

Knowledge Generation:

It provides the country with knowledge on relevant and strategic high technology, for the competitive development of the different sectors of society in the economic, social, and environmental scopes.

Learning Transfer:

It supports learning spaces from inter-university coordination to articulate actions supporting scientific and technological development and forming multidisciplinary groups of researchers with high scientific rigor.

Internationalization:

It strengthens knowledge exchange at the highest national and international levels, in both the public and private sectors.

Institutional Management:

It strengthens organizational management through mechanisms that support the sustainability of CeNAT by promoting efficient and transparent accountability and the development of scientific relevance.





OUR
AREAS, LABORATORIES,
AND
PROGRAMS

OUR AREAS,
LABORATORIES,
AND PROGRAMS

Areas and Divisions of CeNAT



Areas

Materials Science and Engineering
Biotechnology
Advanced Computing
Manufacture
Environmental Management
Science, Culture and Society



Laboratories

National Nanotechnology Laboratory (LANOTEC)
CENIBIOT Laboratory
National Collaboratory of Advanced Computing (CNCA)
PRIAS Laboratory



Programs

Climate Observatory
Agromatics
CREATEC
CeNAT - CONARE Scholarships
CeNAT Teaching

CREATION of **DIVISIONS**

Following agreement 5-99 of the Consejo Nacional de Rectores, CeNAT is comprised of the following areas:

- I. **New Materials Area:**
It was constituted in 2004 by the National Nanotechnology Laboratory (LANOTEC).
- II. **Biotechnology Area:**
Since 2013, the CENIBiot Laboratory has integrated this operational area.
- III. **Advanced Computing Area:**
The National Advanced Computing Collaboratory (CNCA) is part of it since 2009.
- IV. **Manufacturing Area:**
There is no operating unit attached to it.
- V. **Science, Culture, and Society Area:**
This is a cross-sectional area that is managed directly by the Directorate of CeNAT. It encompasses the CeNAT Teaching, CREATEC, and CeNAT-CONARE Scholarship programs.

VI. **Environmental Management Area (AGA):**

This area includes one laboratory and two programs:

PRIAS Laboratory: It started in 2003.

Programs:

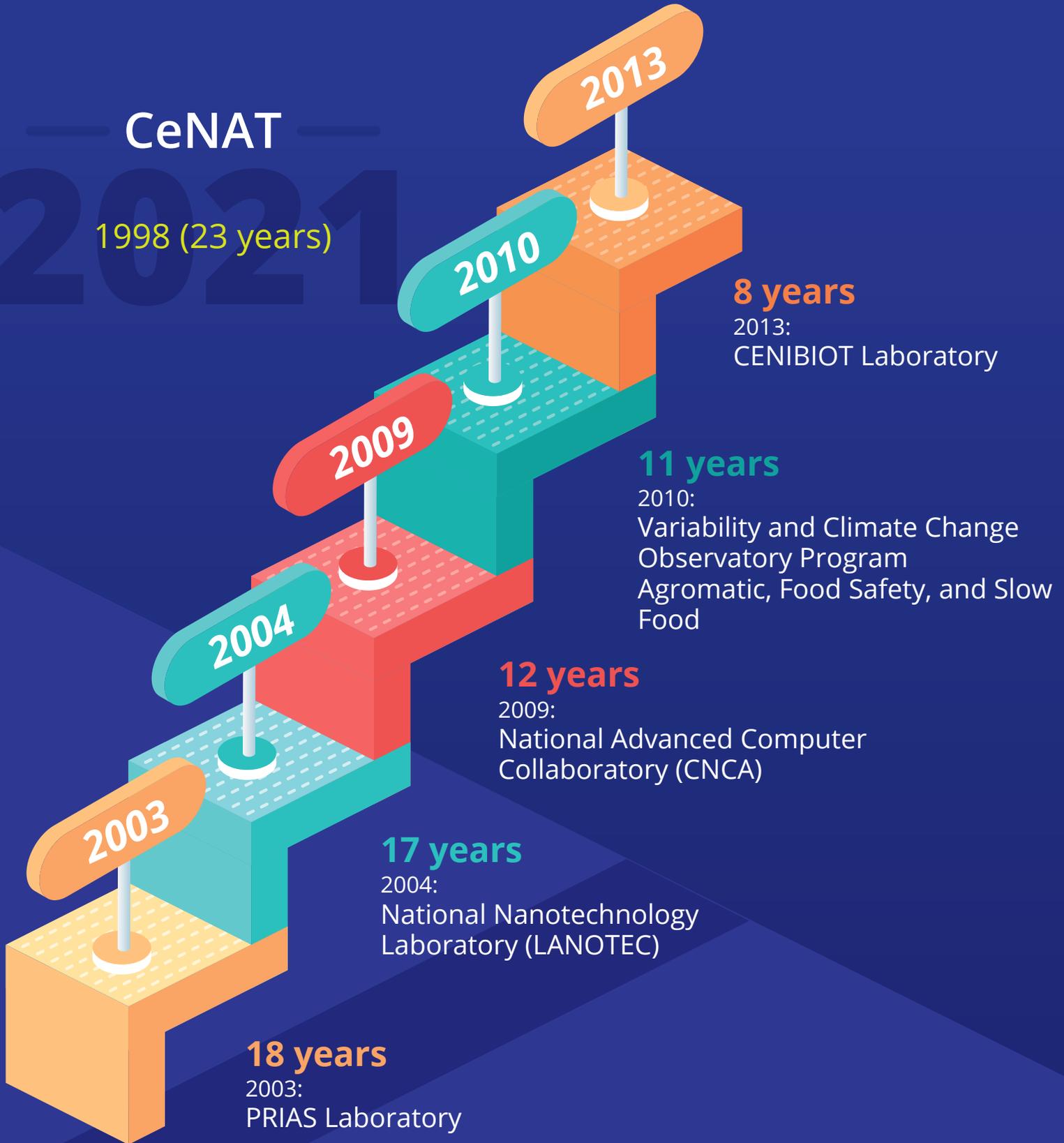
Variability and Climate Change Observatory It started in the year 2010.

Agromatics, Food Safety, and Slow Food It started in 2010.



CeNAT

1998 (23 years)



8 years
2013:
CENIBIOT Laboratory

11 years
2010:
Variability and Climate Change
Observatory Program
Agromatic, Food Safety, and Slow
Food

12 years
2009:
National Advanced Computer
Collaboratory (CNCA)

17 years
2004:
National Nanotechnology
Laboratory (LANOTEC)

18 years
2003:
PRIAS Laboratory



Consejo Nacional de Rectores

Scientific Council comprised by CONARE Vice-Chancellors for Research

Director General of CeNAT

Science and Engineering of Materials	Biotechnology	Advanced Computing	Environmental Management	Science, Culture, and Society
LANOTEC	CENIBiot	CNCA	PRIAS	Agromática Observatorio Climático
<ul style="list-style-type: none"> ● Knowledge Generation ● Knowledge transfer ● Internationalization ● Sustainability 	<ul style="list-style-type: none"> ● Knowledge Generation ● Knowledge transfer ● Internationalization ● Sustainability 	<ul style="list-style-type: none"> ● Knowledge Generation ● Knowledge transfer ● Internationalization ● Sustainability 	<ul style="list-style-type: none"> ● Knowledge Generation ● Knowledge transfer ● Internationalization ● Sustainability 	<ul style="list-style-type: none"> ● Knowledge Generation ● Knowledge transfer ● Internationalization ● Sustainability

Directorate of **CeNAT**

The global pandemic continued to strike during the year 2021. Even though public vaccination was achieved, as indicated last year, there was an institutional re-organization process regarding the form of operation, both in the operational activities and in project development. The year 2021 led to the development of that new way of working. Specifically for CeNAT, it was a very productive year in terms of publications, research, and knowledge transfers, among others, which allow it to contribute to development.

The managing actions of CeNAT's Directorate, as defined in the constitution deed of the Centro Nacional de Alta Tecnología, are:

It seeks the correct performance of CeNAT, following the guidelines dictated by CONARE and the strategic lines defined by the Scientific Council.

- Monitoring and execution of agreements and conventions of CeNAT.
- Establishment of the operational tactics and goals to be developed by the organization.
- Supervision of the Science, Culture and Society areas, which integrates the following programs: CeNAT Teaching, CREATEC, and CeNAT-CONARE Scholarship programs.
- Continuous follow-up to the actions carried out by each area and program attached to CeNAT.



From the directorate, the strategic themes of the Center are overseen, including:

CeNAT Teaching



A fundamental axis of Centro Nacional de Alta Tecnología are knowledge transfer activities. With this aim in mind, CeNAT Teaching holds lectures, workshops, and conferences aimed at different sectors of society, government, and academia, taught by global leading national and international experts, and linked to activities and/or projects of CeNAT, in scientific and technological subjects.

In 2021, CeNAT Teaching was not operational.

Relevant Talks:

In 2021, the participation in relevant talks is listed below:



1

What are the answers from science for the reuse of recovered plastics? At the Circular Economies and their Reality event. Taught by José Vega Baudrit, on April 22, 2021.

2

Nanotechnology and LANOTEC: on the way to regulation in Costa Rica. Webinar: Nanotechnology: concepts and experiences in its standardization. Organized by ILSI MESOAMERICA, INTECO, LANOTEC. Taught by: José Vega Baudrit, on April 28, 2021.

3

“Characterization of ultrathin layers and nanometric patterns by AFM”. Webinar by AFM Park Systems. Taught by Dr. Sergio Paniagua Barrantes on June 30, 2021.

4

Validation of the scientific resource. Second training day on scientific evidence of ILSI-Mesoamerica, taught by Luis Castillo Henríquez, in July, 2021.

5

“Solid-lipid nanoparticles to improve the antioxidant effect of bioactive molecules derived from Curcuma longa and Uncaria Tomentosa”, at the “17th anniversary of LANOTEC and Science month closure” event. Taught by Dr. Andrea Araya, on August 30, 2021.

6

Let's talk about microplastics, what does science tell us? Organized by ACIPLAST. Taught by Dr. José Vega Baudrit, on September 1, 2021.

7

"Nanomaterials in Medicine and 3D Applications"

for the 2021 Postgraduate Biorefinery and Circular Economy of Agri-food Chains course. Taught by Rodrigo Mora, Eng., in October 2021.

8

"New scientific research challenges: the search for scientific evidence-based on laboratory accreditation processes"

, during participation at the "New challenges of scientific research" event, organized by the CocITEc Global Network. Taught by Dr. Andrea Araya, in November 2021.



9

"Scientific evidence and myths about microplastics: analysis and innovation"

, organized by Scanco-Horiba. Panelist Dr. José Vega, on November 25, 2021.

10

Virtual Symposium: Transdisciplinary approach towards developing a test for detecting the SARS-CoV-2 virus, taught by Esteban Meneses at the Central American Network for Epidemiological Data Management (RCMDE) event.

11

Online Advanced Computing Training

, taught by Esteban Meneses at the PRACE - RedCLARA - SCALAC Workshop Online Teaching activity.

12

ASGARD-SAGA: Design of a Bioinformatics tool for identifying antibiotic resistance genes, taught by Maripaz Montero at the Ibero-American Night event for researchers.

13

Computational epidemiology, taught by Mariela Abdalah, at the Ibero-American Night event for researchers.



14

Mapping Nature for People and Planet - International presentation. International scope and impact. Within the framework of the GEO Week 2021 event. Speaker: Cornelia Miller Granados, Director of PRIAS.

15

MOCUPP Project, innovation in the environmental and agricultural sector linked to tenure for Costa Rica. Lecture taught at the Second Edition of the Ibero-American Night event for researchers. International scope and impact. Organized by the Organization of Ibero-American States for Education, Science, and Culture (OEI). International scope and impact. Speakers: Researchers Heileen Aguilar and Christian Vargas.

16

Meeting Sustainability Goals and Agricultural Needs: EO Data for Effective Agricultural Policy in Costa Rica. International lecture. Within the framework of Planet Explore 2021. Speakers: Researchers Francini Corrales Garro and David Romero Badilla.

17

International Webinar: Geographic Information Systems applied to Territorial Planning. As part of the International Seminar on Earth and Sea Sciences framework, organized by the Faculty of Earth and Sea Sciences of the National University. International scope and impact. Speaker: Researcher Christian Vargas Bolaños.

18

Presentation - Environmental Management Area and its programs (Agromatics and Climate Observatory) at the 2021 Second Edition of the Ibero-American Night for Researchers event. Organized by the Ministry of Science, Innovation, Technology, and Telecommunications (MICITT), September 2021. Taught by Allan Campos Gallo, MBA; Dr. Patricia Sánchez Trejos, and Irina Katchan Katchan, M.Sc.



22

19

Lecture at the XXV Latin American Congress of Microbiology. Modality: online. August 25-28, 2021. Link: <https://alam.science/alam-2021-web/>. Speaker: Dr. Max Chavarría Vargas.



21

Lecture at American Chemical Society (ACS) Fall. Modality: Hybrid. Date: August 22 -26, 2021. Link: <https://www.acs.org/content/acs/en/meetings/acs-meetings.html>. Speaker: Diego Rojas Gätjens, student assistant.

20

Lecture at V Latin American Conference on Plant-Growth Promoting Microorganisms (PGPR). Modality: online. Date: October 4-8, 2021. Link: <https://relar-pgpr.com>. Speaker: Efraín Escudero Leyva, student assistant.

22

Legislative Assembly of Costa Rica.
Acknowledgment to Dr. Max Chavarría Vargas, for his contribution to the restoration and rescue process of the Act of Independence of Costa Rica.

23

A female scientist with dark hair, wearing safety glasses, a dark face mask, and a white lab coat, is working in a laboratory. She is wearing blue nitrile gloves and is focused on a task involving a small container. In the background, there is a white funnel on a glass base and other laboratory equipment. The scene is brightly lit, typical of a modern lab.

CeNAT – CONARE Scholarship Program

On the initiative of the Deans of CONARE's member universities, in 2013, the scholarship program started, which is aimed to encourage students enrolled in the state universities to develop final graduation or research works, linked to the areas of CeNAT.

The objectives and topics of these research works and theses should be directly linked to the competence topics of LANOTEC, CNCA, CENIBiot, PRIAS, and Environmental Management, according to specific contests that are held at public universities, which are disseminated by the institutional media and by the Vice-Chancellorships for Research at each university.

Due to the COVID-19 pandemic and to a rethinking of strategies to achieve more effective applicants, there was a variation in both the execution and contest periods of the scholarships. For this reason, the 2021 scholarships began in June 2021 and are projected to end in April 2022. Similarly, the 2022 scholarship process started in November 2021, to begin execution in May/June 2022.

As part of the dissemination efforts, materials were designed to be posted on social networks. Seven designs were made, which focused on the work of each laboratory.

Advertisements

CeNAT – CONARE Scholarship Program



Table 1.
Assigned Scholarships from 2017 to 2021

CENAT - CONARE 2017 2021 SCHOLARSHIPS QUANTITY- UNIVERSITY - LABORATORY

UNIVERSITY	LANOTECH						CENIBIOT						ENVIRONMENTAL MANAGEMENT						CNCA						PRIAS						TOTAL / UNIVERSITY				
	2017	2018	2019	2020	2021	Subtotal	2017	2018	2019	2020	2021	Subtotal	2017	2018	2019	2020	2021	Subtotal	2017	2018	2019	2020	2021	Subtotal	2017	2018	2019	2020	2021	Subtotal	2017	2018	2019	2020	2021
UCR	1	3	1	5	7	17	4	5	4	4	2	19	0	1	1	0	1	3	2	1	5	2	2	12	0	0	1	0	2	3	7	10	12	11	14
UNA	1	2	0	1	0	4	0	1	0	0	1	2	1	1	1	0	0	3	0	0	0	1	0	1	2	2	1	0	0	5	4	6	2	2	1
UNED	0	0	0	0	1	1	0	0	0	0	0	0	1	0	2	1	1	5	0	0	0	0	0	0	2	0	1	0	0	3	3	0	3	1	2
ITCR	2	1	2	2	1	8	2	1	0	1	0	4	0	0	0	1	0	1	0	3	1	0	2	6	0	1	2	1	3	7	4	6	5	5	6
UTN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL / LAB	4	6	3	8	9	30	6	7	4	5	3	25	2	2	4	2	2	12	2	4	6	3	4	19	4	3	5	1	5	18	18	22	22	19	23

ALLOCATION OF SCHOLARSHIPS 2017 - 2021

University	CNCA	CENIBIOT	LANOTECH	Environmental Management	PRIAS	Total/University
UCR	12	19	17	3	3	54
UNA	1	2	4	3	5	15
UNED	0	0	1	5	3	9
ITCR	6	4	8	1	7	26
UTN	0	0	0	0	0	0
Total/Laboratory	19	25	30	12	18	104

Source: Information on the year 2021 provided by the Laboratories and Area of CeNAT.



Table 2.
Individualization of the Assigned Scholarships

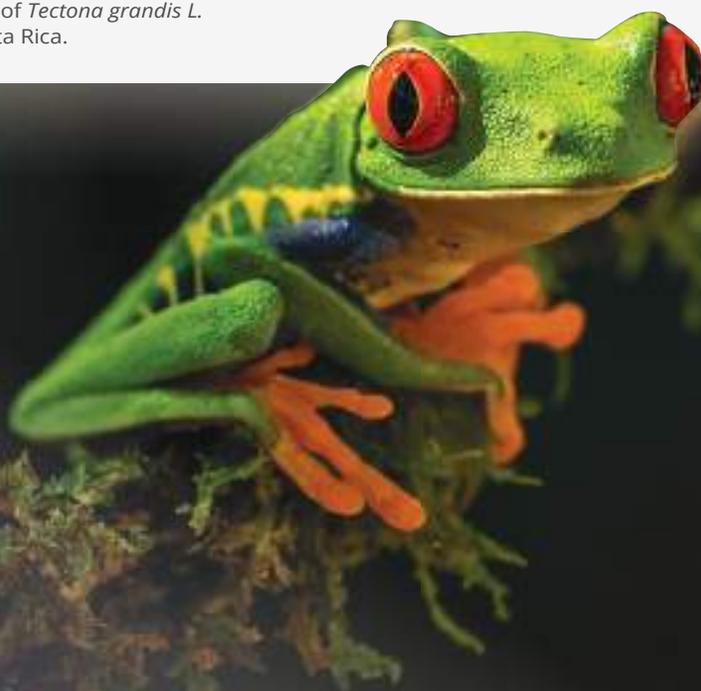
N°	STUDENT	PROPOSAL	UNIVERSITY	AREA / LABORATORY
1	Molina Mora, Ingrid	Evaluation of sustainable agricultural practices on the bird community in a coffee landscape.	UCR	AGA
2	Sánchez Alvarado, Rubén Ignacio	Proposal for an index to evaluate the biotic integrity of the productive landscape in the Páez River sub-basin, in Cartago, based on diurnal Lepidoptera of the Papilionoidea superfamily as indicators of potential habitat use.	UNED	AGA
3	Elizondo Masís, Ana Victoria	Obtaining multi-products with added value through biotechnological and chemical processes from the dehydrated coffee pulp (<i>Coffea arabica</i> L.).	UNA	CENBiot
4	Vásquez Vásquez, Daniela María	Development and validation of a method for quantifying pesticide residues in fruits by HPLC-MS/MS.	UCR	CENBiot
5	Torres Solano, Antony	Removal of drugs in wastewater through a biofilm reactor with natural supports.	UCR	CENBiot
6	Villalobos, Johansell	Programming and Optimization of Codes for Calculation and Visualization of Physical Parameters of the SCR-1.	TEC	CNCA
7	Morales Rodríguez, Luis Pedro	Migration of a driver model for ventricular assist devices to an open-source platform.	TEC	CNCA
8	López Pérez, Kenneth Geovanny	Prediction of the n-octanol-water Distribution Coefficient (logDpH) with Machine Learning Models.	UCR	CNCA
9	Rodríguez Yañez, Javier	Generating a descriptive map of corrosion on metallic materials in the Western Central Valley	UCR	CNCA
10	Segura Rodríguez, Kevin	Evaluation of biopolymers used for food packaging in home-composting conditions.	UCR	LANOTEC
11	Acuña Umaña, Katherine	Analysis of the state of conservation of 20 oil paintings by Costa Rican artists for 140 years, which are in the Museums of the Central Bank of Costa Rica.	UCR	LANOTEC
12	Miranda Oporta, Celia Esmeralda	Development of nano and microscale biomimetic bone structures using bioprinting technology.	TEC	LANOTEC
13	Hernández Chaverri, Rodolfo Antonio	Development of a biorefinery process based on the saccharification of pineapple stubble as a source of lignocellulosic biomass.	UNED	LANOTEC

N° STUDENTS	PROPOSAL	UNIVERSITY	AREA / LABORATORY
14	Badilla Vargas, Lisa Stephanie	UCR	LANOTEC
15	Jiménez Thuel, Gabriel	UCR	LANOTEC
16	Torrez Sequeira, Yeymi Elizabeth	UCR	LANOTEC
17	Horvilleur Gómez, Ximena	UCR	LANOTEC
18	Fernández Méndez, Paulina	UCR	LANOTEC
19	González Hernández, Manfred	UCR	PRIAS
20	Sánchez Guzmán, Sebastián Antonio	TEC	PRIAS
21	Vargas Céspedes, Armando Antonio	UCR	PRIAS
22	Rojas Zamora, Joseph	TEC	PRIAS
23	Porras Granados, Arleth	TEC	PRIAS

Source: Information on the year 2021 provided by the Laboratories and Area of CeNAT.

All the approved proposals have a high impact both in the generation of new knowledge (through articles, graduation papers, generation of new products, and others), as well as in subjects related to biorefinery, presence, and degradation of contaminants, and generation of new products from waste, such as the study of the potential of different areas of the country in terms of agro-industrial value, ecotourism, vulnerabilities, and opportunities.

It is worth highlighting the studies applied to treating diseases, such as COVID-19, as well as projects that are linked to research centers and international universities, about flora and fauna communities.





Throughout the nine years that the CeNAT/CONARE scholarship program has been in operation, more than 100 students from public universities have been supported in developing their undergraduate and postgraduate graduation and research projects in high technology and innovation. Topics include research and recovery of species, environmental pollution, development of communities based on ecotourism, bioeconomy, and circular economy, identification of areas vulnerable to landslides and other environmental threats in communities, biorefinery, synthesis processes of new substances, increased agricultural productivity using ICTs, diagnosis and care of diseases, and artificial intelligence, among others.

Impact of the **CeNAT/CONARE** Fellowship Program

From these scholarships, more than 100 licentiate's, master's, and doctoral graduation projects have been promoted; more than 80 articles published in scientific and specialized journals of the highest level; and more than 30 forums, workshops, and seminars for knowledge transfer. In addition, and as concrete examples of success stories, there are the tourist guide for bird watching for the sustainable economic development of the community of Mora canton; landslide area maps; research that has enabled the identification of new components of great use to humanity, based on arachnid substances and poisons, as well as rescue, reproduction, and controlled release of tarantulas in their natural habitats.



OpenLab: Program for Creativity and Entrepreneurship in High Technology

(CREATEC)

In November 2020, the Philip Morris Costa Rica company agreed to be part of the program, thus obtaining funding to resume the project's operation in 2021, named OpenLab this time, and still being part of the Program for Creativity and Entrepreneurship in High Technology (CREATEC).



Overall Goal of the Project:

To create an ecosystem to support innovation that seeks to create economic impact and job creation.



Specific Goals:

To transfer knowledge and teach hard and soft skills that generate opportunities for entrepreneurs.

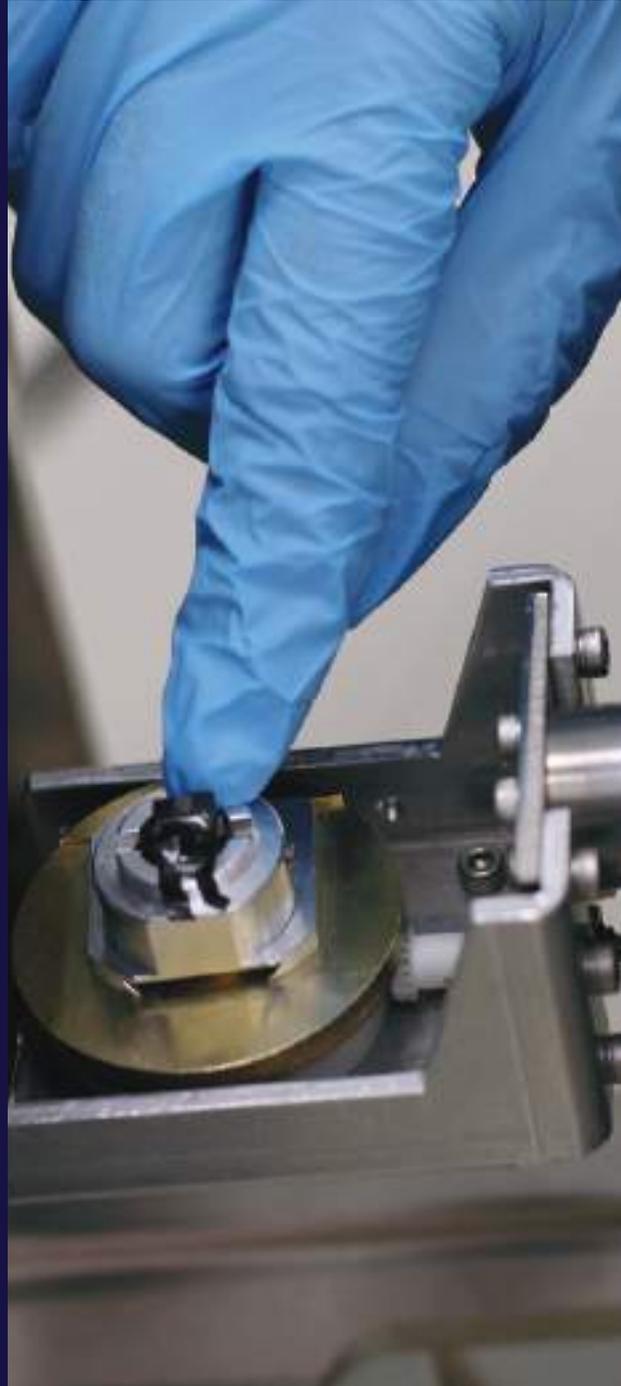
To create a structure that supports Costa Rican entrepreneurs in the early stages.

To support projects that have an impact on direct-interest categories:

- Wellness and health
- Risk reduction
- Environmental

To support projects that have an impact on direct-interest categories:

- To support SMEs, companies, and workers within the COVID and post-COVID contexts.
- Support to communities.



The phases of the project were:

Phase 1 •-----• Phase 2

Incubation generation:
Open Incubation

Operational Integration

Project **impact** report:

An ecosystem was created to support national technology-based entrepreneurs.



Number of ventures that applied:

139



Number of entrepreneurs in database:

245



Number of ventures on the short selection list:

30



Number of incubated ventures:

14



Number of incubated entrepreneurs:

41



Number of projects led by women:

3

Number of entrepreneurs supported through open community programs (virtual sessions):

567



Compliance with specific **objectives**



#1:

To transfer knowledge and teach hard and soft skills that generate opportunities for entrepreneurs.

The OpenLab curriculum is based on teaching theoretical concepts that allow entrepreneurs to make better decisions to build their businesses. Additionally, these concepts are reinforced with a strong emphasis on execution to work on building both hard and soft skills. Every week, theoretical subjects are taught, and an advance of work is presented. This curriculum was successfully applied to two generations, with better progress than mostly theoretical interventions.

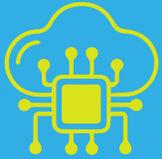
#2:

To create a structure supporting Costa Rican entrepreneurs in the early stages.

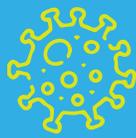
The pandemic presented an opportunity to create a program based on virtuality, which was crucial for creating a support structure for entrepreneurs. Costa Rican entrepreneurs are, in reality, professionals, students, and parents. The lack of investment options makes it impossible for them to dedicate full time to a technology-based venture. Hence, it has been seen that in previous programs a significant obstacle was attending the support sessions. Virtuality allowed the creation of a program with virtual synchronous sessions and asynchronous content that will enable entrepreneurs to extract value from the program at their convenience. Furthermore, the addition of a virtual community made the support among entrepreneurs possible to a much higher level than in the past. Entrepreneurs in the early stages are solving fundamental business problems at a much higher rate, so -unlike entrepreneurs in the scalability stage- they need more constant support, which was possible thanks to the virtual structure.

#3:

To support projects that impact direct-interest categories: wellness and health, risk reduction, environmental, support for individuals, communities, and companies in a post-COVID environment. The calls of the program were oriented to these areas.



Technology



COVID & post-COVID
support



Wellness and
health



Environmental
Protection

Conclusions:

There is considerable work to do in Costa Rica to develop an ecosystem to produce conditions for entrepreneurship that generates the sought economic and social impacts. However, the work done by OpenLab, Phillip Morris, and CeNAT in 2021 can serve as a guide on how education efforts and accompaniment to entrepreneurs can be planned with massive education efforts of a community that wants to learn and with public and private institutions who wish to help.

OpenLab achieved the objectives set from the beginning and continued the work developed for eight years, thus strengthening the integrated ecosystem of entrepreneurship. In addition, we managed to place startups with women founders in other acceleration programs so that they continue their efforts.

As positive externalities of this OpenLab program, a program to create private venture funds for startups was raised as a consultancy, making it a great media and community dissemination effort, with the hope to continue working for entrepreneurs in both Costa Rica and the region for a longer time.



National
Nanotechnology **Laboratory**
(LANOTEC)



LANOTEC

Laboratorio Nacional de Nanotecnología

LANOTEC

Annual
Operational Plan
(CeNAT-CONARE) 2021



Indicators	Achieved Goal
 Scientific publications	25
 Knowledge transfer activities	25
 Research Projects	24
 National / International Agreements	3
 Attention to Students	76

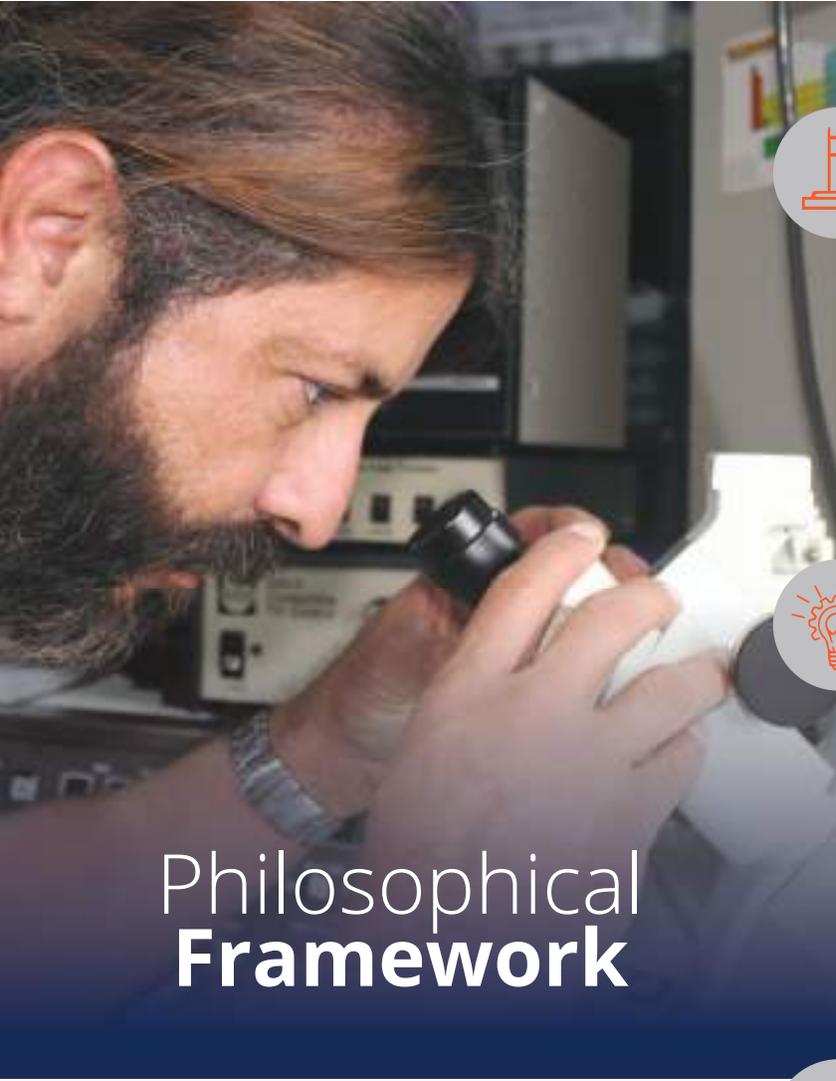
Background

LANOTEC

The National Nanotechnology Laboratory (LANOTEC) is attached to the Centro Nacional de Alta Tecnología (CeNAT). On October 18, 2004, it started conducting research with the goal of being a technological leader in the Central American and the Caribbean region, with cutting-edge engineering on the study of advanced materials for research, design, and training in technologies associated with microtechnology, nanotechnology, and materials science.

In addition, it allowed to expand knowledge development and collaborate with human capital formation, scientific research and to contribute to developing specific applications for the productive sector in different types of industries, such as materials, polymers, microbiology, medicine, geophysics, and space exploration, among others.

Currently, LANOTEC is achieving a more significant impact in activities carried out in the scientific research, innovation-entrepreneurship, and ISO 17025 certification areas, as well as teaching and extension programs.



Philosophical Framework



Mission

We are a research laboratory for the use of nanobiotechnology by specialized professionals who carry out studies with the highest scientific standards in the framework of innovation and development for the public, private, and social sectors of the Region.



Vision

At LANOTEC, respect for Human Rights is enforced, especially the right to life, liberty, and security of every person. Likewise, there is awareness about the environment, and it is expected that the designed products and developments avoid pollution and preserve the environment.



Values Enforced at LANOTEC

- Collaborative management in the projects that are undertaken
- Socialization of scientific information
- Responsible project management
- Commitment to the processes and products that are undertaken



Principles Enforced at LANOTEC

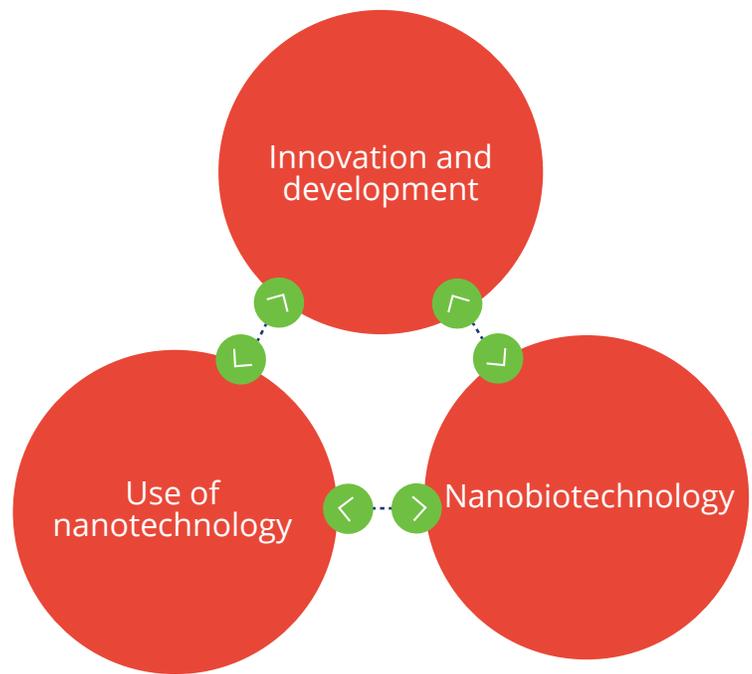
- Efficient use of time
- Efficient use of technological infrastructure
- Accountable administrative management of research projects
- Generation of ideas for process improvements



LANOTEC Development Objective

To generate scientific value from nanobiotechnology to process and product innovation initiatives that impact economic development and the Sustainable Development Goals of Costa Rica.

Operational Structure of **LANOTEC**



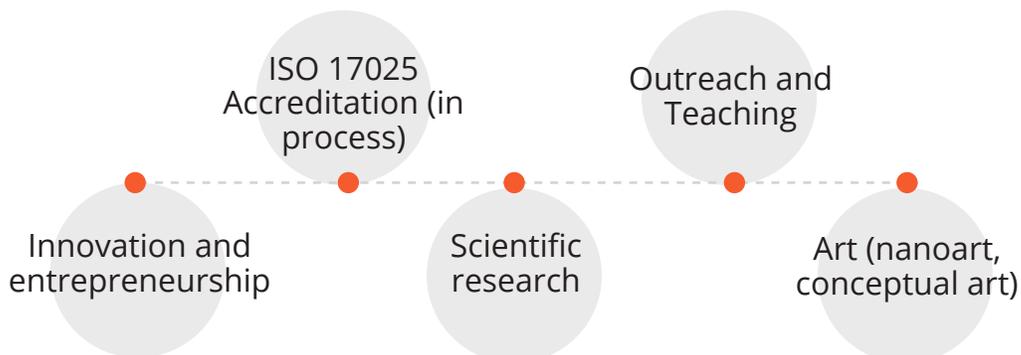
Objectives

To conduct research in the areas of micro and nanotechnology, focused on nanostructures, microsensors, advanced materials, with potential applications in energy, environment, health, and information technologies.

To serve as a nanotechnology training center-laboratory in collaboration with government institutions, interested companies, and state education academic programs.

To establish strategic alliances with high-tech industries (both national and foreign) to develop specialized services and products that contribute to the country's productive sector.

Strategic Nodes



Impact Indicators

Publications



16

Indexed

4

Not indexed

5

Specialized

Knowledge Transfer



11

National lectures

14

International lectures

486

People benefited from knowledge transfer

Research Projects



● Public

3

FEES

8

Internal projects

4

CONICIT-Funded

● Private

1

Scientific vocation

3

International

5

With the industry

Summary of Projects

Project	Progress
FEES Projects	
Molecular bases for interaction and degradation of the vascular basement membrane by hemorrhagic metalloproteinases of snake venoms.	The project's final report was presented, which ended in July of this year. However, laboratory analyzes are still carried out in order to verify the results obtained.
Emerging technologies applied to improving the anti-inflammatory effect of bioactive substances: new nanomaterials of curcumin and proanthocyanidins.	<p>The project ended, and the final report was delivered. Work continues on the development of three scientific publications:</p> <ul style="list-style-type: none"> ● Curcumin Loaded and Co-loaded Nanosystems: A Review from a Biological Activity Enhancement Perspective. Pharmaceutical Nanotechnology. DOI: 10.2174/2211738508666201228150659 ● Use of Nanosystems to Improve the Anticancer Effects of Curcumin. Beilstein Journal of Nanotechnology. DOI: 10.3762/bjnano.12.78 ● Evaluation of Piperine as Natural Coformer for Eutectics Preparation of Drugs Used in the Treatment of Cardiovascular Diseases. Under evaluation. AAPS PharmSciTech.
Creation of biocompatible scaffolds by means of 3D printing, for their implementation in studies of cellular biophysics and bone tissue engineering.	This project has ended. A document partly prepared by LANOTEC was sent to incorporate the results of other groups of the consortium to compose a paper by Lilliam Trejos from TEC.

LANOTEC Projects - Operation

Textile Face Masks

This project is funded by the call for Special Projects: Modality - Emerging Needs facing COVID-19 in Peru, coordinated by David Asmat, M.Sc., coordinator of the Applied Sciences and New Technologies research group at Universidad Privada del Norte (UPN), Peru. The budget is managed by the UPN, and as part of the collaboration with LANOTEC, they bought for us about 300 mesh copper grids with carbon film for SEM and some standard grade carbon fibers for coating. Gabriela Montes de Oca, Diego Batista, and Reinaldo Pereira collaborate on behalf of LANOTEC.

The project aims to synthesize and characterize metal nanoparticles (NPs) using green synthesis methods and impregnate them in textiles for use as masks for community use, in order to inhibit bacteria, viruses, and fungi. To do this, they will work with strains of avian coronavirus and dengue, among others, to verify their effectiveness.

The UPN has already synthesized all the NPs and impregnated them using different methods in two types of fabrics and then sent the samples to LANOTEC in December 2020. LANOTEC collaborates in characterizing the different types of NPs synthesized by the team from Pusing TEM and FTIR. It is also in charge of the characterization of the fabrics impregnated with the NPs by means of SEM, FTIR, and EDS. 80% of the analyzes have been carried out; only the TEM observation of two NPs and the EDX analyzes are pending. Furthermore, the University of San Marcos in Peru already has the results of the analysis of antimicrobial and antiviral activity available.

CSIC- Arsenic-free - new nano-structured multifunctional materials to remove arsenic in groundwater

LANOTEC has carried out part of the analysis, the results of which are already being analyzed and processed by the technical parties involved in the project, in Argentina and Spain, as well as in Costa Rica.

The objectives are:

- To develop a low-cost system that does not require electricity to operate, thus being implementable both in countries with energy resources and vulnerable communities without access to electricity.
- To enhance and consolidate international cooperation with the two recipient countries of ODA (Argentina and Costa Rica) to move forward in mutual knowledge exchange.
- Scaling up the developed technical solution for implementation in low-income countries and communities in vulnerable and disadvantaged situations.

Structural elucidation of Irbesartan Form A using Rietveld and Le Bail methods.

Work is being done in collaboration with the Applied Crystallography Laboratory of the General San Martin University of Argentina. Experimental powder X-ray diffraction data of Irbesartan form A have been used. Rietveld and Le Bail methods have been applied to these data using the FullProf Suite software. Not very promising results have been obtained so far; therefore, work is being done on the manually determined calculations of all the hkl reflections of the structure, based on the record of this structure reported in PDF4/Organics.

Projects with Research Vice-Chancellorships

Influence of polymorphism and co-crystal formation. It has been renamed "Influence of polymorphism and co-crystal formation on the physical properties of antihypertensive drugs".

Two manufacturing processes of two antihypertensive drugs in two potencies -both alone and in combination- were evaluated. It was determined that the combination formulation forms a eutectic mixture between both active ingredients, which could influence the final product's characteristics. The evaluation of the preparation of tablets of this combined formulation, using other manufacturing methodologies such as wet granulation, is pending. Negotiations were made so that student assistants from TEC carry out activities that allow obtaining at least two more papers on this project.

The elaboration of binary and Tamman phase diagrams to determine the eutectic composition of hydrochlorothiazide and olmesartan medoxomil began. Nine binary mixtures were prepared in molar composition from 1:0 to 0:1 in intervals of 0.1. They were measured by DSC, and the data is being processed.

The scientific paper, "Interaction and compatibility studies in the development of olmesartan medoxomil and hydrochlorothiazide formulations under a real manufacturing process" was derived from this project, which was accepted for publication in the *Pharmaceutics* journal.

Development of nanoparticle carriers of natural polyphenols to control grain contamination by mycotoxins.

This project was funded by the call for competitive funds of the "Research Groups" from the Research Vice-Chancellorship of the University of Costa Rica and is coordinated by Dr. María Viñas of the Center for Research on Grains and Seeds (CIGRAS). Its execution period goes from January 2021 to December 2024, with a contribution of 30 million colones, which are administered by the University of Costa Rica. The project will be carried out by two research units of the UCR (CIGRAS and the School of Food Technology -TEA-) in conjunction with the National Nanotechnology Laboratory of the Centro Nacional de Alta Tecnología (LANOTEC-CeNAT) and two international groups (the group of Prof. Dr. Petr Karlovsky with extensive experience in the area of mycotoxins and the group of Prof. Dr. Ralf Schweiggert. On behalf of LANOTEC, Gabriela Montes de Oca and Sergio Paniagua are collaborating.

This proposal intends to extract, identify, and purify polyphenols from Costa Rican plants, as well as to develop polymeric NPs that allow their encapsulation and controlled release in foods. The development of this objective is the responsibility of LANOTEC. Finally, the effectiveness of nano-encapsulated polyphenols for controlling mycotoxins in significant grain crops in Latin America, such as corn, beans, rice, and peanuts, will be determined. The grains will be stored in the usual conditions used by small producers in Costa Rica. In this way, this could become an environmentally friendly alternative that could be used by small producers, who usually do not have the optimal conditions for storing harvested grains.

The UCR is making progress in purchasing the necessary reagents and supplies to develop the proposal. In addition, in April, a student of Chemistry from the UCR will begin his supervised professional practice at LANOTEC, optimizing the NPs synthesis protocols required for objective 2 of the proposal.

Nano-phytomedicines for the prevention and treatment of COVID-19: Solid-lipid nanosystems and in-silico and in-vitro study of natural inhibitory candidates of the SARS-CoV-2 virus.

Theoretical selectivity screenings of the proposed substrates have been carried out with the Mpro protein of the SARS-CoV-2 virus and the spike (S) protein, using four open-access computer programs. Promising results have been obtained with various conformations of curcumin, bisdemethoxycurcumin, and demethoxycurcumin.

The previously developed methodology for the preparation of curcumin nanoparticles was applied and applied in the preparation of bisdemethoxycurcumin and demethoxycurcumin formulations, as well as their respective characterization.

A paper was written and published. Design of Hybrid Polymeric-Lipid Nanoparticles Using Curcumin as a Model: Preparation, Characterization, and In Vitro Evaluation of Demethoxycurcumin and Bisdemethoxycurcumin-Loaded Nanoparticles.

DOI: 10.3390/polym13234207

Project

Progress

Internal Project

Development of chitosan-based scaffolds, as controlled release systems in the treatment of wounds.

Six formulations were designed with adequate consistency and an ideal pH value to allow the physicochemical stability of each prototype. In addition, other thermo-responsive polymers such as PVA and gelatin were incorporated to evaluate their impact on the performance of the scaffolds in the kinetic release test. The active ingredient that was incorporated is an analgesic and non-steroidal anti-inflammatory drug (NSAID) called Dexketoprofen. The trometamol salt of said active ingredient is used to improve its solubility. It was successfully incorporated into the six prototypes, so we are evaluating the release at 1, 3, 6, 12, and 24 hours, using distilled water as a medium and studying the behavior at 32°C (in compliance USP) and 39°C (to simulate body temperature rises during wound healing). It should be noted that the release assay is being carried out in the Laboratory of Biopharmacy and Pharmacokinetics (LABIOFAR) of the Faculty of Pharmacy, UCR, which resulted from the request to carry out collaborative work.

International Project - CONARE:

Understanding of the velvet worm anti-adhesive sin mechanism as a model for biodegradable and low protein adsorption coatings

The project was approved, approaching the closing date of work in December 2021. For this reason, it was only possible to carry out the review of the required supplies and internal planning of the equipment to be procured for the development of the project.

Private Funds: International Linkage

H2020- Automated functional screening of IgGs for diagnostics of neurodegenerative diseases (AUTOIgG).

Image analysis using computational algorithms was performed using AFM, a process that began in June.

Production and characterization of bacteria-repellent microcontact printed substrates and bactericidal nanostructured surfaces.

This project is in its extension year that ends on April 30, 2022. The project consists of three main axes and a summary of the progress of each one is made.

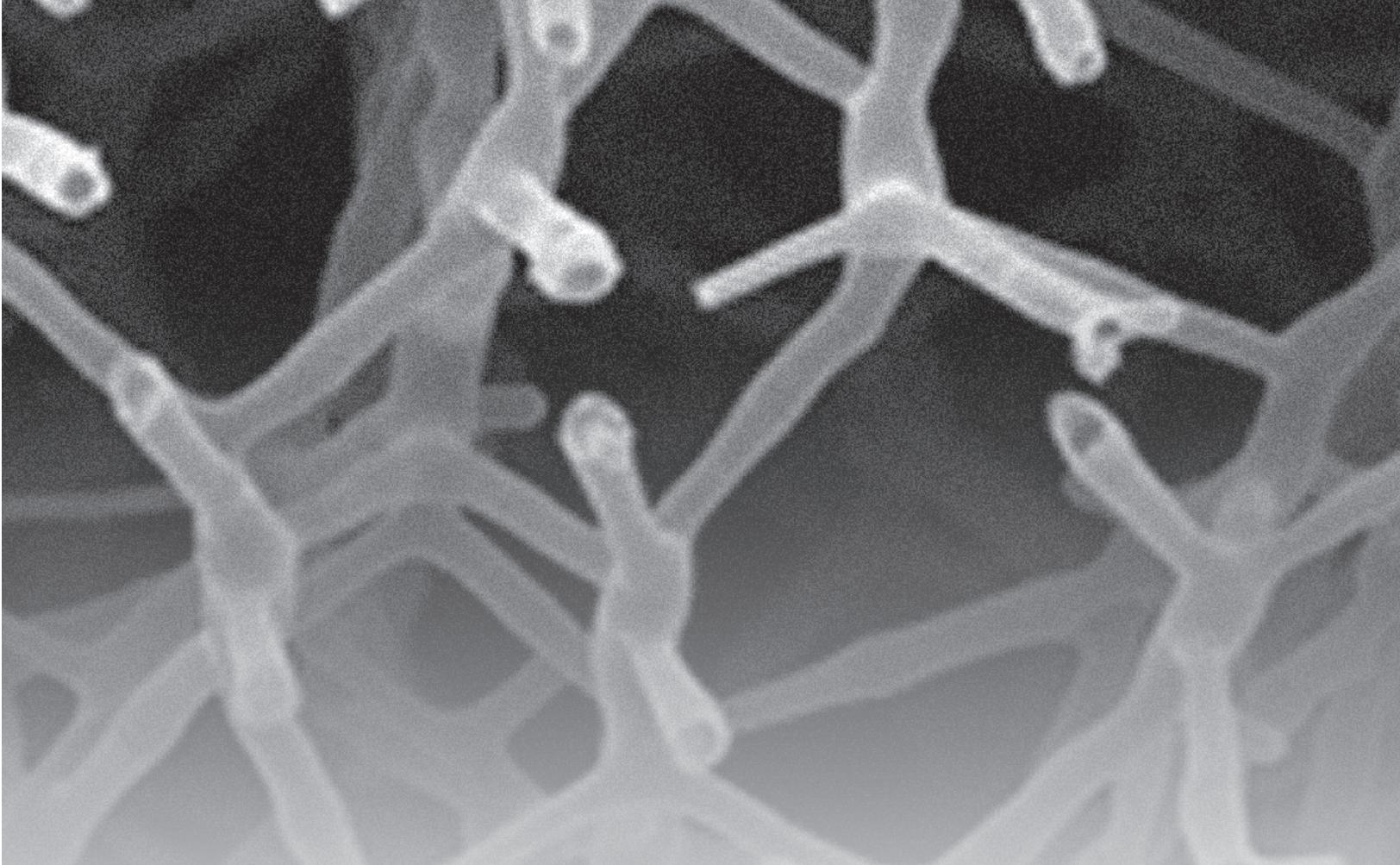
Nanometric patterns for bacteria repellency: Nano and microstructured prints from anodized aluminum, internal layers of optical media, and silicon with calibration grids for microscopy have already been prepared and characterized. Patterns have been generated with these prints on aluminum and silicon. Still, the expected repellency has not been observed, so alternative methodologies are being tried to increase the dimensions of the structures and thus increase Cassie-Baxter behavior.

Surfaces with bactericidal potential: protocols have been determined to modulate the height, width, and periodicity of the aluminum pillars by anodizing, and bactericidal tests are currently being carried out. It is expected to start writing the paper in the I Quarter 2022.

Carbon-based quantum dots: A review. This paper is due to be published in 2022. Two methodologies are being used in experimental terms - reactor hydrothermal synthesis and microwave synthesis. Different results have been noted in both, including that the purification for each case should be different. Some contrast is seen in fluorescent bioimaging tests with bacteria when using the prepared CQDs. It is expected to purify better to increase the contrast further.

Bio-inspired and low-cost 3D printing of hydrogels with biomedical applications.

The project began in May and is undergoing preliminary experimental studies. The necessary equipment and most of the supplies and reagents needed for the project's development are already available. The student will be hired in 2022 to advance with the experimental part of the project.



Project	Progress
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Private Funds With the Industry	
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Material characterization	The project presents a delay due to factors unrelated to LANOTEC, as the delay occurred in the reception of the samples to be processed and analyzed.
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Stein: Antimicrobial nanoemulsion using chlorhexidine as an antimicrobial active and co-surfactant ingredient	We are in the process of evaluating the antimicrobial properties of the formulations and hydrogels. The first and second reports of results have been delivered. The experimental analyzes continue. It is expected to finish in June.
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Evaluation of antimicrobial activity	The experimental part has ended, and the final report has been prepared, and was presented to the company's representatives, with the Argento I project being successful. The second part of this project was submitted for evaluation.
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Evaluation of the impact of cigarette smoke vs. THS on indoor air quality.	The samples and respective analyzes continued, as well as the assessment and interpretation of the results. The portable particle chromatograph was acquired to continue with the sampling of the project.
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Design and development of a concept model to establish a bioinformatic study of lung cancer by means of computer vision of nanomolecular-scale 3D images and circulating molecular biomarkers of associated genes.	Work is being done on the identification of biomarkers.
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Scientific Vocation Project	
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Promotion of scientific vocation Challenge Fair	Since this project consisted of the preparation and participation at mass events, its development has been affected due to the health crisis that is being faced worldwide.
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MICITT-CONICIT Projects

Generation of agro-industrial capacities and creation of a comprehensive unit (physical-chemical, organoleptic, and microbiological characterization) to improve the production process of Turrialba cheese with Designation of Origin.

In the R&D stage, the SME approves the proposal presented to obtain a fertilizer from cheese whey. It begins with the logistics coordination to make a tour to Turrialba (dates, required supplies, transportation, lodging, and food) and selecting a soil sampling area. The necessary materials to conduct the sampling were purchased, and a mini greenhouse was installed, where the experimental tests of the developed fertilizer will be carried out.

A new proposal is developed to obtain a food product from cheese whey. This proposal will be presented at the end of June, taking advantage of the fact that the tour will take place.

Work is being done on the procuring process of the necessary equipment for the implementing unit of the project.

Reevaluation of the coffee brush as an alternative adsorbent material to activated carbon in removing bromacil from water sources.

The first disbursement was recently received, and its validity began from there. Three different types of biomass material with three different granulometries were selected to prepare the new adsorbent materials and their comparison with activated carbon to remove bromacil. The content of total polyphenols in the extracts obtained in the cleaning of these three materials, which will be used as starting material, was determined. These starting materials and four activated carbons have been characterized by different solid-state characterization techniques such as FT-IR, SEM, DSC, and TGA; as well as through the iodine index, methylene blue, surface area, densities, ash content, and moisture. Preliminary tests were started to functionalize this material with SO₃ groups.

The method for the determination of methylene blue was optimized to determine the adsorbent capacity and the Boehm acid-base titration to determine the functional groups present on the material's surface.

The thesis defense by student Deilin Ureña Portugués was performed on the "Evaluation of an alternative adsorbent material to activated carbon from the biomass generated in the preparation of the coffee drink.". Final Graduation Project to opt for the Licentiate's degree in Environmental Engineering from TEC.

Nano-phytopharmaceuticals for the prevention and treatment of COVID-19: Scaling of solid-lipid nanosystems and in-silico and in-vitro studies of inhibitor candidates of the SARS-CoV-2 virus.

The disbursement was received. The supply needs are being reviewed to start materials and equipment procurement processes.

Analyzes were performed to determine the purity of metabolites using thin-layer chromatography, HPLC, and MSQ. In addition, their purification was carried out using various crystallization techniques, as well as the determination of their antioxidant effect. The samples were sent for analysis and crystals for structure determination.

Development of two agro-nutritional formulations to improve agricultural soils, ensure their efficient use in agriculture, and reduce environmental impact

The approval of the request for change of a budget item for the payment of a drying machine is being awaited (the delay is due to the fact that CONICIT now has a different name and roles are being restructured).

The greenhouse is ready; however, there is a delay in formulating fertilizers due to one of the required reagents being out of stock. Therefore, another alternative is being sought.

Projects in **negotiation**

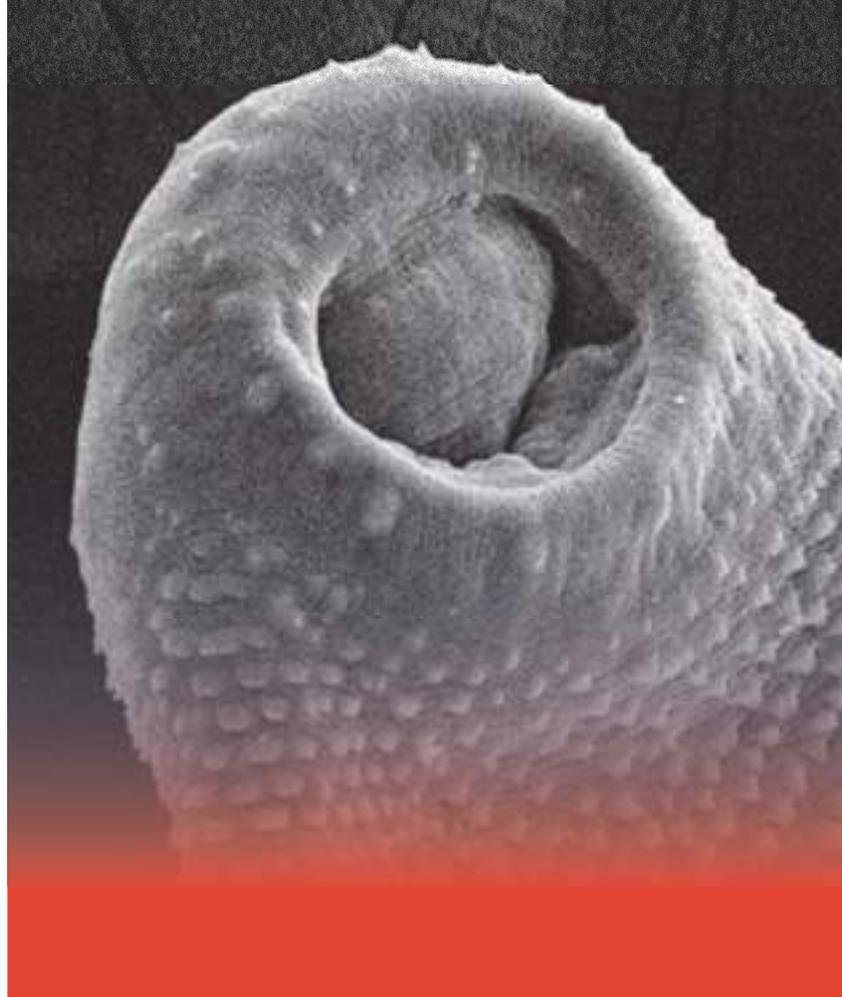


2

FEES

3

With the
industry



Attention to **Students:**



76

Students at
the lab

17

Scholarships

21

Accompaniments
in thesis

29

Interns

6

Professional
practices

3

Volunteers



Articulations

National academic sector:

- University of Costa Rica
- National University
- Universidad Estatal a Distancia (State Distance Education University)
- Costa Rica Institute of Technology
- ULatina
- Ulacit
- Invenio

International universities or institutes:

- Adolphe Merkle Institute, Switzerland
- University of the Republic of Uruguay
- Private Northern University, Peru
- Max Planck Institute, Germany
- Fraunhofer Institute, Germany
- Bar Ilan University, Israel
- University of Belgrade, Serbia

International companies:

- Philips Morris
- Purdy Motor Group
- Confluent
- Boston Scientific
- Allergan
- Smith & Nephew
- Microvention
- Proquinal
- CooperVision
- Establishment Lab
- Bayer
- Ilsi Mesoamerica

National companies

- Stein Laboratories
- Calox Laboratories
- Lisan Laboratories
- Florida Ice & Farm Corp.
- Asoproa
- Ecoinsumos

3

Agreements:

- Cooperation framework agreement between the Centro Nacional de Alta Tecnología (CeNAT) and the Latin American University of Science and Technology (ULACIT).
- Framework cooperation agreement between the Centro Nacional de Alta Tecnología (CeNAT) and Banco Popular.
- Framework cooperation agreement between the Centro Nacional de Alta Tecnología (CeNAT) and the Municipality of Montes de Oca.



CENIBiot

Laboratory



CENIBiot

CENIBiot

Annual
Operating Plan
(CeNAT-CONARE) 2021



Indicators	Achieved Goals
 Scientific Publications	17
 Knowledge transfer activities	12
 Research Projects	39
 Agreements	6
 Attention to Students	77



Background **CENIBiot**

The National Center for Biotechnological Innovations (CENIBiot) is an inter-university laboratory for research, development, innovation, and scaling up in biotechnology, which is attached to Centro Nacional de Alta Tecnología (CeNAT), with the financial support of Consejo Nacional de Rectores (CONARE).

It seeks to contribute to the generation of innovative biotechnological solutions and strategic partnerships between the academic, business, and government sectors, through support for entrepreneurship, technology transfer, and university-business linkage. This way it will achieve its vision of being a "World-class interuniversity center in biotechnological innovation".

As an overall goal, CENIBiot aims to generate the most impact in each activity it participates in. To achieve this, specialization in areas of knowledge and focus on strategic issues that have been identified as country needs are sought, by taking advantage of the installed capacity and supplemented by the strengths of the partners inside and outside CONARE.

The focus on impact objectives is exemplified by the implementation of a botanical material extraction system, which in the first year of use allowed to recover half the cost of its investment and generate high-quality standardized extracts to maintain productive activity and growth of rural cooperatives whose products are exported to the United States. Additionally, for the first time since the creation of the laboratory, bioprocess scaling services were rendered to clients outside the country, which will be expanded and consolidated in 2022.

In scientific research projects, the aim is to publish only in journals indexed in Scopus and ranked in the first and second quartiles of Scimago. In 2021, the growth and consolidation in the work teams are evidenced by the publication of 17 first and second quartile scientific papers, representing a 250% growth compared to the year 2019 alone and as an example of quality, a publication in Nature Methods.

In terms of development projects of initiatives conceived at CENIBiot (in association with the universities), technical datasheets of functional prototypes have been produced for biocontrol products based on antimicrobial peptides isolated and identified in CENIBiot, as well as prototypes of medical devices based on collagen, and we are already in search of industrial customers.

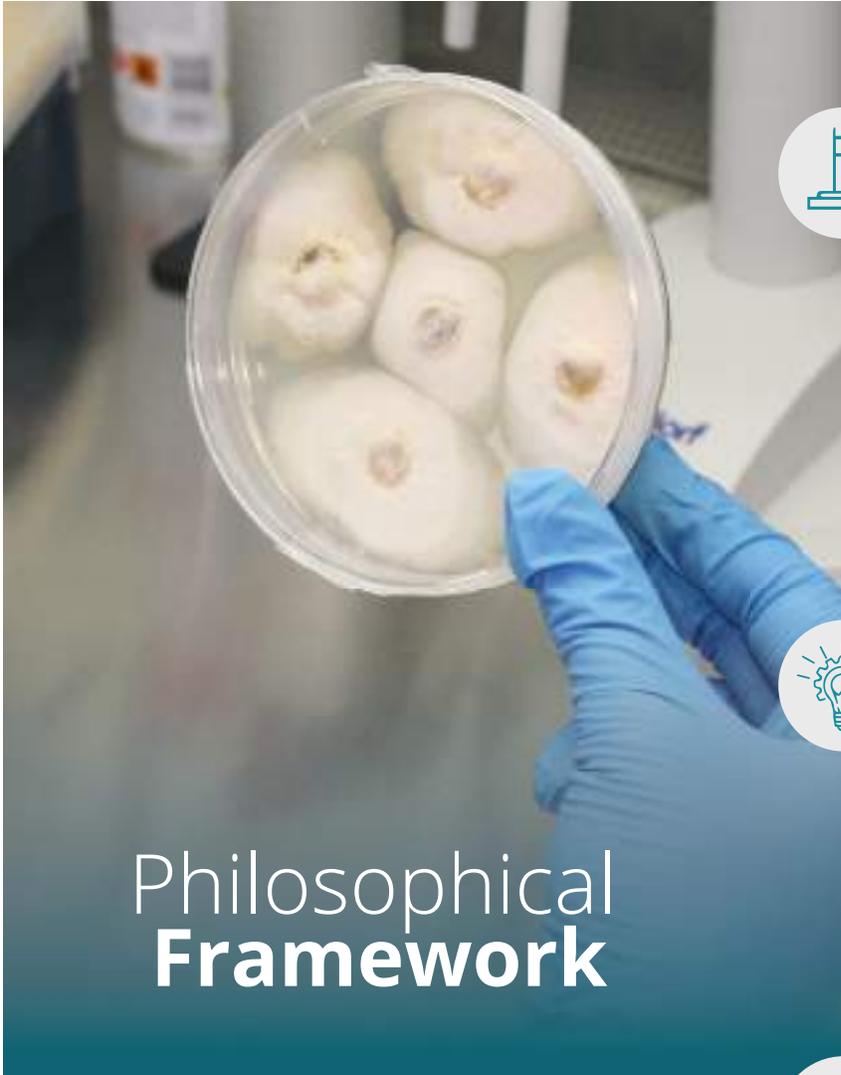
The goal of this report is to present the main strategic actions developed by CENIBiot (CeNAT-CONARE) in 2021, including the main goals based on the opening, linking, and internationalization actions proposed on the 2019-2024 CENIBiot and CeNAT Strategic Plan, as well as the implementation and continuity of the proposals raised in:

The Improvement and Implementation Plan of CENIBiot's 2019-2024 Strategic Plan.

The 2015-2020 National Plan for Higher Education (PLANES) of CONARE.

The 2015-2020 National Plan for Science, Technology, and Innovation of the Ministry of Science, Technology, and Telecommunications (MICITT).

The main operational actions executed by CENIBiot's collaborators (CeNAT-CONARE) during the year 2021 focused mainly on two transversal axes, namely the health and agri-food sectors. This way, the needs and goals proposed on the CENIBiot-CeNAT 2019-2024 Strategic Plan were met, as well the fulfillment of its Mission and Vision:



Philosophical Framework



CENIBiot Development Objective

To generate biotechnological research that contributes to the Sustainable Development Goals for Costa Rica, through scientific projects and impact innovation that contribute to society in the economic, social, and environmental fields, through the exchange of knowledge, services in science, and alliances with the business sector.



Mission

We seek to be a biotechnological research and development laboratory that works with high scientific standards and where higher education in Costa Rica, public and private sectors converge to accelerate scientific and technological innovation.



Vision

We are a self-sustaining laboratory with high scientific, economic, and social impact at the national and international level, strengthening competitive development through scientific rigor and intersectoral articulation.



Values Enforced at CENIBiot

- Human team care
- Ongoing learning attitude
- Attitude of amazement at the findings and achievements obtained
- Collaborative management in the projects that are undertaken

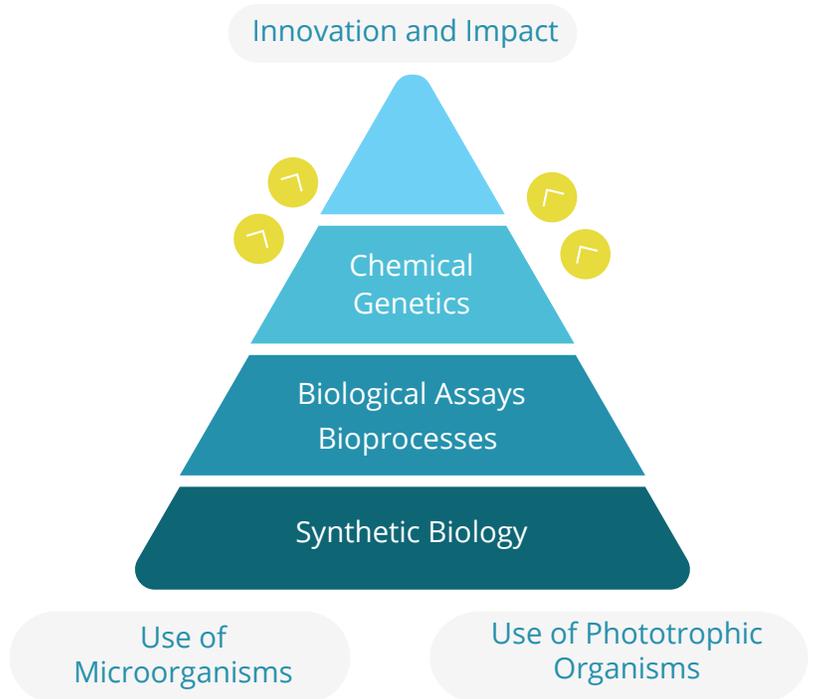


Principles Enforced at CENIBiot

- Supportive and efficient use of scientific equipment
- Accountable administrative management of research projects
- Willingness for constant improvement of the projects that are undertaken

CENIBiot

Operating Structure



The organizational structure of CENIBiot (CeNAT-CONARE) comprises five research groups. This way, the general strategic activities of CENIBiot are obtained from the specific actions developed by five research leaders, who lead, supervise, and collaborate in the development of personnel who are in the training stage with less experience in research, in coordination with the director. The groups overseen by the project coordinators are dynamic and are made up of members with different academic profiles.

In addition, projects in association with the CONARE Universities and the country's productive sector are promoted.

The illustration above details the current distribution of the areas of the orientation of the CENIBiot (CeNAT-CONARE) research groups, describing the general action subjects of each one, which are competent to their role of service and support for biotechnological development of the country and the region.



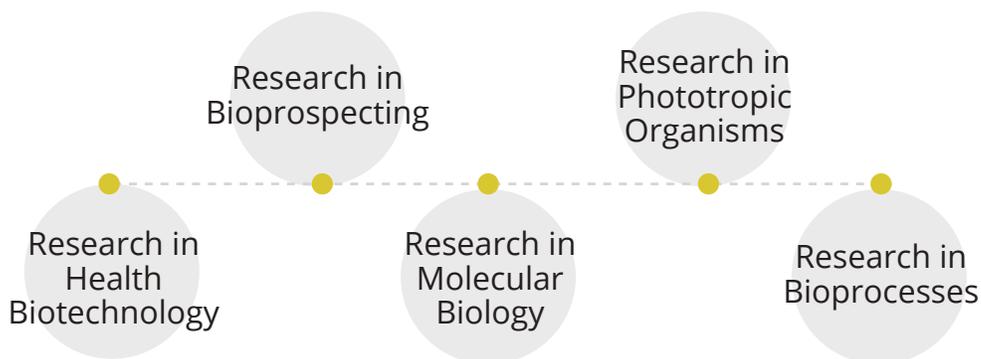
Strategic Objectives

To achieve an effective consolidation of links and strategic alliances with the academia, the business sector, and the government.

To position CENIBiot as a specialized center in industrial bioprocesses for scientific and business development.
To have a structured and optimized quality management system.

To improve the professional development of the human capital of CENIBiot.

Strategic Nodes



Impact Indicators

Publications



17
Indexed

10 Papers in Q1
6 Papers in Q2
1 Paper in Q3

Knowledge Transfer



4	Received	1
Participation at national courses/symposia /conferences	●	Participation at international courses/symposia/ conferences

9	Taught	3
Participation at national courses/symposia/ conferences	●	Participation at international courses/symposia/ conferences

Approximately 3,000 people in the scientific field have benefited from these knowledge transfers.

Projects



● Public

3

FEES

16

Internal

7

CONICIT-funded

● Private

13

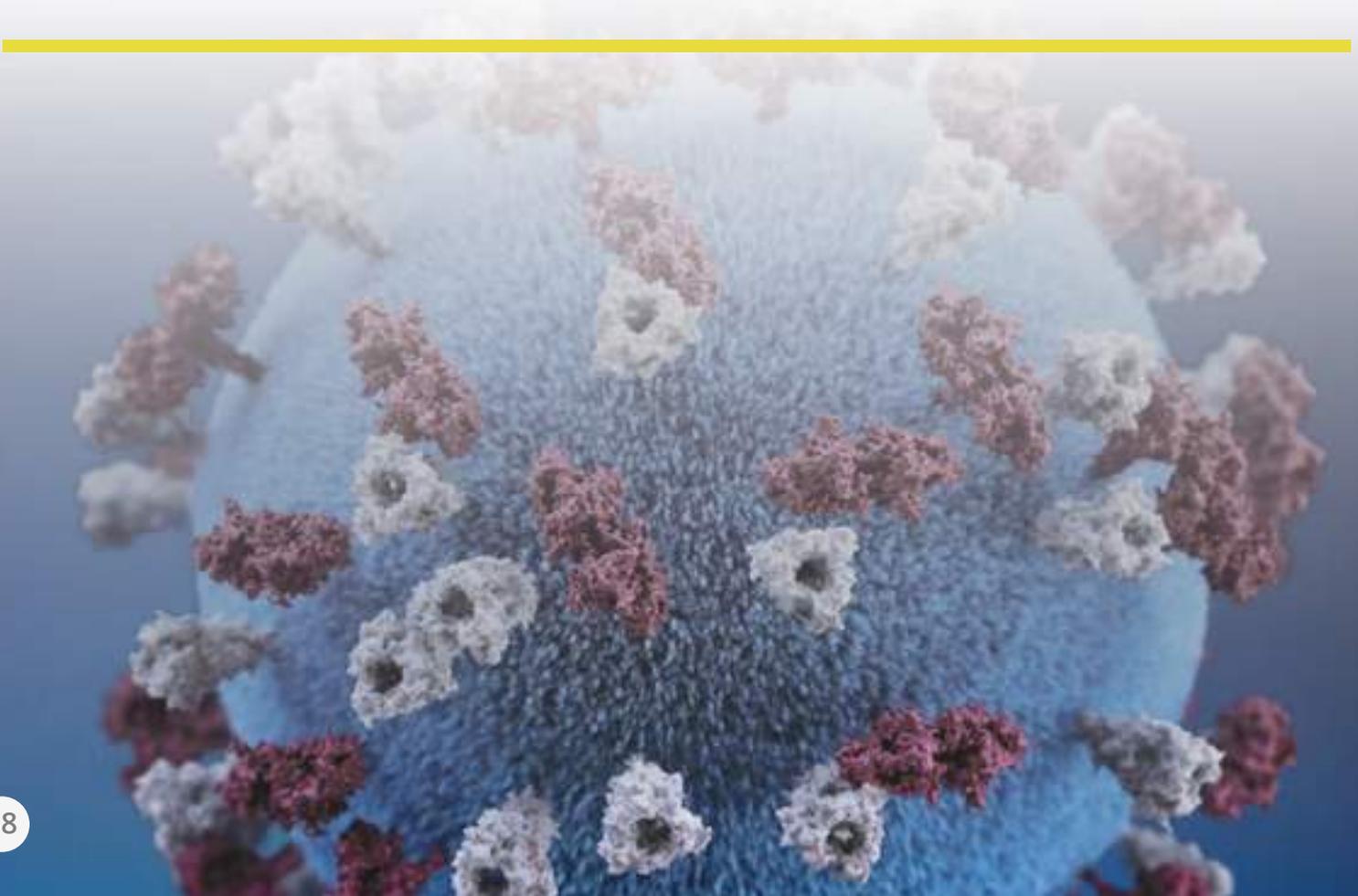
4

Projects under negotiation

Research Projects

Project	Progress
Proyectos privados	
Research of the downstream neuronal path of Neuregulin-2. (VIE).	Progress of 90% has been made in the fulfillment of the activities. The paper has been submitted.
Profiling and validating the downstream molecular pathophysiology of the hyperstimulation of NRG1-ErB4 relevant to <i>schizophrenia</i> (VIE).	Progress of 90% has been made in the fulfillment of the activities. The paper has been submitted.
Characterization of the microbiota associated with the biodegradation of historical documents of Costa Rica VI-4921-2019 (SIPPRES 2019).	Progress of 55% has been made in the fulfillment of the activities.
Genomic and postgenomic analysis of the biosynthetic pathways of antibiotic production in <i>Streptomyces sp</i> M54.-4953-2019 (2019).	There is 60% of progress made. A paper publication was obtained, and a second drafting is being carried out.
Study of the physicochemical and microbiological defense mechanisms of the eggs of Costa Rican forest birds - SIPPRES 2020	Progress of 15% of the activities has been achieved.

Project	Progress
Private projects	
Microorganisms associated with solar panels and their potential for the production of natural pigments: A pilot study of the University of Costa Rica - SIPPRES 2020	Progress of 5% of the activities has been achieved. An agreement is under approval.
Search for antimicrobial-producing bacteria in the fur of sloths of the <i>Choloepus</i> and <i>Bradypus</i> genera from Costa Rica - SIPPRES 2020.	Progress of 75% of the activities has been achieved. A manuscript is being drafted.
Characterizing the microbial communities that inhabit the Amblipigida Cave and evaluating their potential for the production of antibiotics – SIPPRES	Progress of 5% of the activities has been achieved. An agreement is under approval.
Nanoencapsulation of <i>Bacillus</i> for the control of <i>Radopholus similis</i> (pathogenic nematodes of banana) – CORBANA.	Progress of 90% has been achieved. The project's objectives were completed, and field tests are being awaited.
Design of collagen-based medical devices for tissue regeneration, from the use of by-products from the aquaculture industry (GTR).	80% compliance with the objectives has been achieved, generating a PINN-MICITT scholarship approval to develop new technology-based companies.
Development and transfer of a biotechnological process for producing microorganisms and the formulation of biopesticides for the control of pests and diseases of national interest - BIOTECH CR GRM	Progress of 10% has been achieved, where the establishment of protocols for the growth of microorganisms of interest in modified culture medium is attained.
Easy and accessible SARS-COV-2 detection protocol for screening large populations in Latin America.	100% completed project.





Project

Progress

MICITT/CONICITT Funded Projects

Application of nanobiotechnology for the development of carrier-in a-carrier transport systems for nucleic acid transfection, FI-215B-17 (CONICIT).

Progress of 80% has been made. Test cycles of new prototypes have continued to be carried out every two months. Also, significant progress was made by achieving a 15% transfection rate in cancer cells.

Bioprospecting for new extremozymes in Costa Rican volcanic environments, FI-255B-17 (MICITT).

95% compliance and isolation of cellulases and proteases have been achieved. Manuscript writing in progress.

Biotechnological production of terpenes from endemic species of Costa Rica for the control of *Fusarium oxysporum* f.sp. cubense, the causal agent of Panama disease in banana plantations (*Musa spp*), FI-254B-17 (MICITT)

There is 95% progress, including activities such as gene synthesis for the biotechnological production of terpenes from glucose in bacterial systems, sampling plants with reported antimicrobial activity, extraction of essential oils (EO), and determination of the antifungal activity of EOs. Manuscript writing

Use of agro-industrial waste through the development of bioprocesses to produce common and fine chemical products (MICITT).

95% compliance has been achieved by evaluating the use of dry coffee brushes as raw material for producing microorganisms of agroindustrial interest. Manuscript writing

Formulation of a peptide-based biofungicide extracted from *Trichoderma asperellum* and evaluating its ecotoxicity and safety, FI-048B-19 (MICITT).

40% compliance has been achieved, the experimental conditions were determined. Preliminary tests were carried out to determine which fungicides to use.

Bioles as a source of inspiration for the generation of new native microbial biostimulants for Costa Rican agricultural innovation, FI-041B-19 (MICITT).

40% compliance has been achieved. It is in the sample collection and analysis stage.

Optimization of in-house protocols for the extraction and purification of SARS-CoV-2 virus RNA, Code FI-004-20 (MICITT).

100% completed project.

Project

Progress

FEES-funded Projects

Production of bioactive compounds from isolates of the *Ganoderma sp* fungi for commercialization in the nutraceutical industry (FEES). 100% completed project. It is in the process of writing the manuscript.

Effects of endophytic fungi on the health and resilience of coffee plants - *Trichoderma* (FEES). 100% completed project.

Development of a food product from microalgal biomass of *Arthrospira maxima* with high nutritional value (FEES). 30% progress made. It is in spray drying tests.

Internal Projects

Melina's genetic footprint. Progress of 70% of the fulfillment of the activities has been achieved, pending validation of the microsatellite samples of Melina trees.

Construction of a vector based on Tellurite genes for the genetic manipulation of multi-resistant bacteria. 10% progress of the activities has been achieved.

Role of sorcin in lymphocyte in-vitro proliferation. 100% of the experimental activities were completed. Three manuscripts with progress from 85 to 95% are to be submitted.

Biodegradation of fungicides with endophytic strains of *Trichoderma*. 100% completed project. A scientific paper was developed.

Mechanism of Cardiac Dysfunction induced by circulating histones. 5% progress has been achieved. The supplies were purchased, and the permits for using animals were obtained.

Contamination of Costa Rican corn by toxigenic *Fusarium* species. 10% progress has been achieved, pending delivery of the budget for execution of activities.

Production of lipoteichoic acid (LTA) in *Lactobacillus rhamnosus*. 100% of the activities were concluded, a protocol for obtaining lipoteichoic acid (LTA) was obtained.

2021 CENIBiot Operation The execution of 100% of the project activities is achieved, as well as the total fulfillment of the goals of the AOP.

Effects of endophytic fungi from plant isolates of the *Rubiaceae* family on the morphology and physiology of coffee plants. 100% completed project. It is under manuscript writing.

Extraction of lignin from different *lignocellulosic biomasses* to evaluate its use in the production of materials. Progress of 60%. A researcher is in a training period for the continuation of activities.

Preparation of protocols for handling equipment and training in analysis techniques-Bioprospecting. Progress of 20% has been made, including the organization of equipment handling protocols.



Project

Progress

Internal Projects

Analysis of the consumption of nutrients in in-vitro models of sugar cane (*Saccharum officinarum*) using temporary immersion systems.

10% has been made, with submission of the proposal before the direction of CENIBiot.

Domestication process of Coyol (*Acrocomia aculeata*) as a bioenergetic alternative in Costa Rica.

40% progress has been made. Samples to study the content of fatty acids are being awaited.

Genotyping of the Costa Rican Cas fruit.

100% completed project. The first genome of Cas has been published.

Microbiota associated with the biodeterioration of the artworks at the National Theater of Costa Rica.

100% completed project. A paper was published.

Evaluation of the efficacy of an experimental treatment for Chagas disease using purified fractions from plants of the *Hamelia* genus, collected in Sarapiquí and the Osa Peninsula.

95% progress has been achieved. In an advanced state of purification of the last two compounds of the project to generate structure-activity relations.



Attention to **Students**



09

CeNAT-CONARE
Fellowship students

11

Accompaniments in
graduation projects

41

National interns

16

Supervised
professional
practices



Articulations

National Academic Sector:

- University of Costa Rica
- National University of Costa Rica
- State Distance Education University
- National Technical University
- Costa Rica Institute of Technology (TEC), Cartago
- Research Center in Natural Products (CIPRONA - UCR)
- Environmental Pollution Research Center (CICA - UCR)
- National Center in Food Science and Technology (CITA - UCR)
- Research Center for Tropical Diseases (CIET- UCR)
- Systematics, Genetics and Evolution Laboratory (LabSGE- UNA)

International Universities or Institutes

- Hamburg University of
Technology
- Leibniz University of Hanover
- Institute for the Bioeconomy
(IBE) of the Consiglio
Nazionale delle Ricerche
(CNR) in Florence, Italy.

International Companies

- HOLOGIC
- AgroSpheres
- Bioinsumos Nativa
- Thrive Natural Care
- Nippon Paper Papyrus Co., Ltd.

National Companies

- Cooperativa de Café de Costa Rica (Coopetarrazú R.L.)
- Biotech C.R. S.A.
- Cooperativa de Agroecoturismo y Servicios Múltiples de Cartagena de la Rita de Pococi R.L. (Coopecuna)
- Bio CR Products National Banana Corporation (Corbana) S.A.
- Gracia Brewery
- Corporación de Desarrollo Agrícola del Monte S.A.
- CoopeAgri El General R.L.
- Granja Avícola Santa Marta S.A.
- Industrial de Oleaginosas Americana (INOLASA)
- Gutis Ltda.
- Costa Rican Coffee Institute (ICAFE)
- National Institute of Agricultural Technology (INTA)
- Stein Laboratories
- LISAN Pharmaceutical Laboratory
- Sugar Cane Chamber (LAICA)
- Los Nacientes Venture S.A.
- State Phytosanitary Service
- Rise Kombucha S.A.
- Numu Brewing
- Speratum
- Sur Química S.A.
- Treinta y Cinco Fábricas de Cervezas S.A.

Applied Scientific Research Companies

- The World Association of Industrial and Technological Research Organizations (WAITRO).
- CTA Colombia, Technology Center of Antioquia.
- INISEFOR- UNA. A project was conducted to develop a genotyping method for Melina genetic fingerprinting using microsatellite markers.

6 Agreements

- National Banana Corporation (Corbana)
- SPERATUM
- Inciensa Foundation, FUNIN
- PROMED-CeNAT
- Ministry of Health- CeNAT
- Research Center in Natural Products (CIPRONA - UCR) - CeNAT



National
Advanced **Computing**
Collaboratory
(CNCA)



CNCA

Colaboratorio Nacional de
Computación Avanzada

CNCA

Annual
Operating Plan
(CeNAT-CONARE) 2021

Indicators	Achieved Goal
 Scientific Publications	15
 Knowledge transfer activities	43
 Research Projects	14
 Cluster operation	358
 Agreements	2
 Attention to Students	8

Background

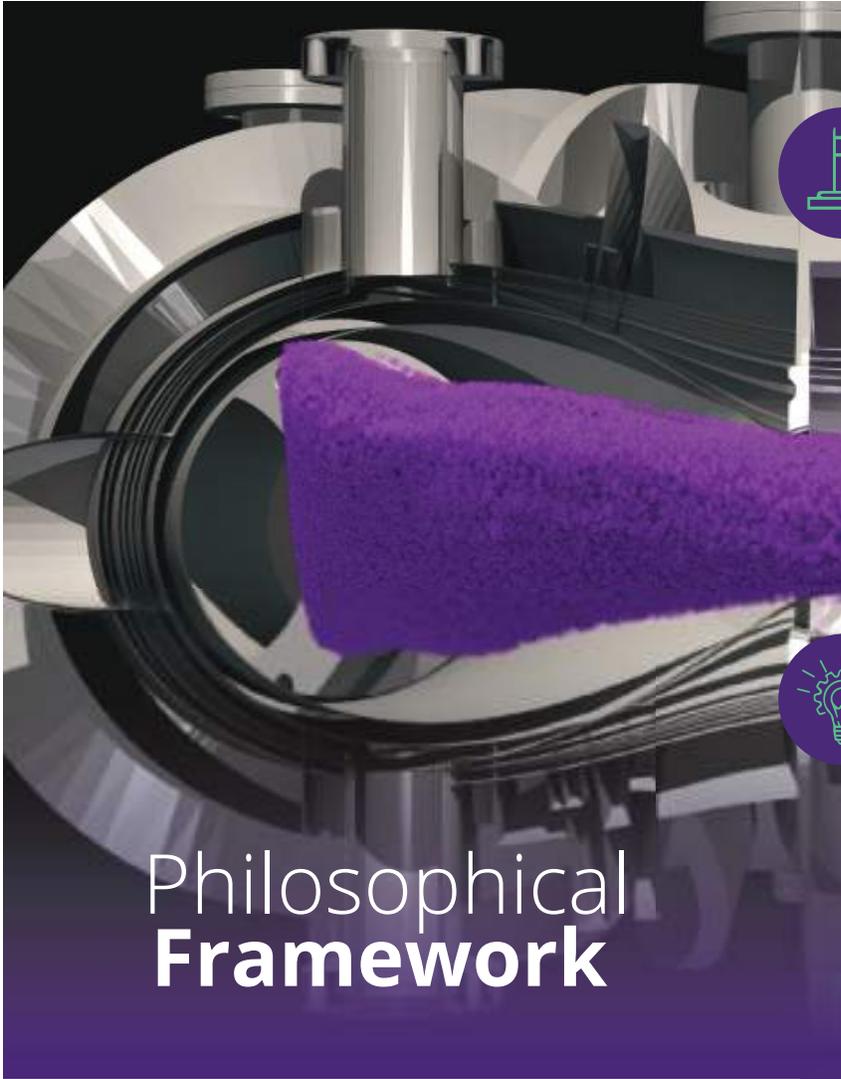
CNCA

The operational indicators of the laboratory derive from the philosophical conception of the institution. It is essential to keep in mind CeNAT's mandate to link the academic, government, industrial, and social sectors. In particular, the CNCA laboratory leverages high technology of advanced computing to achieve institutional objectives.

The National Advanced Computing Collaboratory (CNCA) is a multidisciplinary space where scientific discovery and technological innovation are joined, through the use of advanced computing infrastructure. This infrastructure is made up not only of specialized up-to-date hardware and efficient applications, but also of trained staff in technology and computing, which allow us to take advantage of all this technology in multiple ways. It is for this reason that because of this infrastructure and the professionals, CNCA is able to work on the core dimensions of the development of research projects, training, and service delivery.

The CNCA aims to provide two pillars of scientific development to the Costa Rican community. In addition to theory and experimentation, simulation and analysis of data constitute fundamental pieces in the exploration of the knowledge frontier. To achieve this aspiration, computer hardware and software tools are essential. The work of CNCA members then deals with the computer cluster and the applications installed in it.

The CNCA provides a computational infrastructure of excellence for the development of projects and services that enable the creation of high-impact solutions for society, not only in the technological field but also for the social, health, and science sectors, among others.



Philosophical Framework



Mission

We are a research laboratory that promotes the management of complex information, with professionals specialized in advanced computing who carry out studies with the highest scientific standards, innovating in technological development and articulating studies at national and international levels.



Vision

We aim to be a self-sustaining advanced computing laboratory with the highest technological infrastructure, thus impacting both national and international innovation and development.



Values Enforced at CNCA

- Willingness to good human relationships
- Willingness to continuous learning
- Collaborative innovation at the laboratory work



Principles Enforced at CNCA

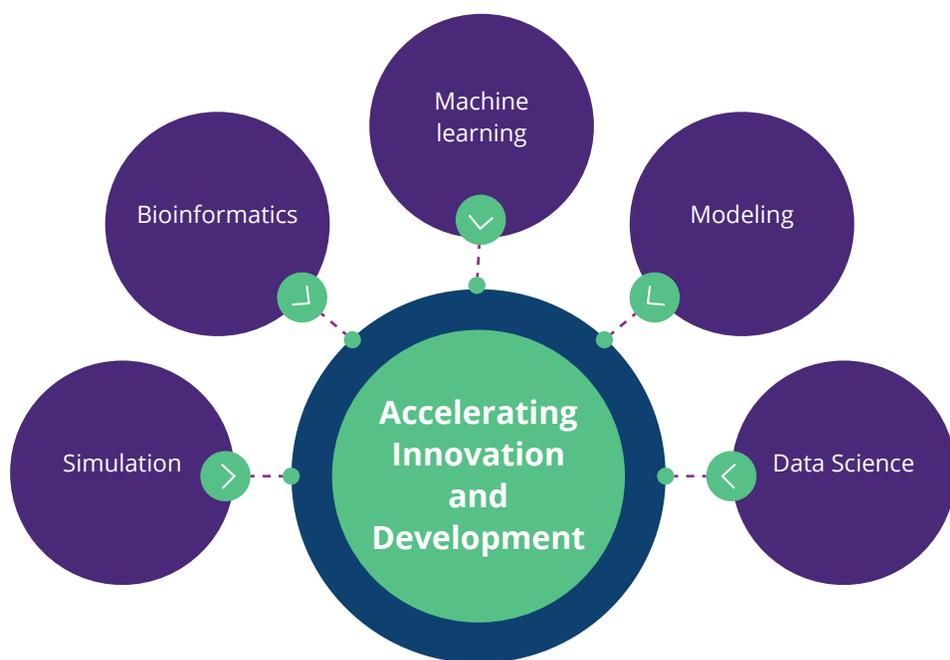
- Collaborative management in the projects that are undertaken
- Creativity in knowledge transfer
- Permanent communication within the work team
- Efficient use of resources



Development Objective of CNCA

To encourage the use of advanced computing in research with complex information that boosts development and innovation, contributing to the achievement of the Sustainable Development Goals in Costa Rica.

Operational Structure **CNCA**



Objectives

To provide advanced computing infrastructure under constant improvement, update, and use for scientific research.

To effectively communicate the results and activities of the collaboratory.

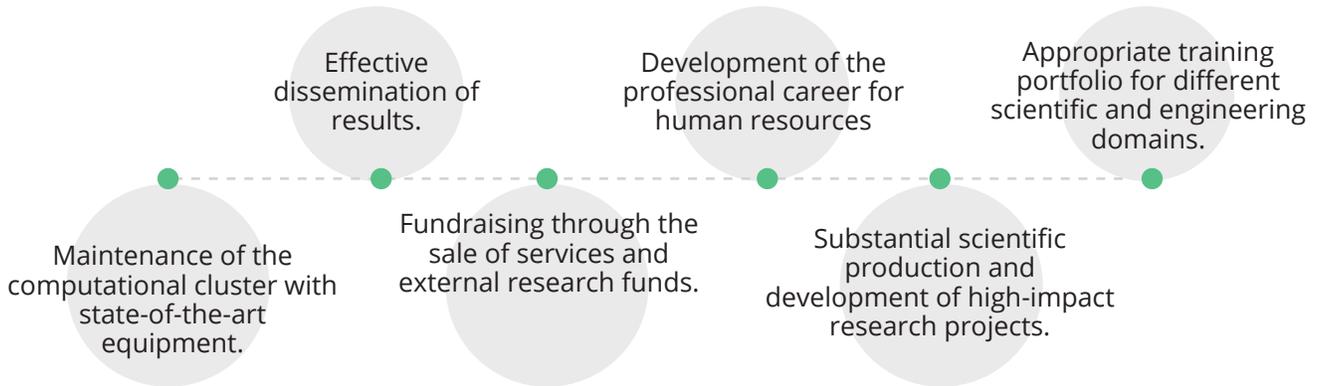
To create mechanisms to attract external funds.

To guarantee the professional growth of the members of the collaboratory.

To enhance the scientific production of the collaboratory.

To strengthen the training offer of the collaboratory.

Strategic Nodes



Impact Indicators

Publications



15 | Are indexed by SCOPUS

Knowledge Transfer



9

Scientific Computing Seminars

Taught

8

Participations at national symposia/ conferences

6

Participations at international academic congresses, meetings, or forums

20

training courses in data analysis and programming with R

Total **43** knowledge transfers.

Total **815** people benefited from knowledge transfers.

Research Projects



12 Public-funded projects:

4

FEES-funded Projects

2

Internal projects

2

CONARE-funded Projects

1

MICITT-funded Project

3

TEC Projects

2 Private-funded Projects

Total **14** computational science and parallel and distributed computing research projects.

Summary of Projects

Project	Progress
	Four FEES-funded Projects:
Search for new antimicrobials in honey, genome, and microbiota associated with stingless bees (Meliponini, Apidae): use of omic techniques at the service of the Costa Rican meliponiculture.	<ul style="list-style-type: none"> ● The transfer of Pac Bio long-read sequences to the Kabré cluster was performed. ● Standardization protocols for eukaryotic genome annotation using the MAKER workflow started. ● Experiments were carried out for the assembly of PacBio long reads with the Canú and Mazurca assemblers. ● Tests for correction of low coverage areas were conducted prior to the annotation tests with the MAKER pipeline. Debugging for the parallel implementation of MAKER in the Kabré cluster. ● Assembly of the Pacbio ccs reads, in addition to an analysis of assembly optimization with the size of the <i>Tetragonisca angustula</i> genome, using the theoretical data and the experimental data obtained from the Kmeros analysis. ● The implementation of the Canu assembler in Kabré was optimized and a comparison was made of the proteins obtained so far against the assemblies made. ● Assembling the PacBio raw reads with 2 different assemblers and comparing the results of both to determine the best result. In addition, genome annotation was performed against the proteins detected in the honey fraction.

Four FEES-funded Projects:

Implementation of a real-time automatic monitoring system for active volcanoes in Costa Rica.

- Progress was made in the creation of a new database of earthquake-volcanic events that will be used by the different classification algorithms. The seismic-volcanic signal analysis workflow was resumed in order to carry out the computational experiments.
- Work was done to refine the program made by Guillermo Cortés for classifying seismic-volcanic signals. This program is foreseen to be applied to the processing of the event database created by volcanologists from the RSN and OVSICORI observatories.
- We have also made progress on the development of deep neural network models for event classification.
- The project officially concluded in July and the final project report was completed.
- Work began on several publications that are in progress. One of these publications aims to use deep neural networks for the classification of earthquake-volcanic events.

Fakenews: An interdisciplinary investigation on the spread of fake news in Costa Rica.

- Review the Crowd Tangle platform to obtain the data that the API returns and compare it with the current data.
- Extraction of data of interest with a time interval from the Crowd Tangle API to store it in the database.
- Research on the elaboration of Work Pipelines oriented to Data Analytics for the Python and RStudio platforms.
- Update of the news collector with CrowdTangle, making it possible to acquire news from digital media from 12 national sources. Also, a repository of pipelines of the techniques implemented in the improvement of the classification algorithm was created, as well as the respective documentation for its implementation.
- The Mongo DB database was updated, which enables making updates to the MediaTIC CMS endpoints for viewing news, and the trends site was updated.
- The maintenance and implementation of the final characteristics of the MediaTIC-Fakenews CMS site for managing downloaded Facebook posts was completed.
- Finally, the news classification algorithm has been completed. The development of the "suspicious" news risk assignment algorithm has begun, and the implementation will be partial, due to delays with the other work teams and the nature of the final result that can be obtained.



Project

Progress

Four FEES-funded Projects:

Diversidad genómica de *Salmonella* entérica y genes de resistencia a los antimicrobianos en poblaciones humanas, animales y alimentos en Costa Rica

- The development of the general pipeline of the ASGARD-SAGA tool concluded, in addition to the final documentation of the ASGARD-SAGA platform.
- The manuscript drafting for the publication of the bacterial genome analysis platform started.
- Improvement of the standardization of the code implementation of the ASGARD-SAGA tool.
- Tests were made for implementation of the new improvements in the configuration files of the tool.
- The manuscript for publication of the ASGARD-SAGA platform in the journal *Current Protocols in Bioinformatics* was written and finished, but thanks to a suggestion by the journal editors, a decision was made to move the publication to the journal *Current Protocols in Microbiology*.

Two internal projects

Assembly and annotation of the Cas (*Psidium friedrichsthalium*) genome for the search of polyphenols of biotechnological interest.

- Preliminary cas genome assembly was performed using PacBio long reads and assays for Cas genome size estimation using a sample of Illumina short reads and the JellyFish tool.
- From PacBio readings using Guava (*Psidium guajava*) and Eucalyptus (*Eucalyptus grandis*), visualization of the functional annotation of the preliminary Cas genome was performed, using the GhostKoala platform and the results obtained from it.
- Phylogenetic analysis was conducted with three plant gene markers, comparing with other Myrtaceae species as outgroups.
- The preliminary assembly of the cas genome was submitted for review to the *Tree Genetics & Genomes* journal. Assays for hybrid assembly of PacBio and NovaSeq reads were initiated.
- Writing and delivery of the manuscript for publication of a short note in the *Genetic Resources and Crop Evolution* journal, as well as the corrections and comments indicated by the editors. A comparison of the assembled Cas genome with the latest published version of the Guava genome was performed.
- Finally, the Cas genome assembly was published in the *Genetic Resources and Crop Evolution* journal. The hybrid assembly strategy of PacBio and Illumina readings was performed.

Project

Machine Learning applied to bioaquatic recognition of tropical birds.

Progress

- All the neural networks that make up the "Sparrow" ensemble were trained for the classification of tropical bird species in audio recordings. Also, all the performance metrics of the Sparrow neural networks were obtained for comparison with the "Turdus" neural network ensemble.
- Programming of the bagging algorithm to use as a baseline to compare with respect to the proposed concept of diversity.
- Writing of the article on the construction of neural network ensembles based on the concept of diversity started.
- Execution of bagging and diversity experiments for large ensembles (25 networks) to measure the scalability of their performance.
- Design of experiments to be carried out and the general structure of the article on the construction of neural network ensembles based on the concept of diversity.
- Execution of the experiments in the three types of neural network assemblies to be compared; likewise, improvements have been made in the code, seeking better results, eliminating potential bugs, and an experiment design process has been carried out, with the aim of having the bases for writing the paper ready.

Two CONARE-funded Projects

Advancing plasma physics computer simulations with the latest high-performance computing techniques.

- Access was obtained to a proxy app developed by the MPCDF based on the GEMPIC plasma physics code.
- The installation of the software and test runs have been carried out.
- Evaluation of the AMReX platform to understand if it is safe against parallel threads. Also, the construction of the AMPI-Charm, AMReX, and GEMPIC software to check if it is possible to solve the load balancing problem in GEMPIC without modifying the source code.
- Integration between the AMReX framework and AMPI.
- Some basic code has been implemented to test and develop skills in using OpenMP for GPU-accelerated code development. Work has been done on the adaptation of a mini-app that calculates a stable heat transfer in 3D.

Industry Project 4.0

- Definition of database security and encryption, including the definition of profiles and debugging.
 - Database backup notifications, including issuer configuration and process documentation.
 - Database and final structure update, including dictionary analysis and debugging of R drivers with the database ecosystem.
 - Redefinition of the web portal for displaying information. The database is also redefined to be compatible with the website and, furthermore, the technology was not necessary as it had been thought at the beginning of the project.
 - The algorithm for processing the profiles and opinions of the university majors was improved, being now a more robust tool that allows for better trimming the display of skills in each discipline.
 - The tool for calculating skill ratios has been successfully completed.
- Proportion detection is complete. A presentation was made in the Educational Journal of UNED. The article will be published in the January edition.
- The probabilistic classification model has been started to find the probability of automation of each discipline.
 - The website was significantly affected since the assistant in charge left the position and the progress of the site in the end was almost nil, because there were problems with the platform used. The development of an alpha prototype has been foreseen recently to present it and seek approval to start its development next year for six months.

A MICITT-funded Project

Understanding the impact of COVID-19 in Costa Rica with a computational platform for epidemiological simulations

- Construction of the COVID-19 epidemiological simulation pipeline for Costa Rica, including a website to publish the results of the model used for the projections.
- Modeling of the spread of COVID-19 in Costa Rica using a graph model.
- Incorporation of mobility, vaccination, and working relationships in the model.
- Current work is being performed on model adjustment and scenario development.
- Implementation of vaccination scenarios, the opening of schools, and lifting of restrictions to small and mass social events completed.
- Solution of the model mismatch in the number of deaths reported.
- Work was done on the configuration and simulation of the epidemiological scenarios for the opening of schools, vaccination, and social events. The model developed and the results of the scenarios were included in a scientific paper called "Understanding COVID-19 Epidemic in Costa Rica through Network-based Modeling", which was submitted and accepted at the 2021 CARLA conference.
- The scientific paper "Understanding COVID-19 Epidemic in Costa Rica through Network-based Modeling" was presented at the 2021 CARLA conference. Work was done on improvements to the Corona++ code and the COVID-19 model in Costa Rica, including the correction of the vaccination model, the implementation of the restart to work with only one graph and thus reducing the execution time of the simulations by half, and the time-windowed optimizer of the basic reproduction number r_0 to automatically adjust this model parameter.

Three TEC Projects

Computational plasma simulation infrastructure for the design and verification of Stellarator-type magnetic confinement devices

- Two papers related to this project were completed and sent to the PEARC21 conference. The developed papers are titled: "Powering Plasma Confinement Simulations: from Classic to Photorealistic Visualizations" and "Adaptive Plasma Physics Simulations: Dealing with Load Imbalance using Charm++".
- In addition, a collection of photorealistic images of the plasma generated by the SCR1 reactor was generated as part of Luis Campos' master's thesis.
- The articles "Powering Plasma Confinement Simulations: from Classic to Photorealistic Visualizations" and "Adaptive Plasma Physics Simulations: Dealing with Load Imbalance using Charm++" were accepted for presentation and publication at the PEARC21 conference.
- We participated at the PEARC 2021 conference where both accepted articles were presented.
- The project concluded and during this quarter the necessary steps were taken with VIE TEC.
- Presentations of some of the results obtained from this project were also made in dissemination forums such as the Americas HPC Collaboration Workshop at the 2021 CARLA conference and the 18th Annual Workshop on Charm++ and its Applications.

Characterization of the subduction zone geometry, crustal deformation, and stress transfer in southern Costa Rica using big data analysis and computer simulations.

- A visualization was created with the crustal deformation simulation pipeline. The goal of this visualization is to serve as a didactic element for several of the laboratory's initiatives. Work was also restarted on the seismological signal analysis pipeline for a paper in the second half of the year.
- Work was done to reactivate the workflow for the location of seismic events, particularly those of low magnitude.
- A new version of the neural network model was integrated into the EQTransformer tool. Work is underway to prepare a scientific paper that is planned to be submitted to the 2021 Bioinspired Processing (BIP) conference.
- Preparation of a proposal for a continuation research project to this one, which was submitted for consideration at the Costa Rica Institute of Technology.
- Writing and submission of a scientific paper with the results of the project. The article presents the geological panorama and describes the computational infrastructure to detect seismological signals. The article was accepted at the 2021 IEEE Bioinspired Processing (BIP) conference.
- The project officially concluded with the delivery of the final report in late September.
- Efforts are done to continue exploring themes for a project that will continue this theme. The new project proposal was sent for approval to the Vice Chancellorship of the Costa Rica Institute of Technology.

Automatic optimization of parameters in high-precision epidemiological simulations

- The optimization techniques for epidemiological simulations were reviewed, to ensure that the latest scientific proposals on this subject were used. The Corona++ simulator code was analyzed to identify several details related to the calculation of variables of interest (reported cases and deaths) and to determine possible parameters to be optimized.
- Various topics of the Corona++ simulator have been explored and the structures of the people graphs that the simulator builds were examined to understand the properties.
- The different ways of parallelizing the code to speed it up were studied.
- Design of the general structure of the optimizer and the implementation of a first stage that allows restarting a simulation using the same random graph. The number of runs is variable and is intended to be the same number of iterations used when generating the real-case estimate.
- Work was done on the implementation of the optimizer in the Corona++ code and on the test cases to verify correctness.

Two Privately Funded Projects

Central American Network for Management of Epidemiological Data.

- Creation of the network logo, establishment of the Facebook page, official email, official network website, and preliminary study of the availability of epidemiological data associated with COVID-19 in each Central American country.
- General processing of epidemiological data in Costa Rica and Guatemala.
- Organization of seminars on mathematical models and epidemiological information systems.
- Continuation of data processing and modeling of epidemiological data from Costa Rica and Guatemala.
- Recruitment campaign to publicize the network. The integration of new members from different areas and countries was achieved.
- Organization of the RedCMDE Symposium event on epidemiological models and simulations, with the participation of five researchers who spoke about their projects and perspectives in the modeling and simulation of epidemics.
- In the publication on the modeling of epidemiological waves in Costa Rica and Guatemala, work was done on the study of different optimization methods for the parameters of the Richards epidemiological model and on the automation of curves obtained for the first wave. In addition, ways of coupling the result of the Richards model with information on population mobility and geospatial data were studied.



Project

Progress

Urban vehicular mobility with Waze.

- Daily monitoring of Waze data downloads and construction of mechanisms that allow easier monitoring and quality assurance of downloaded data.
- Continuation of the daily monitoring of Waze downloads, from the CNCA's Andalan server and from Azure.
- Updating the alerts, intersections, and JAMS packages by day, month, and year. Update of the jsons of the database.
- Comparison of the parquet files generated with spark versus the packages generated without spark. Creation of a notebook to verify the quality of the downloaded and processed data.
- Contribution to the State of the Nation report with Waze data up to August 2021.
- New features were incorporated into the Telegram bot to run a daily report on the status of downloads from Azure and CNCA servers.
- Generation of parquet files for each of the months involved, database update, comparative report of parquet files updating, and resumption of the paper on Urban Mobility with Waze during the COVID-19 health emergency.



Computational Infrastructure

358 days a year of operation of computer services that resulted in:



430

Accounts with access to computing infrastructure services.

89474,39

Science hours in simulations and data processing.

496

Cluster users.



Attention to **Students**



8 students at the lab:

7

CeNAT-CONARE Fellowship students.

1

Graduate intern.



Articulations

Academic sector:

- Articulation with the 5 public universities, through research projects and FEES projects.

Partnership with international and national companies:

- Ministry of Science, Technology, and Telecommunications (MICITT)
- Ministry of Environment and Energy (MINAE)
- Ministry of Agriculture and Livestock (MAG)
- Ministry of Health
- Public Universities (UCR, TEC, UNA, UNED, UTN)
- Instituto Nacional de Aprendizaje (INA)
- Professional Association in Informatics and Computing (CPIC)
- Ministry of Public Works and Transportation (MOPT)
- Chamber of Information Technologies (CAMTIC)
- Lawrence Livermore National Laboratory
- Advanced Computing System for Latin America and Caribbean (SCALAC)
- Barcelona Computing Center (BSC)
- Central American Higher University Council (CAUCA)
- Association of Professionals of the Comptroller General of the Republic
- Supreme Electoral Court (TSE)

CONARE NETWORK

One of the services of RedCONARE and the ICT departments of the universities is Eduroam, which has the following indicators:

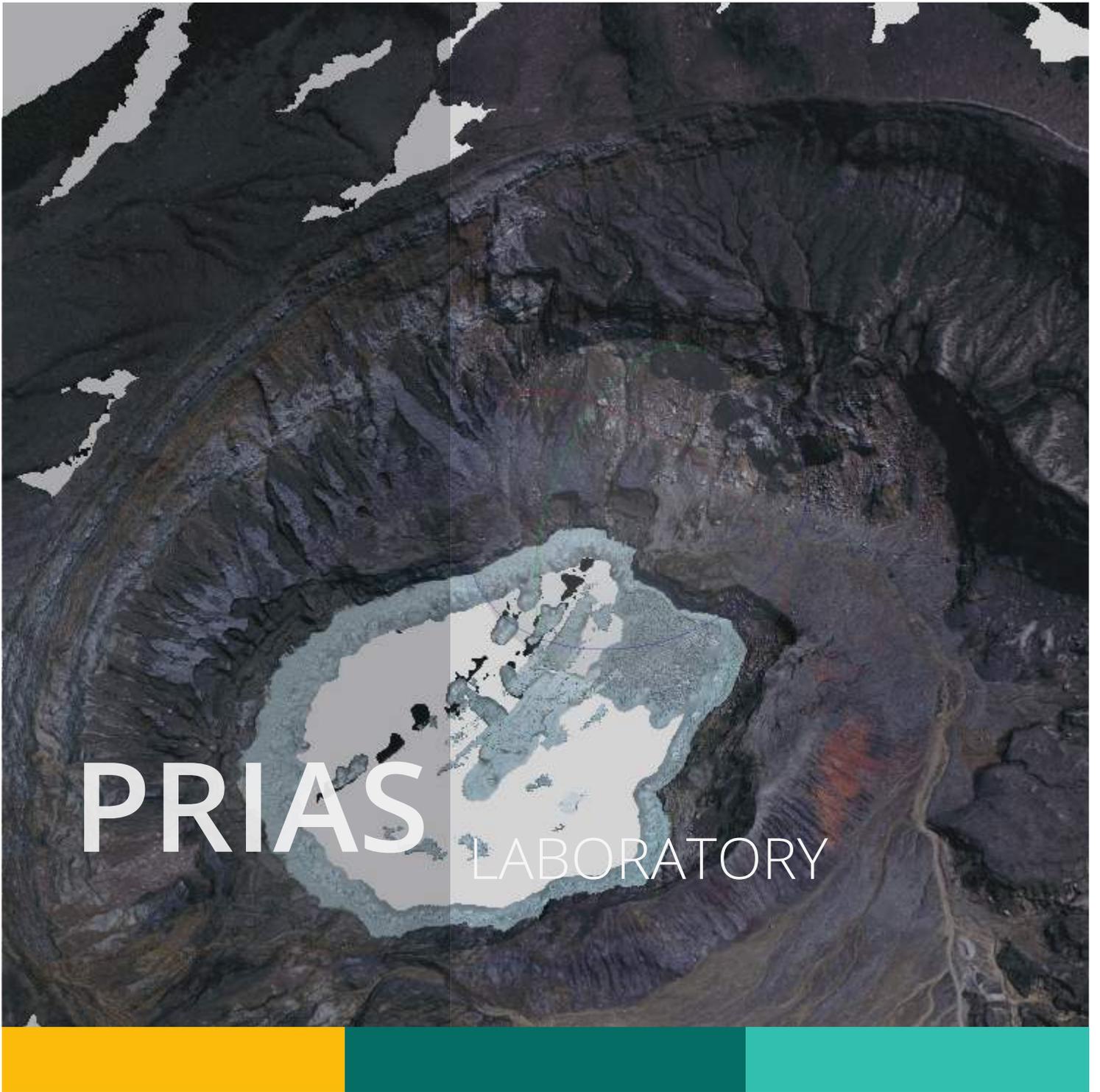
- Network services available to approximately 125,161 students, staff, and teachers.
- There are more than 2 billion authentications of the Eduroam network in international territories.
- Access to Eduroam internationally in 106 countries that participate in the deployment of the connectivity network.
- Eduroam deployed in Wireless Internet Zones (Zii) through which free Internet access is provided to the population in 515 Wireless Internet Zones (Zii).

Eduroam network deployed in the headquarters and campuses of the five public universities. Research centers and the CONARE-CeNAT building.

2

Agreements:

- Agreement with the Professional Association in Informatics and Computing (CPIC) and CeNAT.
- Agreement with the Association of Professional Employees of the CGR and CeNAT.



PRIAS

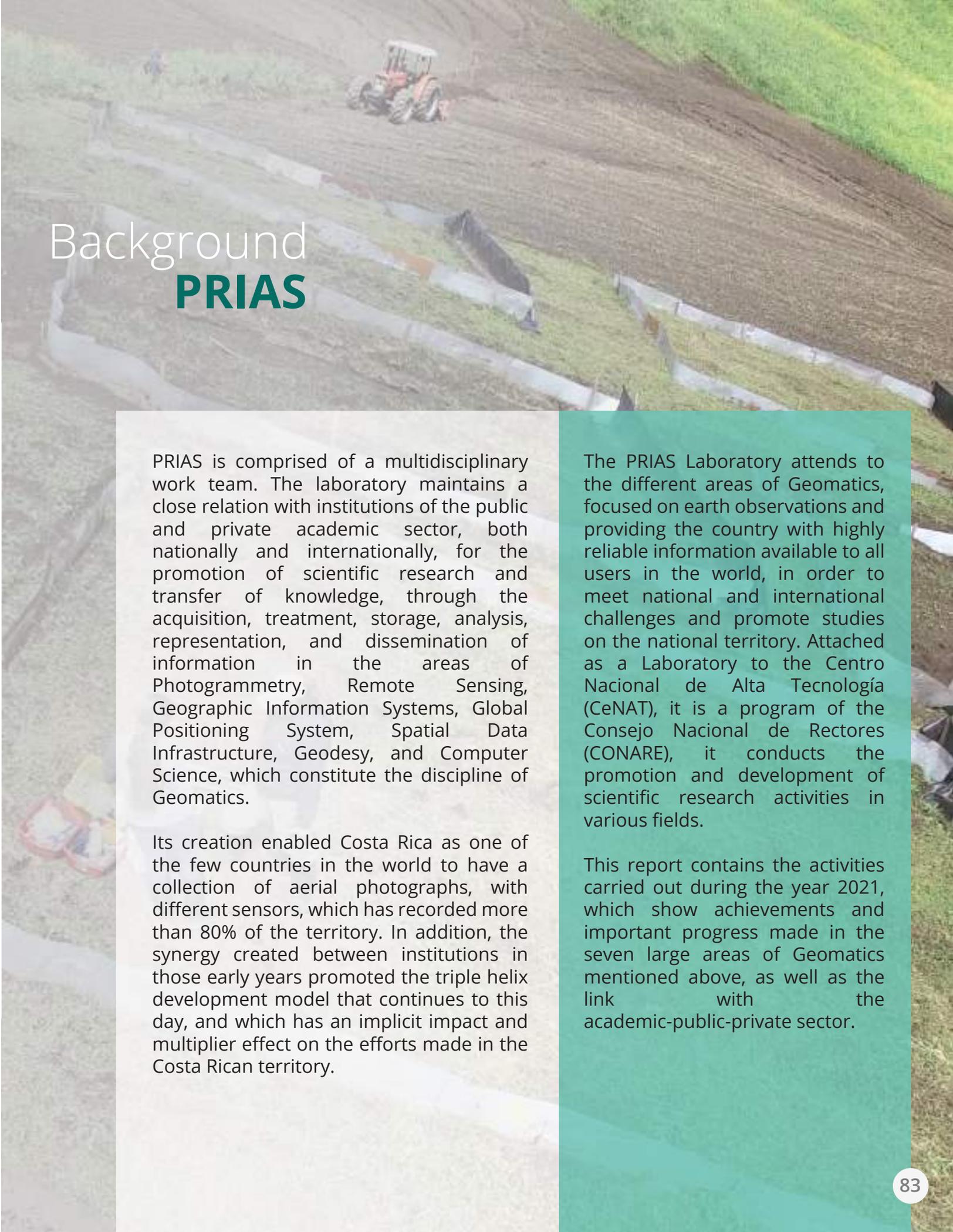
LABORATORY



PRIAS

Annual
Operating Plan
(CeNAT-CONARE) 2021

Indicators	Achieved Goals
 Scientific Publications	16
 Knowledge transfers	7
 Research Projects	11
 Agreements	3
 Attention to Students	11



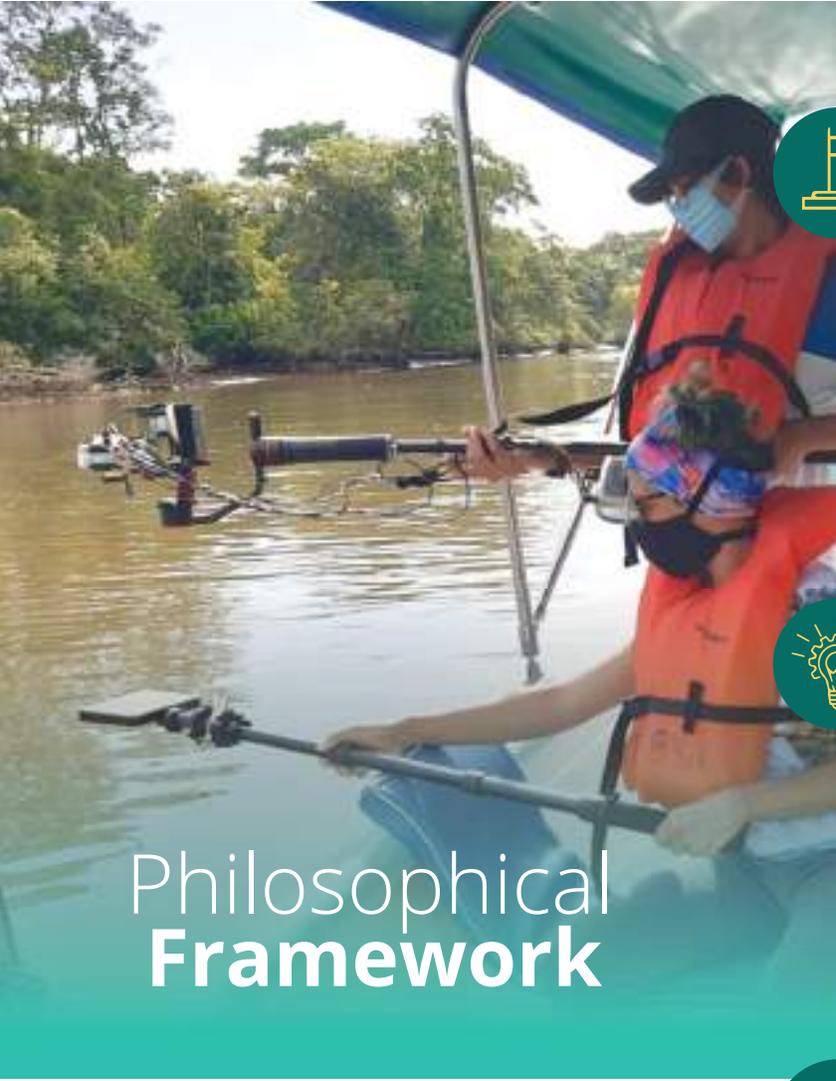
Background **PRIAS**

PRIAS is comprised of a multidisciplinary work team. The laboratory maintains a close relation with institutions of the public and private academic sector, both nationally and internationally, for the promotion of scientific research and transfer of knowledge, through the acquisition, treatment, storage, analysis, representation, and dissemination of information in the areas of Photogrammetry, Remote Sensing, Geographic Information Systems, Global Positioning System, Spatial Data Infrastructure, Geodesy, and Computer Science, which constitute the discipline of Geomatics.

Its creation enabled Costa Rica as one of the few countries in the world to have a collection of aerial photographs, with different sensors, which has recorded more than 80% of the territory. In addition, the synergy created between institutions in those early years promoted the triple helix development model that continues to this day, and which has an implicit impact and multiplier effect on the efforts made in the Costa Rican territory.

The PRIAS Laboratory attends to the different areas of Geomatics, focused on earth observations and providing the country with highly reliable information available to all users in the world, in order to meet national and international challenges and promote studies on the national territory. Attached as a Laboratory to the Centro Nacional de Alta Tecnología (CeNAT), it is a program of the Consejo Nacional de Rectores (CONARE), it conducts the promotion and development of scientific research activities in various fields.

This report contains the activities carried out during the year 2021, which show achievements and important progress made in the seven large areas of Geomatics mentioned above, as well as the link with the academic-public-private sector.



Philosophical Framework



Mission

We are a geospatial research laboratory made up of a specialized team of professionals who work with the highest scientific standards in earth observation, articulated with higher education in Costa Rica and international cooperation, within the framework of innovation with the public, private, and social sectors.



Vision

We aim to be a self-sustaining scientific research laboratory with high impact on decision-making both nationally and internationally to strengthen geospatial innovation, by transferring technical and scientific knowledge at the academic, socioeconomic, and environmental levels.



Values Enforced at PRIAS

- Empathy in collaborative work
- Willingness to multidisciplinary learning
- Creativity to face improvements
- Commitment to the goals set in each project



Principles Enforced at PRIAS

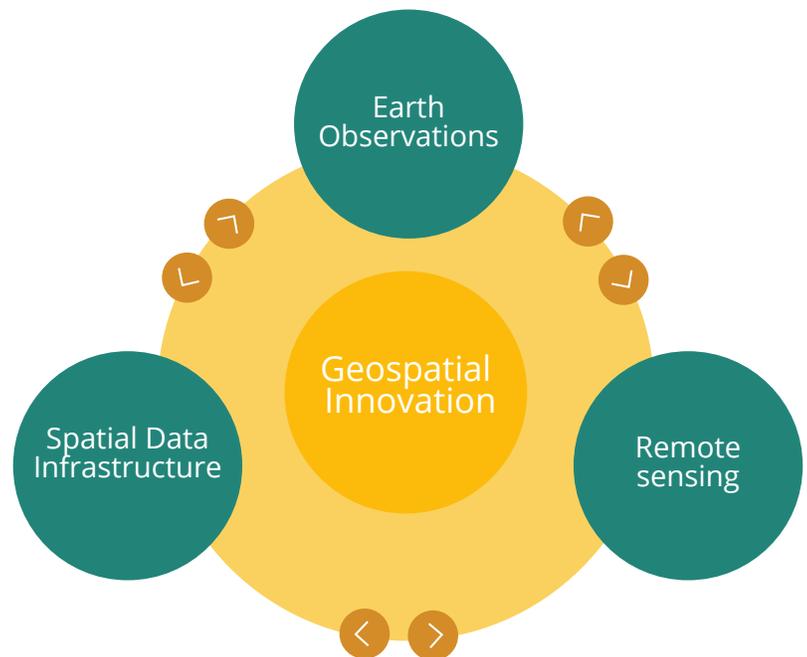
- Efficient use of technological infrastructure
- Interdisciplinary collaborative work
- Knowledge transfer adapted to populations
- Willingness for constant improvement of the projects that are undertaken



Development Objective of **PRIAS**

To develop geospatial research that contributes to the knowledge of the Costa Rican territory and the achievement of the Sustainable Development Goals, thus enabling a contribution in decision-making, through specialized scientific-technical assistance projects that empower improvement in the academic, socioeconomic, and environmental areas in the region.

Operational Structure of PRIAS



Objectives

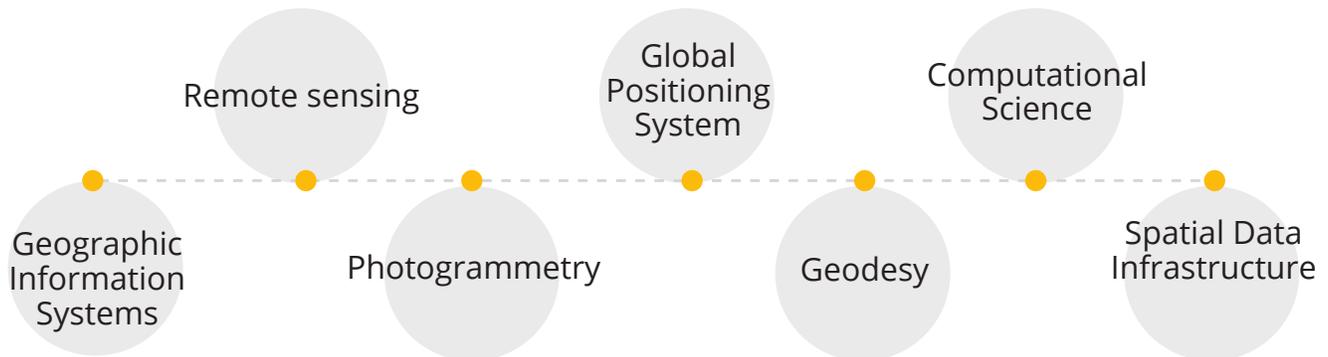
To position the image of the laboratory through the establishment of strategic alliances that allow for services and scientific-technological exchange.

To attract additional resources for the development of research and innovation at PRIAS Laboratory.

To improve the internal processes of the PRIAS Laboratory on geospatial data management.

To increase the operational capacities at the PRIAS Laboratory, for the maintenance of a culture of continuous improvement.

Strategic Nodes



Impact Indicators



Research Projects



8 Public

5

Internal

2

PEN

1

CONICIT funds

3 Private

3

Other funds

Summary of Projects

Project	Progress
Internal Projects	
Internal Implementation Project of distributed storage in datacenter.	<p>The following activities are being worked on, which are responsibility of the Task Force team, which is made up of researchers Francini Corrales, David Romero, and Ketcha Hernández Vargas:</p> <ul style="list-style-type: none"> ● Implementation of a backup system for the information generated by PRIAS' researchers, as well as weekly monitoring of said information. ● Implementation of a knowledge base (Wiki js) as a virtual machine in the PRIAS data center. This knowledge base has been fed with various pieces of information: <ul style="list-style-type: none"> a- Geoserver and geonetwork section b- GNSS section c- Datacenter section d- Support section e- Laboratory licensing information section. f- Section regarding backups. <p>This knowledge base has been fed by Ketcha Hernández, David Romero, and Francini Corrales to date, and the necessary actions are being managed so that other researchers can also feed the knowledge base.</p>

Internal Spectral Signatures Project.

Work is currently being done on the processing of spectral data from the tours carried out in 2021. In addition, the review of two scientific articles derived from the research of student Adriana Fallas focused on the line of research of spectral signatures (TFG scientific article mode) continues. Work is also being done on the technical support of student Arleth Porras on the subject of spectral signatures associated with her research work and on the planning of a field trip with the student to collect multispectral data for signature analysis from RPAS. In this sense, a support tour for the fellow student was scheduled, with multispectral information gathering with drone flights, with the aim of strengthening capacities and skills in the capture, analysis, and processing of spectral signatures.

Furthermore, as part of the PRIAS internal project and thanks to the relationship and linkage established in the past with the company by Researcher Heileen Aguilar Arias, for the Spectral Signatures Library project, a Framework Agreement of Cooperation between CeNAT and the company MTF Teca de Costa Rica Ltda. was generated, which focuses on increasing the collection of spectral signatures of PRIAS through MTF Teca and its Living Laboratory and thus take advantage of the experience and capabilities of both entities for research and growth.

At the level of specialized equipment, in the year 2021 the purchase of a new Field Spectroradiometer Field Spec 4 and accessories was done, with the aim of updating the equipment that the laboratory currently has. To do this, it was necessary to acquire an instrument that covers a wider wavelength range, going from 350 to 2500 nm, which will allow the development of new research associated with the Spectral Signature Library Project and as an input of high scientific value for research carried out by interns and students of the CeNAT-CONARE scholarship program that currently develop research in the area of Spectroradiometry, in conjunction with the laboratory.

Internal Implementation of Spatial Data Infrastructure PRIAS Project.

Advances within the development of the Hephaestus system include:

- Validation of the loan form. The validation includes:
 - a- Prevention of duplications on equipment loans.
 - b- Listing only devices and consumables that are available.
 - c- Loading of packages that do not include previously loaned equipment on the set dates.

Internal Implementation of Low-Cost GNSS Data-Receiving Equipment Project.

The project's continuity under another name and its evolution are being assessed, considering that the portable GNSS station that the laboratory currently has is being used in different internal projects and in supporting research by students of the CeNAT-CONARE scholarship program. At this time, information is being generated in the field to assess needs and define the implementation of these tools.

Unmanned Aircraft for Research (UAV) Internal Project.

With the arrival of researcher David Romero, the internal Unmanned Aerial Ships for Research Project (NANTI) has been reactivated. It incorporates and integrates the use of UAVs and photogrammetry, in the Spectral Signatures project and in the development of at least two research works by students of the CeNAT-CONARE scholarship program.

Project

Progress

Joint Projects with the State of the Nation Program (PEN)

Local productive structures: productive and labor chains and territorial value chains in Costa Rica (PEN).

The agreement with SINAC, PEN, PRIAS is in the process of endorsement by SINAC to be sent and signed among the parties.

The results of the evolution layers from 1955 to 2021 were finished.

The urban stain layer for the years 1986, 1996, 2006, 2014, and 2019 has already been prepared for future use.

Cantonal Historical Geospatial Representation of Costa Rica period 1905-2014 (pen), a Project with State of the Nation Program (PEN).

We are in talks with student Jose Pablo Arguedas from the UCR School of History, to use in his master's thesis the information generated from the bordering cantons in the south of the country -Corredores and Golfito- to analyze the evolution they have had with their export products. This is an opportunity to give continuity to the project that is being considered. Researcher Christian Vargas collaborated with the development of Chapter 4 "Harmony with Nature", of the State of the Nation Report, 2021 edition, in the document called "Tools for the analysis and territorial approach of forest policies in Costa Rica".

CONICIT-Funded Projects

Applicability of Sentinel-2, DESIS, and Landsat 8 satellite imagery data for water quality studies, on water bodies related to crop coverage surroundings of the National Térraba-Sierpe Wetland (MONEO-WET).

Spectral absorption, spectral dispersion, and solar brightness parameters are defined for Costa Rica.

Preliminary maps have been generated where changes in the concentration of chlorophyll and suspended solids are associated with changes in land use and the agricultural dynamics of the region.

There is evidence of an increase in oil palm plantations, which could be related to the increase in the concentrations of the variables under study between 2019 and 2021.

An extension to the Letter of Agreement is under review by CeNAT, in accordance with the DLR.

Contracts for professional services are being planned.

Private Funds

Conserving Biodiversity through Sustainable Management of Productive Landscapes and Pastures in Costa Rica-MOCUPP.

The IV quarterly progress report was presented to UNDP in the month of December. To date, the progress made in the pasture layer corresponds to 88.89% of the country's total.

During this period, technical support, assistance, and improvements to processes have been provided, including:

- Implementation of a storage protocol within DatosPRIAS to standardize the organization of information and its constant updating.
 - Start of the process of creating a data mirror to safeguard the integrity and availability of the information generated by the MOCUPP project.
- Regarding the progress made on the layers of the different productive landscapes, the following are detailed:

To date, progress in the Tree Cover (AC) layer corresponds to 88.89% of the country's total. The areas of the cantons that remain in production are: Bagaces, Cañas, Tilarán, Abangares, San Ramón, Montes de Oro, Esparza, San Mateo, Orotina, Palmares, Atenas, Naranjo, Zarcero, Sarchí, Grecia, Poás, Alajuelita, Aserrí, Barva, Belén, Cartago, Curridabat, Desamparados, Dota, El Guarco, Escazú, Flores, Goicoechea, Heredia, La Unión, León Cortés Castro, Montes de Oca, Mora, Moravia, San Isidro, San José, San Pablo, San Rafael, Santa Ana, Santa Bárbara, Santo Domingo, Tarrazú, Tibás, Vázquez de Coronado, Turrialba, Oreamuno, Alvarado, Paraíso, and Jiménez.

In addition, carrying out the closure of the productive landscapes of Pineapple and Oil Palm is being planned, together with the publication of the detection layers of loss-gain changes and no change of Forest Coverage in the period 2018-2019 and with the publication of their metadata. In addition, the delivery of the respective reports on the preparation of the layers of loss-gain and no change in tree cover was done.

Project

Digital system for monitoring illegal logging in the Golfo Dulce Forestry Reserve and a study area on the Pacific side of La Amistad National Pilot Project

Development of three technological tools for marine ecology and its application on the Antillean manatee in Costa Rica Project

Progress

The technical report on the final deliverables 2 and 3 of the project was presented with the results, conclusions, and recommendations. Among the final outcomes, it has been highlighted that there is a relationship between the slope and the distance to the roads with the possibility that a sector suffers logging. Likewise, the possibility to determine, by means of remote sensors, sites where logging has been carried out has been made evident, which, when comparing the results with official logging permits, could help detect illegal logging.

The project has concluded at a technical level and the development of a scientific paper derived from the research continues, in conjunction with international counterparts.

Carrying out the following field trips as scheduled for 2021.

The Network of Data Collectors reached 50 people. Digital materials were shared within the network and individualized monitoring was carried out during the field trips, to reinforce the induction regarding the use of the application.

The purchase of energy protection equipment was requested for the external disks that support the recordings made in the field, as well as USB power equipment: 2 UPS R-UPR 508 500VA 250W Regulator units, 8 outputs, and 1 charging station 5-USB Ports 6.

The passive acoustics algorithm is currently undergoing code refactoring and is still under development. The vocalization detection stage using deep learning is already concluded, and part of the code is being ported to count individuals. There are more than 50,000 recording hours as of the date of this report, which are being processed by the algorithm. In addition, recordings of West Indian manatees and Florida manatees were obtained to train the vocalization detection stage, thanks to contributions from researchers in Florida and Brazil.

The marine ecology application was brought to its beta version, both in Android and iOS operating systems, and their publication in the Play Store and Apple Store, respectively, was managed. It was approved by the Play Store. For the Apple Store, work is underway to implement the requested changes. The assembly of the species guide is pending, whose illustrations are still in the process of being developed. 40 scientific illustrations were developed, revised, and corrected in their linear version. They are in the process of painting. The project was broadcast on the Raíz online program: (<https://open.spotify.com/episode/2xOb5UpIWvdQlpC2L8ZPko>) and the production of a report on the 7 Días program on Channel 7 was managed, to be produced in December 2021 and published in January 2022.

Negotiations were made with the Kölbi and Yamaha Marino brands to sponsor -respectively- a spot for TV and radio, and 11 signs to be placed on the docks of the three protected areas. These procedures are still in process.

Negotiations were initiated with COLAC of the Cabo Blanco Marine Management Area and with tour guides who work with humpback-whale tourism, so that they use the marine ecology application, since part of the project's commitments to NATGEO is to use the App in other areas beyond manatee habitats.

A review of the project was made on the 7 Días TV program by Telenoticias.





Attention to **Students**



11 Students at the lab:

6

CeNAT-CONARE
Fellowship
students

5

National
internships



Articulations



National Academic Sector (5)

- University of Costa Rica.
- Costa Rica Institute of Technology.
- National University of Costa Rica.
- State Distance Education University.
- National Technical University

International universities or institutes (37)

- Organization for Economic Cooperation and Development (OECD)
- Central American Integration System (SICA)
- National Aeronautics and Space Administration (NASA)
- Global Environment Facility (GEF)
- German Aerospace Center (DLR)
- German Society for International Cooperation (GIZ)
- United Nations Development Program (UNDP)
- United States Agency for International Development (USAID)
- Regional Visualization and Monitoring System (SERVIR)
- Silvacarbon
- Food and Agriculture Organization of the United Nations (FAO)
- System for Earth Observations, Data Access, Processing & Analysis for Land Monitoring (SEPAL)
- European Commission
- Google Earth Engine
- Natural Capital Project
- Global Fishing Watch
- University of Maryland
- Central American Aeronautics and Space Association (ACAE)
- Boston University
- United States Geological Survey (USGS)
- Stanford University
- Fairbanks University
- Secretariat of the Group on Earth Observations (GEO)
- Community of Latin American and Caribbean States (CELAC)
- International Union for Conservation of Nature (IUCN)
- University of British Columbia
- Georgia University
- UNDP Biodiversity Lab
- United Nations (UN)
- National Geographic Society
- Gordon and Betty Moore Foundation
- Inter-American Development Bank (IDB)
- United States Forest Service
- Secretariat for Central American Economic Integration (SIECA)
- Waitt Foundation
- Copernicus Reference Center of the University of Chile
- Government of Ecuador

National Universities or Institutes (55)

- Ministry of the Presidency
- National Center for Geoenvironmental Information (CENIGA)
- Tropical Agricultural Research and Higher Education Center (CATIE)
- Central Bank of Costa Rica (BCCR)
- Banco Popular y de Desarrollo Comunal (BPDC)
- National Monitoring System for Land Cover and Use and Ecosystems (SIMOCUTE)
- State Phytosanitary Service
- Municipality of San José
- Municipality of Garabito
- Costa Rica National Institute of Statistics and Census (INEC)
- Consejo Nacional de Rectores (CONARE)
- Ministry of Environment and Energy (MINAE)
- National Geographic Institute (IGN)
- State of the Nation Program (PEN)
- Ministry of Agriculture and Livestock (MAG)
- Costa Rican Institute of Electricity (ICE)
- National Power and Light Company (CNFL)
- National Meteorological Institute of Costa Rica (IMN)
- Costa Rican Coffee Institute (ICAFFE)
- National Forest Financing Fund (FONAFIFO)
- National Institute of Agricultural Technology (INTA)
- Ministry of Science, Technology, and Telecommunications (MICITT)
- National Commission for Risk Prevention and Attention to Emergencies (CNE)
- Instituto Nacional de Aprendizaje (INA)
- National Chamber of Pineapple Producers and Exporters (CANAPEP)
- National Chamber of Palm Producers (CANAPALMA)
- Sectoral Planning Secretariat of Environment, Energy, Ocean, and Territorial Planning (SEPLASA)
- Livestock Corporation (CORFOGA)
- Regional Agricultural Cooperative of Milk Producers (COOPELECHE)
- Environmental Quality Management Directorate (DIGECA)
- Institute of Aqueduct and Sewers (AyA)
- Climate Change Directorate (DCC)
- Ministry of Economy, Industry, and Commerce of Costa Rica (MEIC)
- Administrative Environmental Court (TAA)
- National Commission for Biodiversity Management (CONAGEBIO)
- Inter-American Institute for Cooperation on Agriculture (IICA)
- National Council for Scientific and Technological Research (CONICIT)
- Comptroller General of the Republic (CGR)
- Ministry of Housing and Human Settlements (MIVAH)
- Vice Ministry of Water and Oceans
- Costa Rican Institute of Fisheries and Aquaculture (INCOPESCA)
- National Geographic Institute (IGN)
- National University of Costa Rica
- National System of Territorial Information (SNIT)
- SIRGAS Network (Geocentric Reference System for South America)
- Ministry of Foreign Trade (COMEX)
- Agronomic Research Center (CIA)
- REDD Secretariat (Reducing Emissions from Deforestation and Forest Degradation)
- Water Directorate
- General Directorate of Civil Aviation (DGAC)
- Center for Research and Training in Public Administration (CICAP)
- CENFOTEC University (Training Center in Information and Communication Technologies)
- Latin American University of Science and Technology (ULACIT)
- Volcanological and Seismological Observatory of Costa Rica (OVSICORI)
- The National Seismological Network of Costa Rica (RSN)



International Companies (7)

- EO Data Science
- Picturatus
- Planet Inc.
- Yamaha Marine
- Microsoft Corporation
- Pacific Scientific Institute
- Earth Blox

National companies (9)

- GAAS Real Estate
- Geotecnologías S.A.
- Aeronautical Education Academy (AENSA)
- MTF Teca Ltda.
- Pineapple Development Corporation (PINDECO)
- Panamerican Woods Plantations S.A.
- PALMA TICA
- Manejo Técnico Ambiental MTA S.A.
- Kölbi

Agreements:

- Letter of Understanding for the provision of territorial information signed between the Ministry of Housing and Human Settlements (MIVAH) and CeNAT.
- Cooperation Framework Agreement between CeNAT and the Municipality of San José.
- Cooperation Framework Agreement between CeNAT and the company MTF Teca de Costa Rica Ltda.



ENVIRONMENTAL

MANAGEMENT Area



**Gestión
Ambiental**

Environmental Management

Annual
Operating Plan
(CeNAT-CONARE) 2021



Indicators	Achieved Goal
 Publications	2
 Knowledge transfer activities	23
 Research Projects	4
 Attention to Students	9

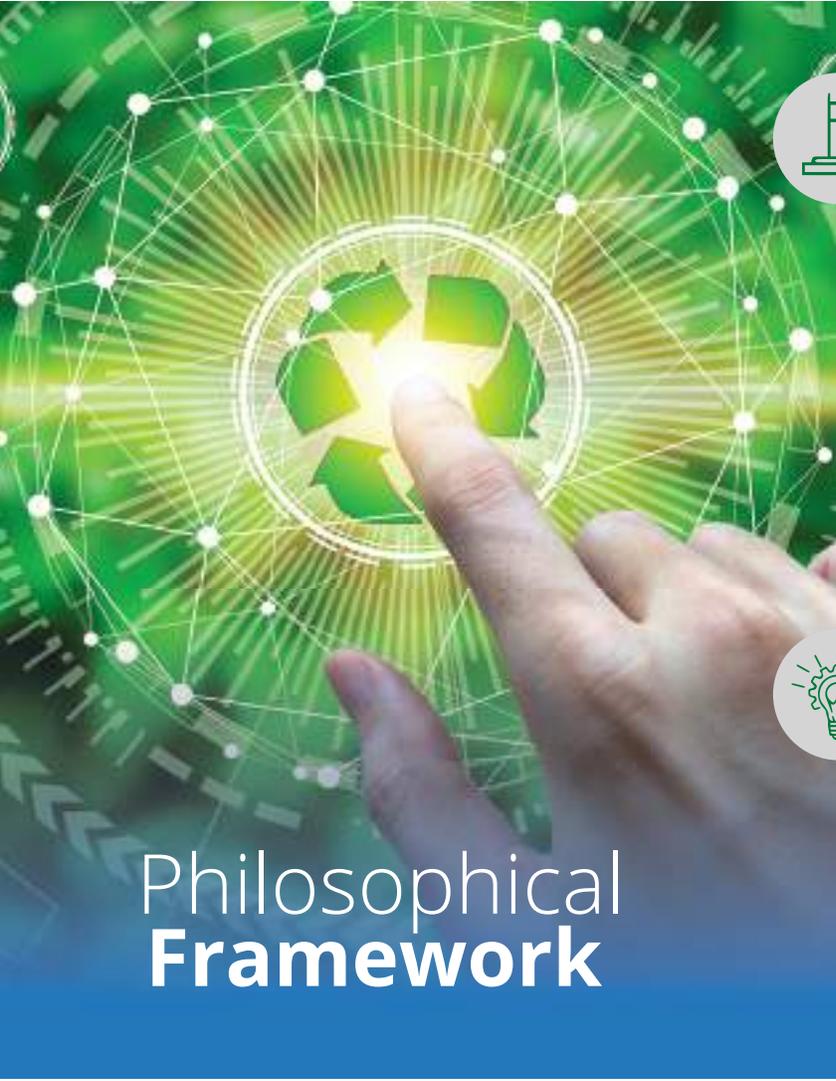
Background

ENVIRONMENTAL MANAGEMENT

The Environmental Management Area, the first CeNAT area that was developed, has played a fundamental role in environmental, climatic, and agromatic issues, with various institutions, public and private universities, large, medium, and small companies, independent producers, and associates, as well as entrepreneurs. It focuses on subjects such as consulting and searching for sustainable alternatives in production processes, natural resources, good production practices, crops, academic activities, and specialized training, research, and applications of new environmentally friendly technologies in relation to auto-mobility, clean energy, and development of innovative processes.

Its main objectives include support, coordination, and projection in the areas of Environmental Management of the universities, development of environmental projects and interdisciplinary activities with the other areas of CeNAT, management and conservation of natural resources, climate, and food safety, and support in improving the country's environmental policies.

The Area is currently conducting a reengineering process for the Climate Observatory Program, with the purpose of making it more sustainable in both time and resources.



Philosophical Framework



Mission

We are a research area with national and international linkages, which supports the public, private, and civil society sectors in technical assistance for decision-making in the face of risks of weather events and in productive development, through a team of specialized professionals who carry out studies with the highest scientific standards, within the framework of innovation and development of higher education in Costa Rica.



Vision

We aim to be a self-sustaining research area with high economic and social impact at the national and international levels, which contributes to knowledge generation on climate change, production chains, and product added value, being a leader in strengthening competitive development and technical assistance from the intersectoral articulation.



Development Objective of Environmental Management

To disseminate and empower society from the Sustainable Development Goals, in the economic, social, and environmental fields on climate change, productive chains, and added value of products, by developing technical assistance processes that territorially impact innovation projects, technology, and entrepreneurship for the productive development of Costa Rica.



Values enforced in Environmental Management

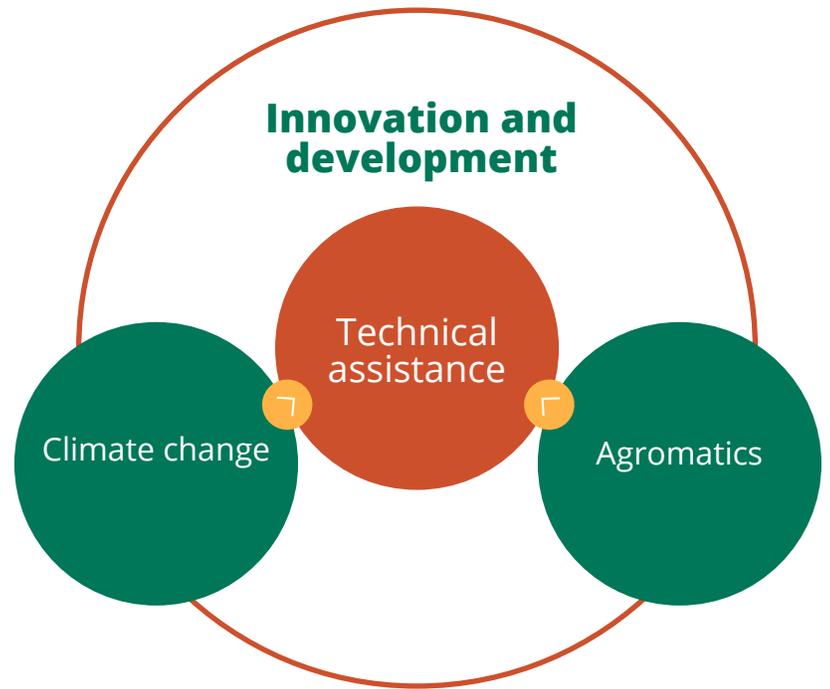
- Human team care
- Gastronomic and productive support under constant improvement
- Collaborative management in the projects that are undertaken
- Socialization of scientific information to society



Principles enforced in Environmental Management

- Efficient use of time
- Accountable administrative management of research projects
- Willingness for constant improvement of the projects that are undertaken
- Knowledge and skills empowerment

Operational Structure of Environmental Management



General strategic objective

To consolidate the Environmental Management area as support and linkage instance for public-academic-private initiatives for the social development of communities, through high-tech tools in remote sensing, climate variability and change, and Agromatics.

Environmental Management Programs

General Directorate

The Directorate of the area supports and aligns the strategic actions of the different programs that make up the area. In addition, it collaborates with the management of the projects and/or links developed in the different CeNAT laboratories.

In addition, and following instructions of CeNAT General Directorate, it promotes business innovation actions and projects with European and American linkage projects, focusing on SMEs and high-tech ventures. This is done in association with the Ministry of Science, Technology, and Telecommunications (MICITT) and the Ministry of Economy, Industry, and Commerce (MEIC).

The Environmental Area Director, in representation of the General Directorate, coordinates the annual CeNAT - CONARE Scholarship Program, aiming at both undergraduate and postgraduate students from public universities, so that they can carry out their graduate or research projects at CeNAT laboratories and/or programs.

Finally, and following the instructions of CeNAT General Directorate, the logistic development of inter-laboratory projects and events (congresses, seminars, and others) of other CeNAT units is supported. In addition, there is participation on behalf of the General Directorate of CeNAT at different activities.



Climate Observatory

The Climate Observatory Program of the Environmental Management Area responds to the need to strengthen the capacity to adapt to the climate variability and change that extreme variations in weather and climate generate on the productivity of the agricultural sector.

It is a Program dedicated to researching past and current situations, as well as climate perspectives with the purpose of social benefit facing climatic adversities.

The Observatory continuously and innovatively provides services to the agricultural sector in research and training, with personalized assistance from a technological platform on issues related to adaptation and resilience to variability and climate change to agricultural communities, in order to sustain productivity and increase the yield of crops and livestock; thus helping in decision-making and planning of activities.



Agromatics

The Agromatics program is dedicated to working with the support of alliances and high technologies (with universities, institutions, ministries, companies, regulatory bodies, and CeNAT's own laboratories), in publicizing local resources and products.

Products and their gene expression are typified to detect genes for adaptation to the environment and resistance to diseases and pests, which are linked to quality and hardness, according to the variability of the existing species. Typification is done through the knowledge of the organoleptic and culinary quality of local products, many of which are little known.

In addition, morpho-agronomic, physicochemical, organoleptic, and biochemical characterizations are carried out to allow knowing and evaluating both nutritional and anti-nutritional contents of products and, through high technologies, the technical specifications that may indicate that a product deserves a distinctive sign of quality are endorsed. The aim is to determine the origins and uses of the different products and the good use of agro-industrial by-products. These comprehensive studies make it possible to address natural disasters, climate variability and change, deforestation, and loss of harvests that cause higher prices of products and food insecurity.

Through the alliance with Slow Food, activities are developed to promote quality, clean products (innocuous and with clean technologies that minimize damage to human, animal, and environmental health), and fair pricing, by reducing intermediation chains in a way that not only producers and their families win, but also co-producers, who are conscious consumers and understand the problems of producers and their families and consider the great effort they make to provide more sustainable and healthy products.

Objectives

To manage effective links with different stakeholders of civil society, both nationally and internationally.

To implement technology tools for both access and dissemination of information.

To increase knowledge in communities on environmental management matters.

To strive to the financial sustainability of Environmental Management.

Strategic Nodes

Development of computer platforms and information access tools for decision makers, producers, and communities, on population, spatial, environmental, climate and agrifood matters.

Development of joint projects to support communities and environmental impact studies with national and international organizations.

Promotion of knowledge and added value of products through agronomic strategies attached to national, regional, and global initiatives, such as the SAN-CELAC plans, Slow Food, denominations of origin, Mother Earth fairs, and related.

Impact Indicators

Publications



1

Indexed

1

Specialized

Knowledge transfer



● National: (Taught/Received)

6 Courses and workshops taught:

- SME manager course. Trademarks and distinctive signs
- Two Ecogastronomy and Slow Food courses - PIAM/UCR
- Three Project Management courses

5 Talks/symposia taught:

- Presentation in Siquirres - Gastronomy of Costa Rica's path from sea to sea project
- Value-added as a development engine lecture
- Lecture on local products
- SIPAM video presentation for Tucurrique
- Lecture on identification and assessment of local sustainable uses and practices

● International: (Taught/Received)

1 Course, workshop: received/taught

- NICA WOMAN TECH - FACEBOOK LIVE

11 Lectures/symposia taught:

- Ibero-American Night Presentations
- Ten webinars taught at national-international levels

● People benefited

More than

6000 people benefited from the different knowledge transfers carried out.

Other Collaborative Activities



20 Participations in committees, subcommittees, or technical events

1 Submitted Agreement

20 Participation in activities (Courses, Symposia, Lectures)

1 Collaboration in Antarctica Project

31 Participations in dissemination of specialized information as WhatsApp chats, news bulletins, radio or television interviews, and collaboration in events, reports, and proposals with other laboratories or institutions, among others.

Research Projects



1 Public

- Operational Environmental Management Project

3 Private

- PINN-ASOPROA Project: "Creation of the Comprehensive Quality Unit of the Turrialba Cheese Designation of Origin" PINN-MICITT.
- Earth Market Project
- Fundecooperación project

4 Projects/Proposals Under Negotiation

- Desamparados Landfill Project
- Proposal for the achievement of the regency of 20 farms, including per diems, among others- Patricia Sánchez
- Project proposal submitted on Exchange for Nature- Patricia Sánchez
- SIPAM-Tucurrique project proposal – Patricia Sánchez

1 Sale of Services

- Sale of services: as a project manager on promotion and development of CeNAT-FunCeNAT-CONICIT Culture of innovation - Allan Campos.



Summary of Projects

Project	Progress
ENVIRONMENTAL MANAGEMENT	Among other actions, the design for transforming a conventional vehicle into an electric vehicle was developed and concluded, including its adaptation to turn it into a mobile vehicle. The procurement of the unit to be transformed is pending.
PINN-ASOPROA	Two by-product prototypes were developed in the laboratory phase. The design of the ICU was completed. Operation protocols were developed. The technology transfer tour to Spain was carried out.
EARTH MARKET	The development of agro-tourism routes, integration of productive communities, participation, and promotion of cookbooks was achieved.
FUNDECOOPERACIÓN	The project was successfully completed. This way, the stated goals were met, where the adaptation of the agricultural sector was supported through the dissemination of meteorological information.



Attention to **Students**



- **CeNAT-CONARE Scholarships**

4 CeNAT-CONARE Fellow students

- **Assistant Hours:**

2 Student assistants

- **Student Hours:**

1 Student working on student hours

- **Volunteer students:**

2 Volunteer students



Articulations

National Academic Sector:

- Articulations with **5** public universities, through research projects and/or collaboration.

International Universities or Institutes:

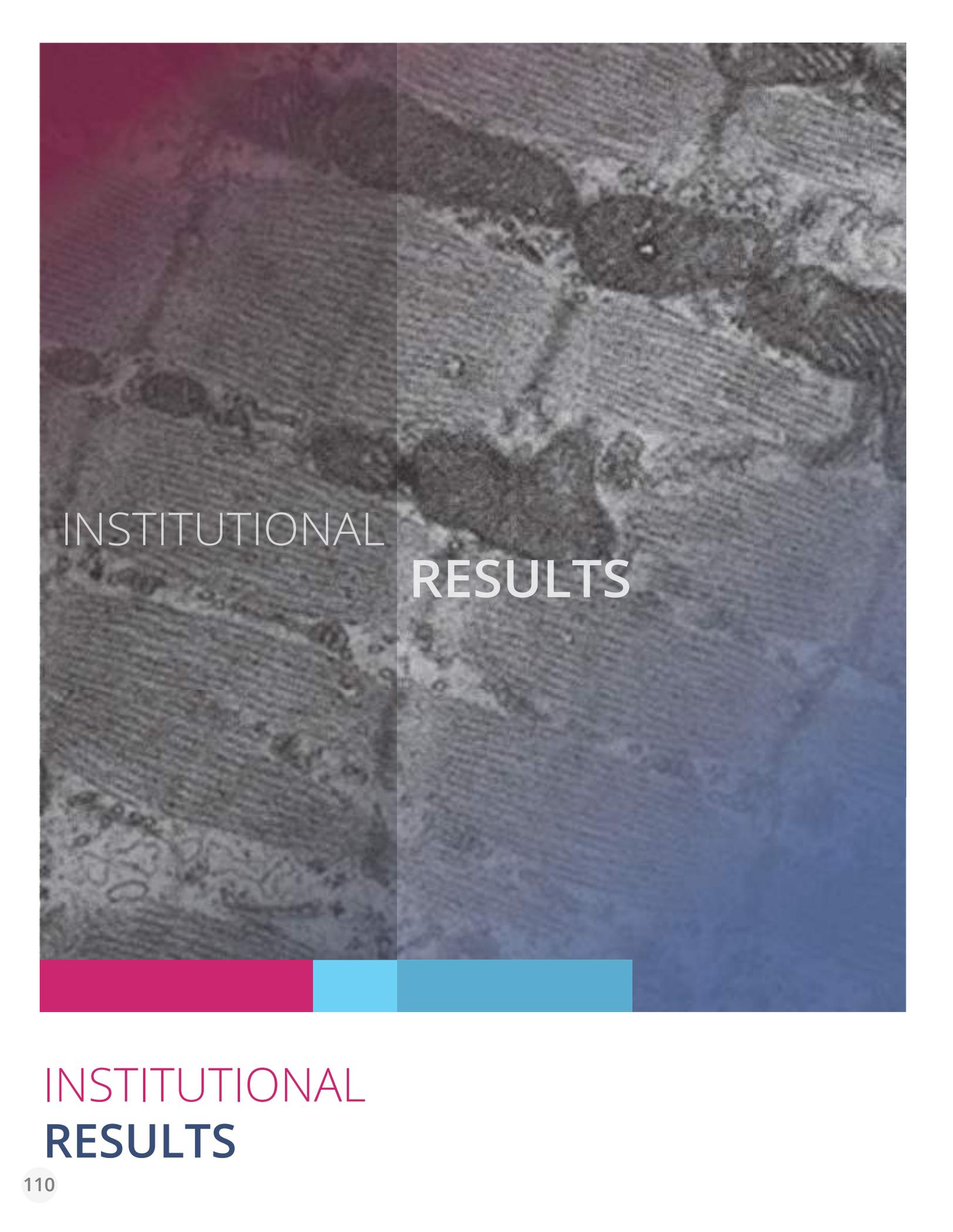
- Scientific and Technological Research Council. TUBITAK-Turkey.

International Companies

- ISEF Science Fair event in conjunction with the European Union
- UNA University in Nicaragua
- Organization of American States (OAS)
- National Association of Cattle Breeders (ANAGAN)
- Walmart Central America
- TRIFINIO Plan: organization of members of the borders of Honduras, Guatemala and El Salvador.
- Honduran National Radio

National companies

- Ministry of Agriculture and Livestock
- Repretel Channel 6
- Columbia Radio Station
- La Extra Newspaper
- Sugar Cane Chamber (LAICA)
- National Institute of Innovation and Transfer in Agricultural Technology (INTA)
- CACPROSA
- La Casa del Agricultor (CASAGRI)
- Livestock Corporation (CORFOGA)
- Radio Santa Clara
- MICITT-CONICIT
- Ministry of Economy, Industry, and Commerce of Costa Rica (MEIC)
- Costa Rican Institute of Tourism (ICT)
- Ministry of Environment and Energy, Costa Rica (MINAE)
- Ministry of the Presidency
- Instituto Nacional de Aprendizaje (INA)
- Ministry of Justice
- Banco Popular de Desarrollo Comunal (BPDC)
- ASOPROA
- Chamber of Industries of Costa Rica (CICR)



INSTITUTIONAL

RESULTS

INSTITUTIONAL
RESULTS

Support in knowledge transfer:

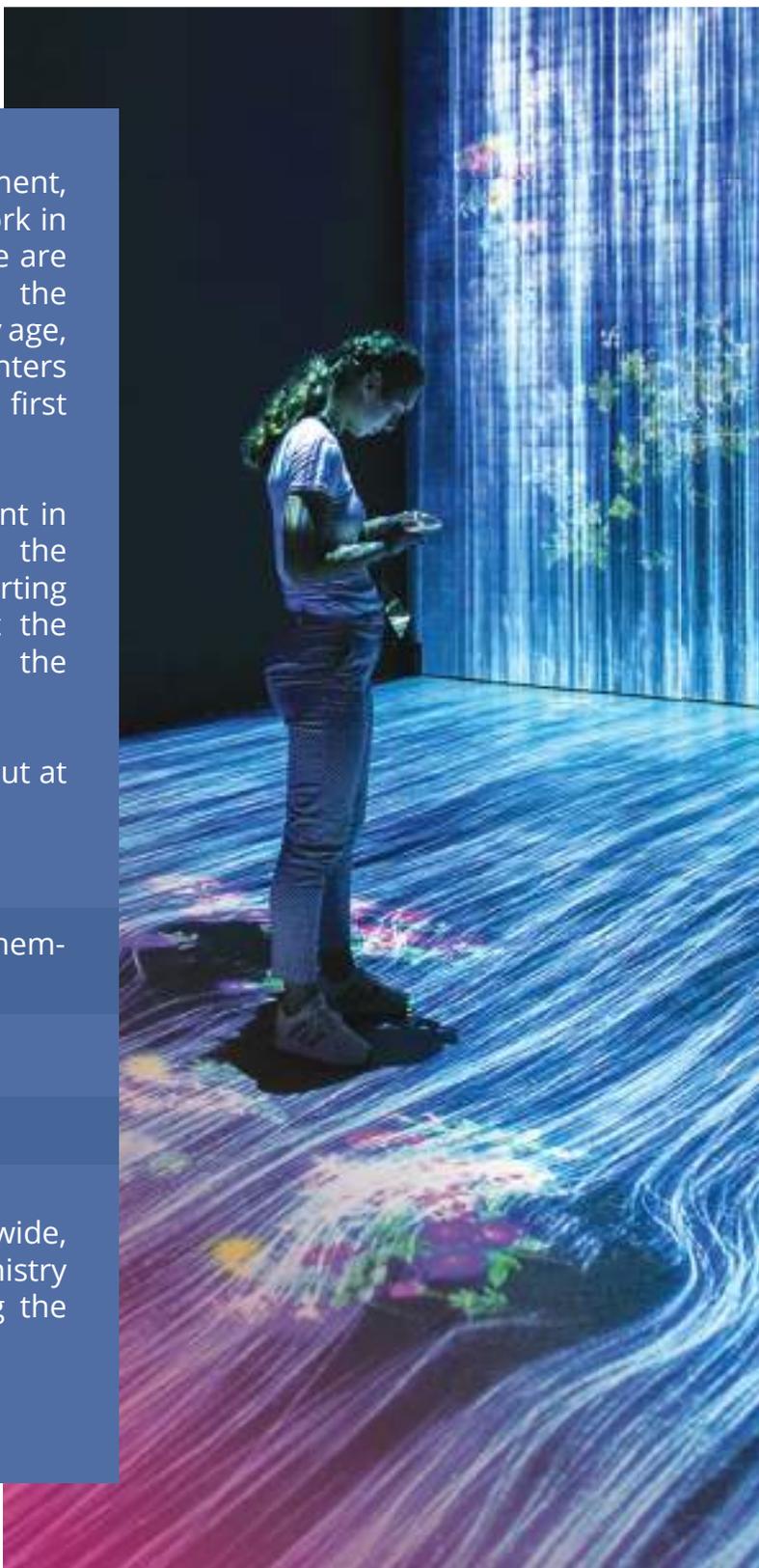
In addition to its focus on research development, for LANOTEC is also essential to maximize work in the areas of extension and teaching, since we are concerned with developing and enhancing the promotion of scientific vocations from an early age, seeking a rapprochement with educational centers to involve children in the process from the first school cycle.

Part of the commitment in this area is evident in the participation of student delegations in the various Science and Chemistry Olympics, starting the process at the national level to select the representatives to participate in events at the international level.

In 2021, the following activities were carried out at the international level:

- XIV Central American and XII Caribbean Chemistry Olympics
- XXV Iberoamerican Chemistry Olympics
- 53° International Chemistry Olympics

Given the pandemic that is being faced worldwide, the organization of the International Chemistry Olympics chose to carry it out online, using the Zoom and OlyExam platforms.



XIV Central American and **XII Caribbean Chemistry Olympics**

Due to the pandemic, in 2020 there were no Olympics. Thereafter, at the sessions of the Central American Committee (there is a representative from each country) it was decided to hold the 2021 edition online. Additionally, this year -for the first time- Honduras participated as a competitor in the Olympics.

Costa Rica organized the Olympics and was responsible for the Costa Rican Chemistry Olympics, being Mr. Fabio Araya the coordinator of the Scientific Committee and Andrea Rivera the coordinator of the Organizing Committee.

It was held virtually from November 1 to 12, 2021. The delegation included:

- Oscar Andrés Barahona Aguilar, Head of Delegation
- Wendy Villalobos González, Mentor
- Matías José Portillo Fuentes, Student
- Diego Alonso Espinoza Rojas, Student
- Mario Villalobos Forbes, Observer

Achievements:



**Diego Alonso
Espinoza Rojas**

Student



**Matías José
Portillo Fuentes**

Medal

Silver

Bronze

XXV Iberoamerican Chemistry Olympics

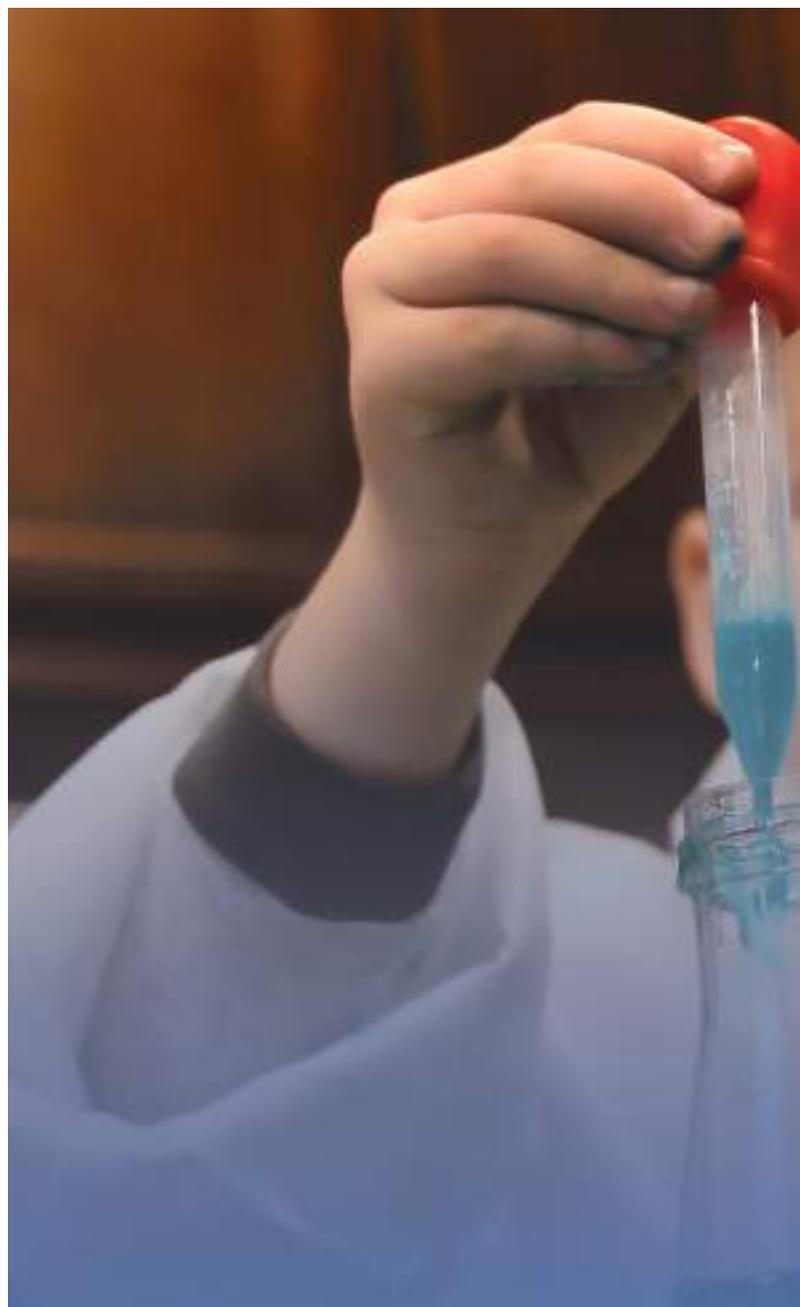
The Olympics were held virtually, using the Zoom, Google Drive, and OlyExam platforms. In addition to the protocol activities, they were broadcast on Youtube.

The meetings for discussion of evidence, translation, and decision were held on the streaming platform. The laboratory test was done through explanatory videos uploaded to Google Drive and the exam document was downloaded and printed through the OlyExam platform. This test was performed at the CeNAT Computer Laboratory.

The theory test was performed in the same way by the OlyExam platform and the students had five hours to complete it in one of CeNAT's meeting rooms. The discussion, translation, and subsequent test review went off smoothly.

The activity was carried out from September 30 to October 10, 2021. The Costa Rican delegation was made up of:

- Oscar Andrés Barahona Aguilar, Head of Delegation
- Fabio Araya Carbajal, Tutor Professor
- Matías José Portillo Fuentes, Student
- Ignacio Herrera Gamboa, Student
- Mario Villalobos Forbes, Observer
- Andrea Rivera Alvarez, Observer



Achievements:

Student	Award
 Matías José Portillo Fuentes	Honorable mention

53° International Chemistry Olympics

The Olympics were held virtually, using the Zoom and OlyExam platforms, and the protocol activities were carried out from the activity page.

The meetings for discussion of evidence, translation, and decision were held on the streaming platform. The theory test was performed in the same way by the OlyExam platform, and the students had five hours to complete it in one of CeNAT's computer laboratories. The discussion, translation, and subsequent test review went off smoothly.

It was held in Japan, from July 25 to August 2, 2021. The Costa Rican delegation was made up of:

- José Roberto Vega Baudrit, Head of Delegation
- Wendy Villalobos González, Tutor Professor
- Olivia Sojourner Dixon, Student
- Fanny Mariana Solís González, Student
- Ignacio Herrera Gamboa, Student
- Mario Villalobos Forbes, Observer
- Andrea Rivera Alvarez, Observer

Achievements: no medals or prizes were awarded; however, the commitment, participation, and growth of the students at an academic level during the development of the Olympics is highlighted.



Innovation

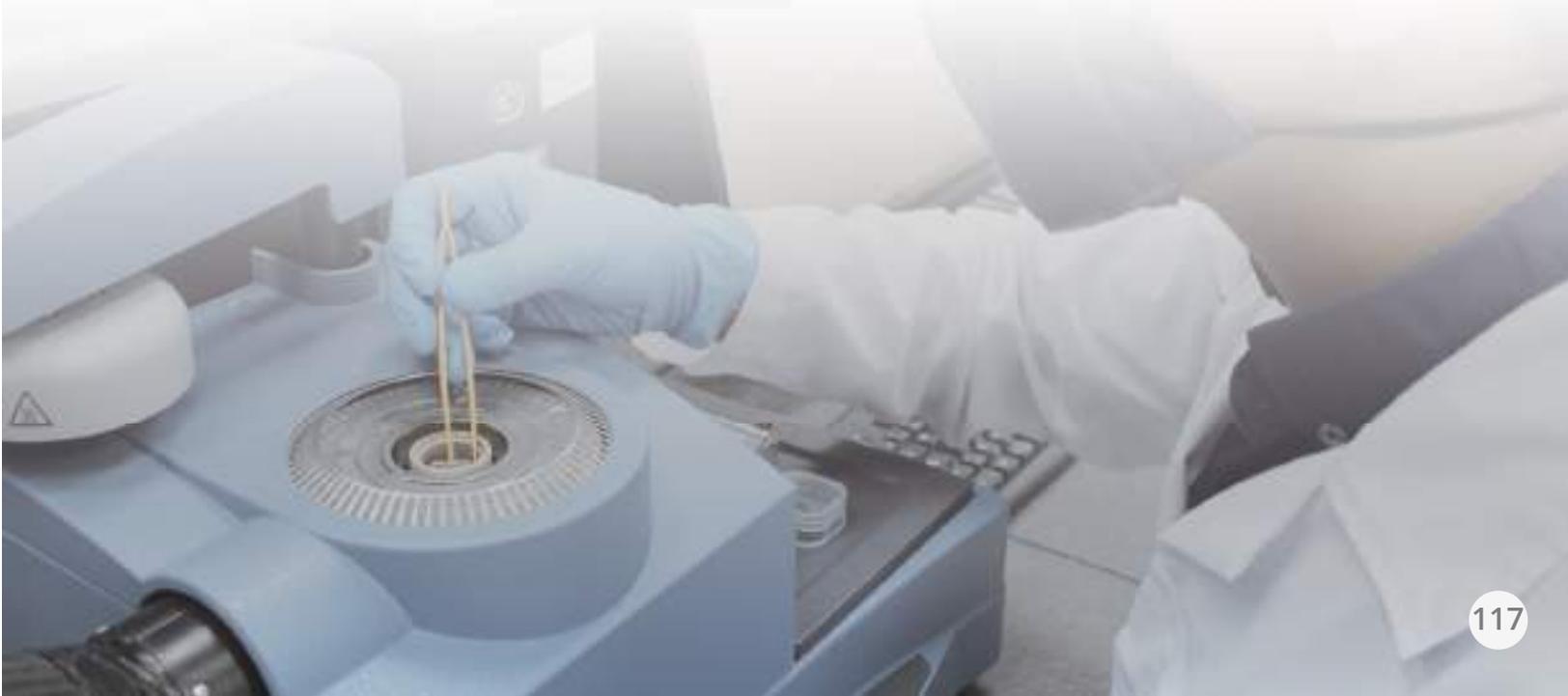
Innovation

Entrepreneurship:

Support to Companies of Applied Scientific Research

COMPANY	LABORATORY	RESEARCH
ASOPROA Santa Cruz	LANOTEC and Environmental Management	PINN: Generation of agro-industrial capacities and creation of a comprehensive unit (physical-chemical, organoleptic, and microbiological characterization) to improve the production process of Turrialba cheese with Designation of Origin.
ECOINSUMOS	LANOTEC	PINN: Development of two agro-nutritional formulations to improve agricultural soils, ensure their efficient use in agriculture, and reduce environmental impact.
FIFCO	LANOTEC	Plastic bottle characterization analysis
H2020 - EU - University of Belgrade, Serbia	LANOTEC	Automated functional screening of IgGs for diagnostics of neurodegenerative diseases (AUTOIgG).
Office of Naval Research, Boston, MA, USA	LANOTEC	Production and characterization of bacteria-repellent microcontact printed substrates and bactericidal nanostructured surfaces.
Stein Laboratories	LANOTEC	New Product Generation - Confidential Status
Proquinal	LANOTEC	Evaluation of the antimicrobial activity of four vinyl fabrics produced by the company.
Adolphe Merkle Institute, Switzerland	LANOTEC	Bio-inspired and low-cost 3D printing of hydrogels with biomedical applications.
Philips Morris	LANOTEC	Evaluation of the impact of cigarette smoke vs THS on indoor air quality.
Philips Morris	LANOTEC	Design and development of a concept model to establish a bioinformatic study of lung cancer by means of computer vision at nanomolecular-scale 3D images and circulating molecular biomarkers of associated genes.
CHIMUSA	LANOTEC	Development of analysis of products made by the company and development of experimental method for the type of products.

COMPANY	LABORATORY	RESEARCH
FIFCO - ISEF	LANOTEC	Eureka - ISEF Workshop Promotion of scientific vocations and participation at fairs at the high-school level.
Calox Laboratories	LANOTEC	Product development consulting.
Lisan Laboratories	LANOTEC	Development of an analytical method.
HOLOGIC	CENIBiot	Cell adhesion and/or proliferation assay.
Bioinsumos Nativa	CENIBiot	Molecular identification (DNA barcoding) of living organisms.
Thrive Natural Care	CENIBiot	Preparation, quantification, characterization, and method development for extracts of plant origin materials.
Nippon Paper Papyrus Co., Ltd.	CENIBiot	In-vitro plant setting.
Costa Rican Coffee Cooperative (Coopetarrazú RL)	CENIBiot	Preparation, quantification, characterization, and method development for extracts of plant origin materials.
Biotech C.R. S.A.	CENIBiot	Molecular identification (DNA barcoding) of living organisms.
Cooperativa de Agroecoturismo y Servicios Múltiples de Cartagena de la Rita de Pococi R.L. (Coopecuna)	CENIBiot	Scaling process for the extraction of three essential oils.
Bio CR Products	CENIBiot	Development and validation of quantification and identification methods by HPLC and mass spectrometry techniques.
National Banana Corporation (Corbana) S.A.	CENIBiot	Molecular identification (DNA barcoding) of living organisms.
Corporación de Desarrollo Agrícola del Monte S.A.	CENIBiot	Molecular identification (DNA barcoding) of living organisms.
CoopeAgri El General R.L.	CENIBiot	Quantification of total polyphenols.
Gutis Ltda.	CENIBiot	Molecular identification (DNA barcoding) of living organisms.
National Institute of Agricultural Technology (INTA)	CENIBiot	Training in Temporary Immersion Systems.



COMPANY	LABORATORY	RESEARCH
Speratum	CENIBiot	Implementation Unit.
Treinta y cinco fábricas de cervezas S.A.	CENIBiot	Production of Microorganisms Bacteria, yeasts, and fungi.
Stein Laboratories	CENIBiot	Development and validation of quantification and identification methods by HPLC and mass spectrometry techniques.
LISAN Laboratories	CENIBiot	Quantification of vitamins.
Numu Brewing	CENIBiot	Production of Microorganisms Bacteria, yeasts, and fungi.
Sur Química S.A.	CENIBiot	Amino-acid profiling.

Source: Information provided by CeNAT's laboratories for 2021.

Support to applied scientific

research organizations
or institutions

PRIAS

Institution	Research
CONICIT, MICITT, DLR	MONEO-WET Project: Applicability of Sentinel-2, DESIS, and Landsat 8 satellite imagery data for water quality studies, on water bodies related to crop coverage surroundings of the National Terraba-Sierpe Wetland (MONEO-WET).
UNDP, MAG, MINAE	MOCUPP Project: Conserving Biodiversity through Sustainable Management of Productive Landscapes in Costa Rica.
FAO	FAO-SEPAL Project Pilot digital system for monitoring illegal logging in the Golfo Dulce Forestry Reserve and a study area on the Pacific side of La Amistad National Park.
National Geographic Society, Microsoft Corporation	NATGEO Project: Development of three technological tools for marine ecology and its application on the <i>Antillean manatee</i> in Costa Rica.
TEC	Indirect derivation of the spatial distribution and development status of secondary forests in Costa Rica, using satellite images of medium spatial resolution.

Institution	Research
TEC	Indirect derivation of the spatial distribution and development status of secondary forests in Costa Rica, using satellite images of medium spatial resolution.
ICAPE	NAMA Coffee Initiative of Costa Rica, which seeks to define the Action Plans of the Strategy for low-emission and climate-change resilient coffee in Costa Rica, related to the subject of Technology.
Earth Blox	Earth Blox Platform: Platform for processing and analysis of geospatial data, based on the cloud, for the creation of algorithms such as supervised and unsupervised classifications, temporal series, change detection, and comparisons, among other processes, through computational block programming.
Planet Labs Inc.	Participation in the 2021 Planet Explore webinar with the "Meeting sustainability goals and agricultural needs: EO Data for Effective Agricultural Policy in Costa Rica" presentation for dissemination and knowledge exchange regarding the use of Planet products in the development of the MOCUPP project, its scope, and benefits for the country, in terms of achieving sustainable development goals.
UNDP, GEF, MINAE	UN Biodiversity Lab 2.0 platform: A free open-source platform that enables governments and others to access state-of-the-art maps and data on nature, climate change, and human development in an innovative way to generate knowledge about nature and sustainable development.
UNED, UNA	Workshop on Google Earth Engine: Training of at least 15 researchers and students from UNED and the UNA School of Topography.
REDD++ National Secretariat, SINAC, SEPLASA, IGN, FAO, SilvaCarbon, GEE, CENIGA, CATIE	National "Tackling deforestation and forest degradation in Costa Rica using Google Earth Engine" project: Improving the methodologies available worldwide to detect deforestation and forest degradation using satellite images and different technological tools.
Group on Earth Observations (GEO), UN Habitat, MIVAH, SEPLASA, UNDP, INEC, Municipality of Garabito	National Proposal: Earth Observations for Sustainable Cities and Communities Toolkit: Developing a customizable and continuously updated set of tools for integrating Earth observations and geospatial information into urban monitoring and reporting processes on SDG targets and indicators based on input from Member States and cities of the United Nations. In this particular case, work is being done on SDG 11.
Comptroller General of the Republic (CGR)	Technical support to develop the urban sprawl mapping for Costa Rica in secondary cities. Work is being done on the methodological definition for data analysis and use of images of urban sprawl growth, for expense estimating purposes by the government in the investment of public works for cantons in the national territory.
NASA, MINAE, Stanford University	Natural Capital Project: Improved linkages between Earth observations and ecosystem service models with essential biodiversity variables



Institution	Research
UNDP, MINAE, MINAE, University British of Columbia	ELSA: Mapping nature for people and the planet: Identification and prioritization of essential areas for life, where nature-based solutions can be implemented to meet management, protection, and conservation needs for sustainable development.
CONARE-PEN	<p>Project, "Cantonal Historical Geospatial Representation of Costa Rica for the 1905-2014 period: Constructing the spatial representation in the form of geographic information layers that enable reproduction of the Territorial Administrative Division of Costa Rica for the periods 1905, 1950, 1963, 1973, 1984 and 2014".</p> <p>Project, "Local productive structures: productive, labor, and territorial value chains in Costa Rica".</p>

ENVIRONMENTAL MANAGEMENT

ENTITY/INSTITUTION	PROJECT
Restaurateurs, chefs, and cooks, PIAM/UCR	Ecogastronomy and Slow Food Course
5,300 Producers using the platform in CR and Central America	Management of PIACT and Mercado de la Tierra Facebook pages
530 Agricultural producers	Central American Climate Chat update
ASOPROA - Santa Cruz	PINN Project. Creation of the Comprehensive Quality Unit for Turrialba cheese with Denominations of Origin.
FUNDECOOPERACIÓN	Support to adaptation of the agricultural sector through the dissemination of meteorological information - Phase II.
CONICIT/Costa Rican Promoter of Innovation and Research	INSPIRA: Promotion and development culture of innovation Update of the Innovation Atlas of Costa Rica.
Organization of American States (OAS)	PIACT-Trifinio Plan
Innovation Commission - Chamber of Industries of Costa Rica	Creation of the FESTO-CICR-CeNAT/CONARE Learning Factory
Scientific/Technological Department-Embassy of the People's Republic of China in Costa Rica	Development of a prototype mobile laboratory for the deployment of the CR-2023 Antarctic Mission.

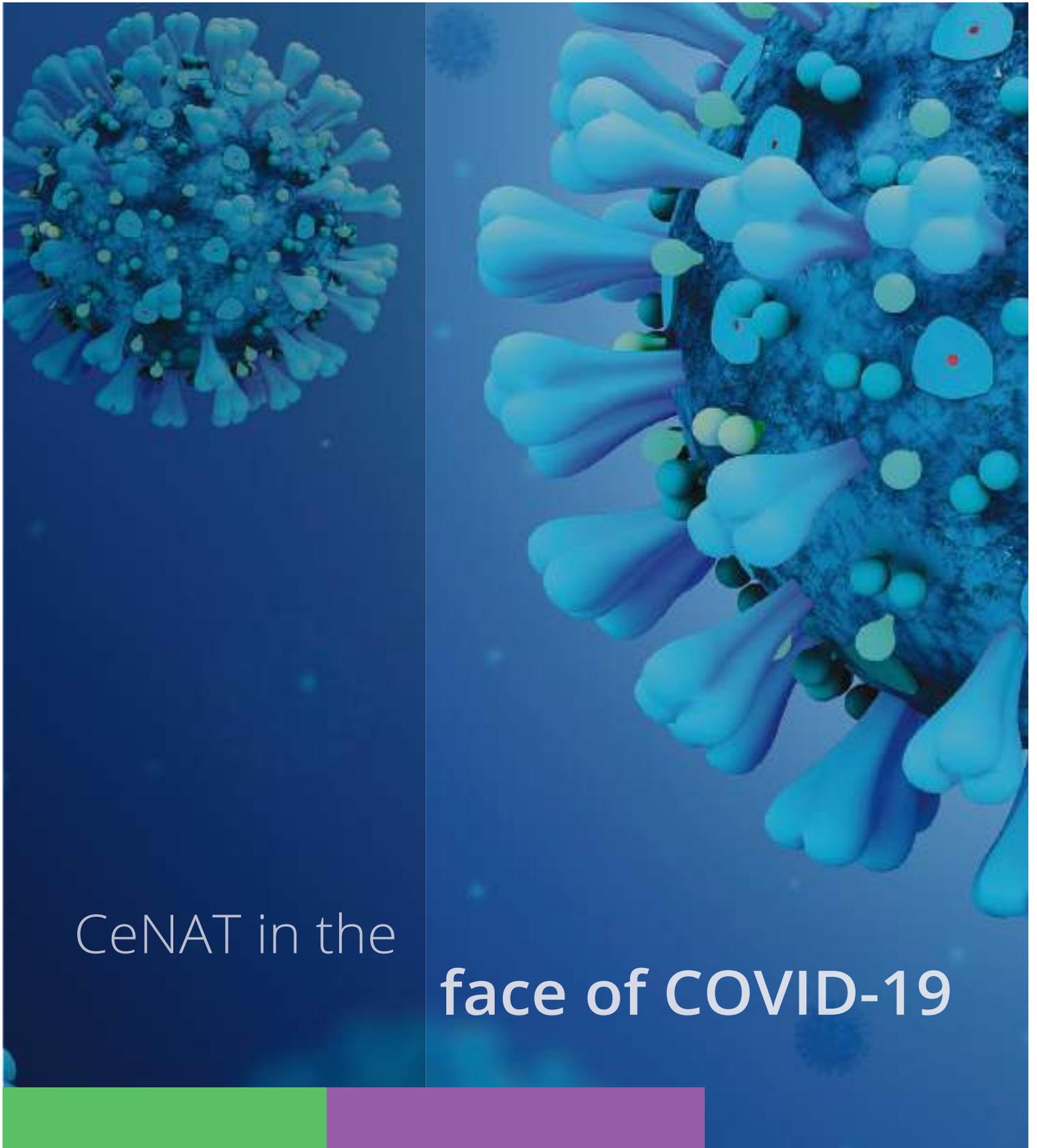


CNCA

ENTITY/INSTITUTION	PROJECT
Academic and similar national and international networks	Central American Network for Management of Epidemiological Data.
Kabré Computational Cluster	Access to CeNAT's Kabré computational platform for data processing.

Source: Information provided by CeNAT's laboratories for 2021.

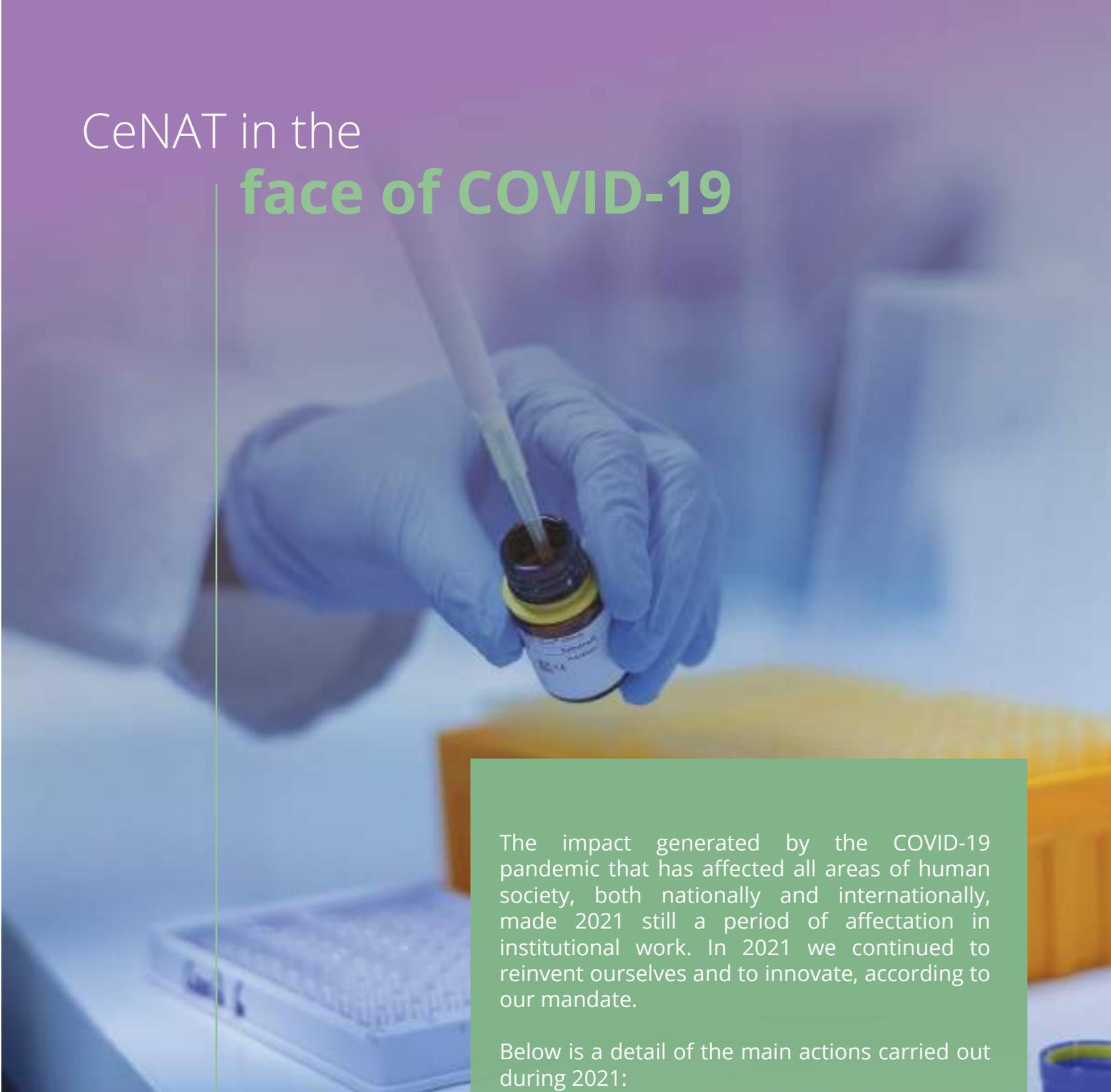




CeNAT in the

face of COVID-19

CeNAT in the
face of COVID-19



CeNAT in the **face of COVID-19**

The impact generated by the COVID-19 pandemic that has affected all areas of human society, both nationally and internationally, made 2021 still a period of affectation in institutional work. In 2021 we continued to reinvent ourselves and to innovate, according to our mandate.

Below is a detail of the main actions carried out during 2021:



LANOTEC

Category	Name of the Activity
Project	"Nano-phytopharmaceuticals for the prevention and treatment of COVID-19: Scaling of solid-lipid nanosystems and in-silico and in-vitro study of inhibitor candidates of the SARS-CoV2 virus".
CeNAT-CONARE Scholarship	Development of a coating with antimicrobial properties for a saliva collection device for molecular diagnostic tests for the SARS-CoV-2 virus.
Scientific paper writing	CRISPR-Cas9 system as an alternative cancer treatment and its application for COVID-19 assessment.
Internal collaboration	TEM analysis of metallic NPs samples for standardization of the Covid-19 diagnostic kit developed by CENIBiot.

CENIBiot

Category	Name of the Activity
Project	Clinical and analytical validations of diagnostic tests designed by CENIBiot that are in the process of obtaining the health registration issued by the Ministry of Health.

ENVIRONMENTAL MANAGEMENT AREA

Category	Name of the Activity
News Bulletin	Radio interview - Santa Clara Radio 01/06/2021
News Bulletin	Radio interview - National Radio in Honduras 01/12/2021.
News Bulletin	TV interview - Channel 6 Repretel 01/29/2021.
WEBINAR	Climate Outlook for 2021 in Costa Rica and Central America 01/29/2021.
WEBINAR	Climate Outlook Update for 2021 in Costa Rica and Central America and good practices in agriculture_02/23/2021
WEBINAR	Climate Outlook Update for April 2021. Start of the rainy season in Costa Rica and Central America, Current status of water resources in Central America, and Advice on good practices in agriculture_03/23/2021
VIRTUAL COURSE	SME manager course. Trademarks and distinctive signs_06/02/2021
VIRTUAL COURSE	Ecogastronomy and Slow Food PIAM/UCR - I Semester
VIRTUAL LECTURE	Presentations of the Environmental Management Area at the Ibero-American Night of Researchers event_September 2021
VIRTUAL LECTURE	Local products lecture _09/29/2021
VIRTUAL COURSE	Project Management Course _November 15, 22, and 29, 2021: Course taught by Allan Campos Gallo, to a group of researchers from the PRIAS laboratory at CeNAT
VIRTUAL COURSE	Project Management Course _November 16, 23, and 30, 2021: Course taught by Allan Campos Gallo, to a group of researchers from PRIAS and LANOTEC
VIRTUAL COURSE	Project Management Course _November 18, 25, and December 2, 2021: Course taught by Allan Campos Gallo, to a group of researchers from PRIAS, Environmental management and management staff from CENIBiot
VIRTUAL LECTURE	Identification and assessment of sustainable local uses and practices, as a heritage proposal: Talk taught by Patricia Sánchez Trejos, to a group of professionals from the Ministry of Economy, Industry, and Commerce of Costa Rica.
VIRTUAL COURSE	Ecogastronomy and Slow Food PIAM/UCR - II Semester: During the second semester, Patricia Sánchez Trejos taught the virtual course, ECO-GASTRONOMY and SLOW FOOD
VIRTUAL LECTURE	NICA WOMAN TECH - FACEBOOK LIVE. Technologies that help Climate Monitoring and Forecasting 04/21/2021.
WEBINAR	Climate outlook for May 2021 in Costa Rica and Central America. 2021 Atlantic Hurricane Season and Winter Droughts 04/27/2021
WEBINAR	Climate outlook update for June-July-August 2021 in Costa Rica and Central America. ENSO Conditions and Outlook. 2021 Hurricane Season and Winter Droughts 06/1/2021
WEBINAR	Update of the climate outlook for the 2021 second stage of the rainy season in Costa Rica and Central America. ENSO Outlook 2021 Tropical Cyclone Forecast July-August-September 06/29/2021

Category	Name of the Activity
WEBINAR	Subjects: Climate outlook update August - November 2021. ENSO Outlook Hurricane Season Forecast Update on 2021 Rainy Season End Forecast 07/27/2021
WEBINAR	Subjects: ENSO Outlook 2021-2022, Climate Outlook Update for September and October 2021 -2022-2023, and Tropical Cyclone Season September-October 2021 08/31/2021
WEBINAR	Facebook Live. Subjects: ENSO 2021-2022 Forecast Update, Tropical Cyclone Formation Forecast Update October-November 2021, Climate Outlook Update for October-November-December 2021, and Rainy Season End Forecast Update 09/28/2021
WEBINAR	Facebook Live. Subjects: Climate outlook update from November 2021 to March 2022_3/11/2021

CNCA

Category	Name of the Activity
Virtual Workshops:	<ol style="list-style-type: none"> 1- Adaptive Message Passing Interface 2- Introduction to Programming with Python Workshop 3- Introductory workshop on genomic and metagenomic data analysis 4- Scientific Computing Workshop with Python 5- Introduction workshop to programming with R 6- Workshop on Data Visualizations with R 7- Statistical Analysis Workshop with R 8- Linux and Kabré introductory workshop 9- Machine Learning with Python Workshop.
Scientific computing virtual seminars:	<ol style="list-style-type: none"> 1- Hydrological and hydraulic modeling in the Zapote River basin for generation of flood maps. 2- Challenges for the Automated Detection of Fake News (Disinformation) in the Costa Rican Context. 3- Representation Learning: Learning useful representations through generative models with few labels. 4- Scientific computing in water resources and the link with artificial intelligence. 5- Application of transcriptomics in the detection of transcriptionally-active endogenous retroviruses (ERV) in primate testicular tissue. 6- Three Trends in HPC and their Future Implications. 7- Bioinformatics and epidemiological surveillance of pathogens: Aeruginosa AG1 and SARS-CoV-2 Pseudomonas in Costa Rica. 8- Accuracy for Energy? Approximate Computing to the Rescue. 9- Parallelism and Resilience in Distributed Deep Learning Training.
Virtual Schools:	<ol style="list-style-type: none"> 1- Costa Rica HPC School 2- Costa Rica Big Data School



Socialization of Science

Part of the work carried out by the Centro Nacional de Alta Tecnología is the dissemination of the institutional work of CeNAT and attention to the queries of the media, in order to maintain an approach to the work of the Center with the general population.

Labor of CeNAT through Media

22



Written press

14



Television

21



Radio Media

45



Digital media

102

Total

Fuente: Information from the year 2021.



Social
Media

Social
Media



Facebook of **CeNAT**



13 465

Number of followers



13.414

Number of Likes of the page



490.354

Annual reach of posts



40.863
people

Average monthly reach of posts



49

Number of countries that follow the page

Currently, the presence in social networks is fundamental within the dissemination strategy, as a permanent communication channel, which has the advantage of the immediacy of information sharing to the audiences of the institution. CeNAT has a YouTube channel, Soundcloud profile, Facebook page, and website, which represent the institutional channels that provide information to the different segments.

Within the digital ecosystem, our Facebook page is constantly growing in followers and the audience is stratified by 53% women and 47% men. The posts that are made are announcements of the virtual courses or workshops, news of the institutional work, CeNAT-CONARE scholarship programs, and digital media campaigns that are developed on different topics. In 2021, three campaigns were implemented: CeNAT-CONARE Scholarships, Management Indicators, and Research Projects of the dependencies.

Fuente: Information from the year 2021.

*The number of followers has been generated organically, without resorting to paid social media advertising. As of December 31, 2021



Countries that monitor CeNAT to the activities socialized by Facebook

Costa Rica

Mexico

Peru

Ecuador

U.S

Guatemala

Colombia

Spain

Nicaragua

El Salvador

Honduras

Argentina

Germany

Bolivia

France

Brazil

Chile

Canada

Panama

UK

Venezuela

Paraguay

Italy

Netherlands

Portugal

Switzerland

Uruguay

Dominican Republic

Puerto Rico

Denmark

Sweden

South Korea

Austria

Russia

Belgium

Japan

Israel

Turkey

Egypt

Australia

Czech Republic

Philippines

Cuba

Vietnam

Iraq

Norway

New Zealand

Syria

Nigeria



Below, the main data of information on reach, achievements and impacts evidenced by each of the Laboratories of CeNAT in the year 2021 are presented.

Human Resources at **CeNAT**

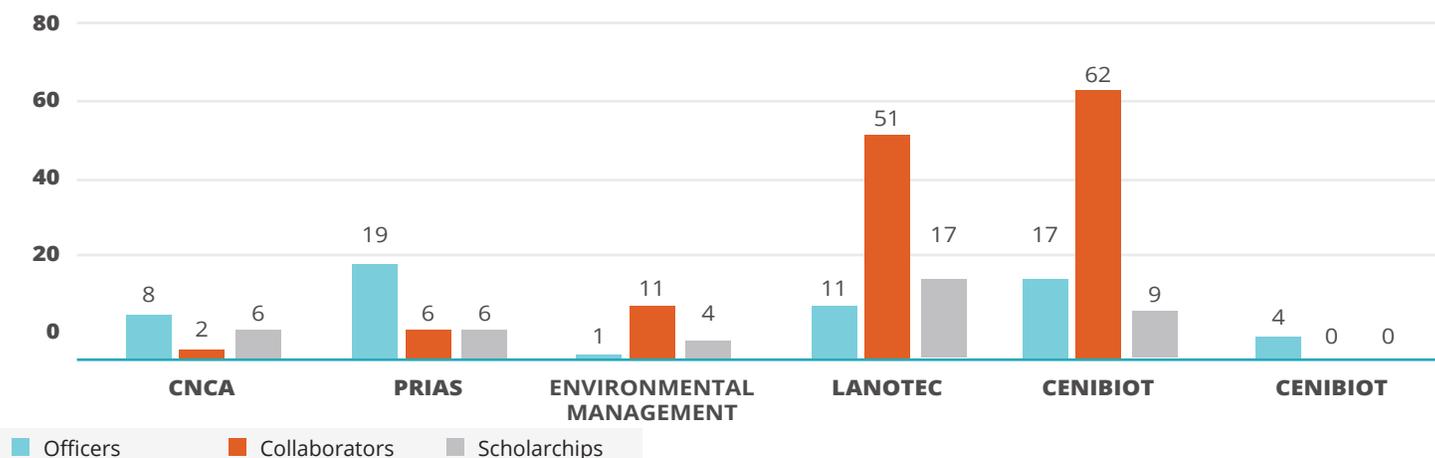
CeNAT R & D Human Resources 2021

Laboratory	Officers	Collaborators	Scholarships	TOTAL
CNCA	8	2	6	16
PRIAS	19	6	6	31
ENVIRONMENTAL MANAGEMENT	1	11	4	16
LANOTEC	11	51	17	79
CENIBIOT	17	62	9	88
CENAT	4	0	0	4
TOTAL	60	132	42	234

Source: Information from the year 2021 provided by the Laboratories and Areas of CeNAT.

Participation Percentage of R & D Human Resources in 2021, according to Officers, Collaborators and Scholarships present at CeNAT

Graphic 1.
R & D Human Resources
2021 Period



Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

2021 Indicators, according to CeNAT Laboratories and Areas

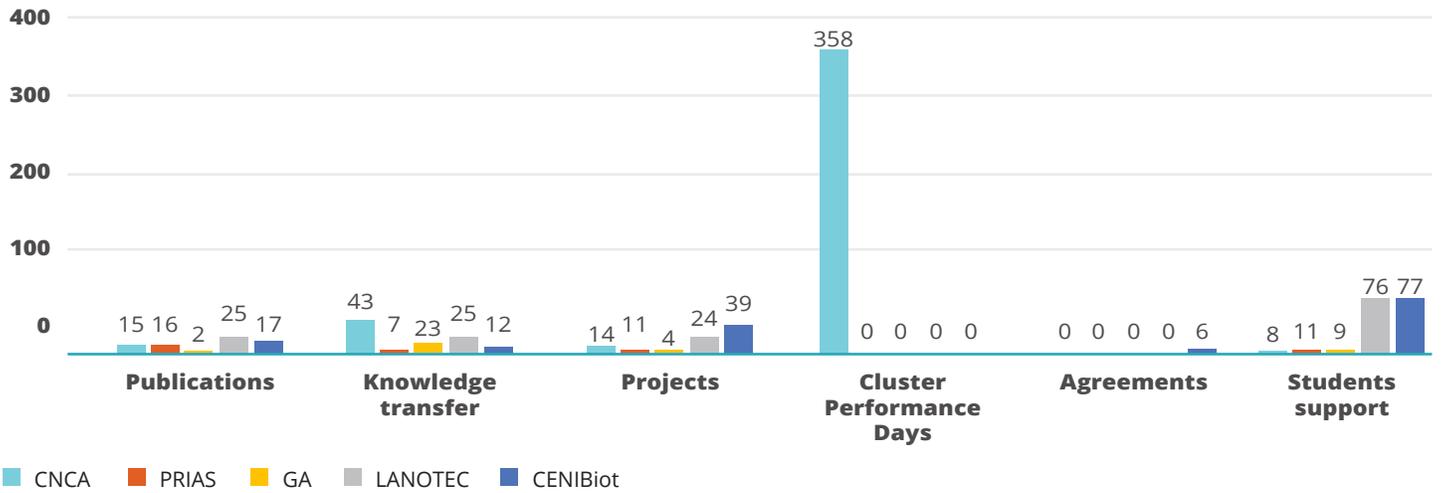
CeNAT Public and private indicators 2021

Indicator	CNCA	PRIAS	GA	LANOTEC	CENIBIOT	TOTAL
Publications	15	16	2	25	17	75
Knowledge transfer	43	7	23	25	12	110
Projects	14	11	4	24	39	92
Cluster Performance Days	358	0	0	0	0	358
Agreements	2	3	0	3	6	14
Student support	8	11	9	76	77	181
Total	440	48	38	153	151	830

Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

Graphic 2.
2021 Indicators, According to CeNAT Laboratories and Areas

Public and private indicators 2021

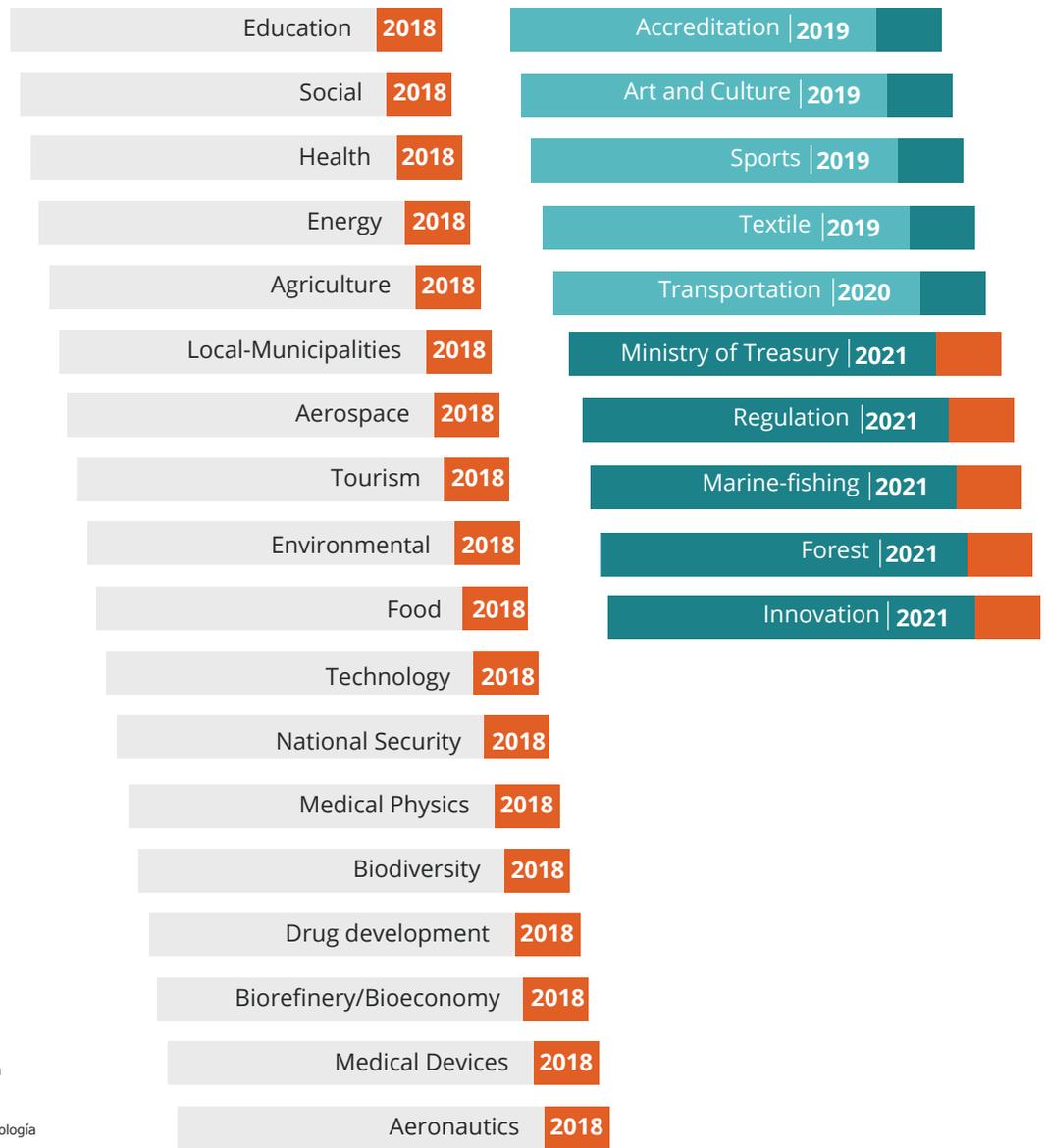


Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.



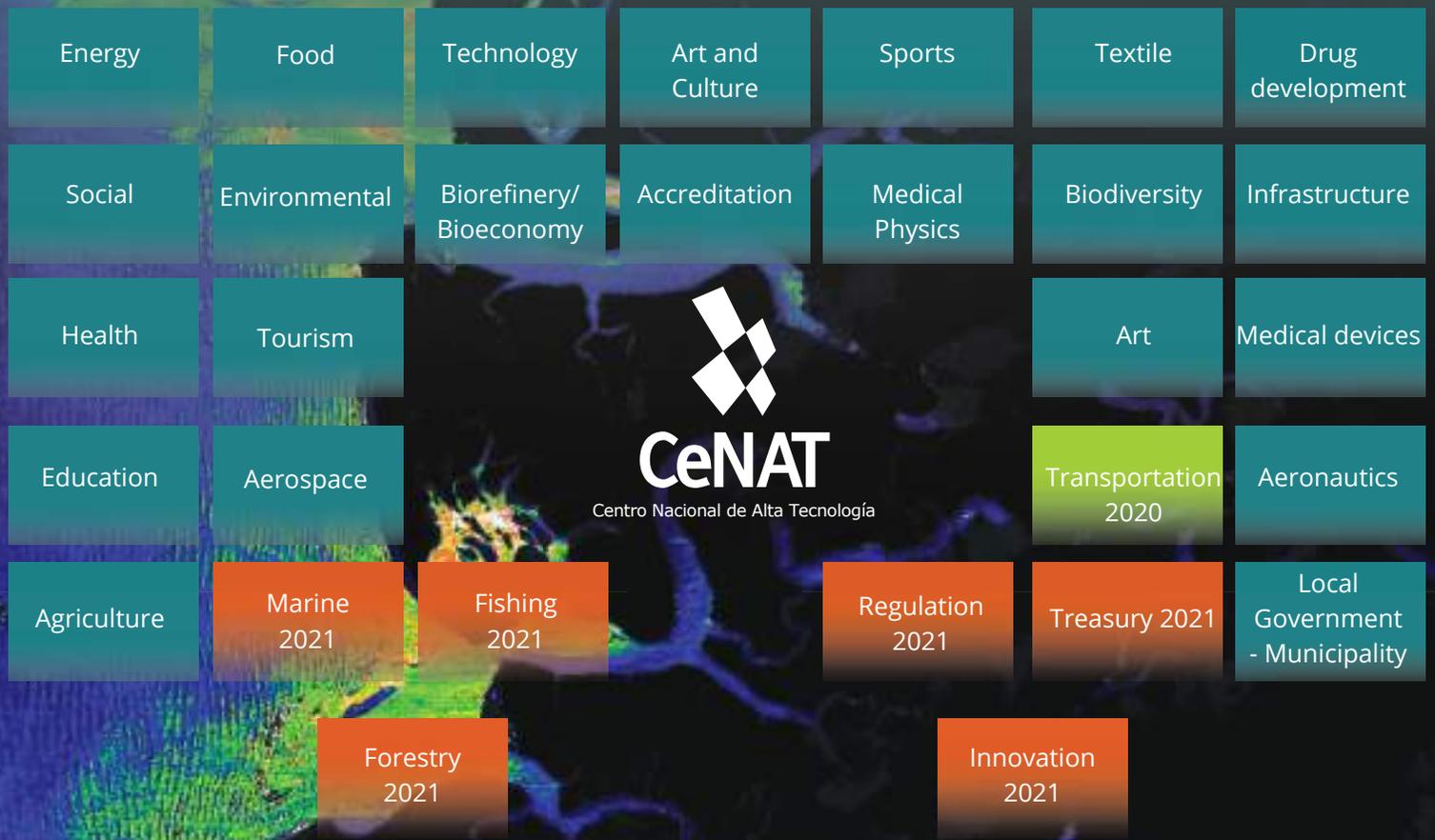
Strategic Sectors of Society Linked with CeNAT
 Identification of sectors CeNAT has relation with as of November 2021

Sectors that are linked to CeNAT



Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

Strategic Sectors of Society Linked with CeNAT





CeNAT

Centro Nacional de Alta Tecnología

Transforming knowledge into development



Gestión Ambiental



PRIAS



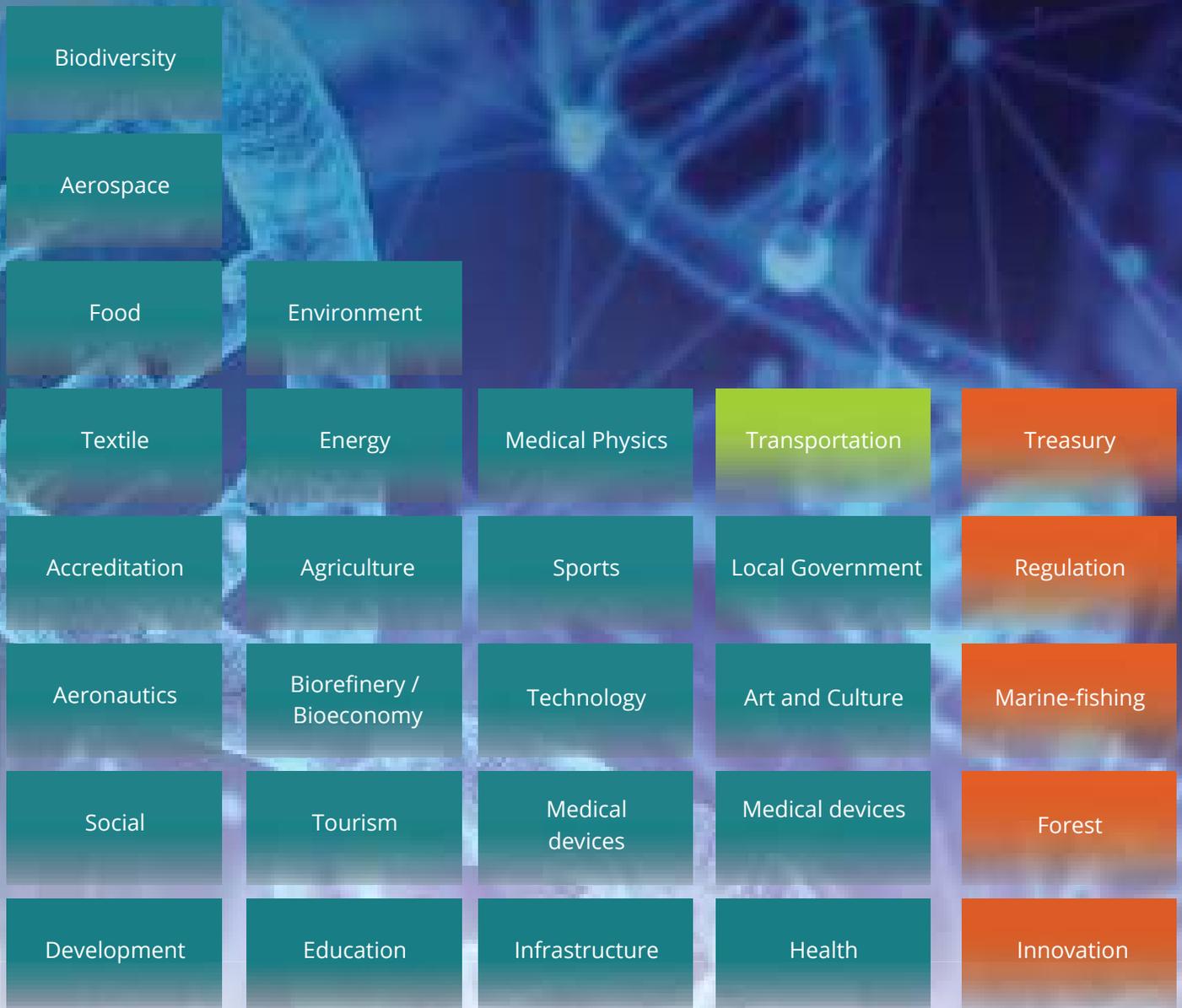
LANOTEC
Laboratorio Nacional de Nanotecnología



CNCA
Colaboratorio Nacional de Computación Avanzada



CENIBiot



■ Baseline 2019 ■ 2020 ■ 2021

Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

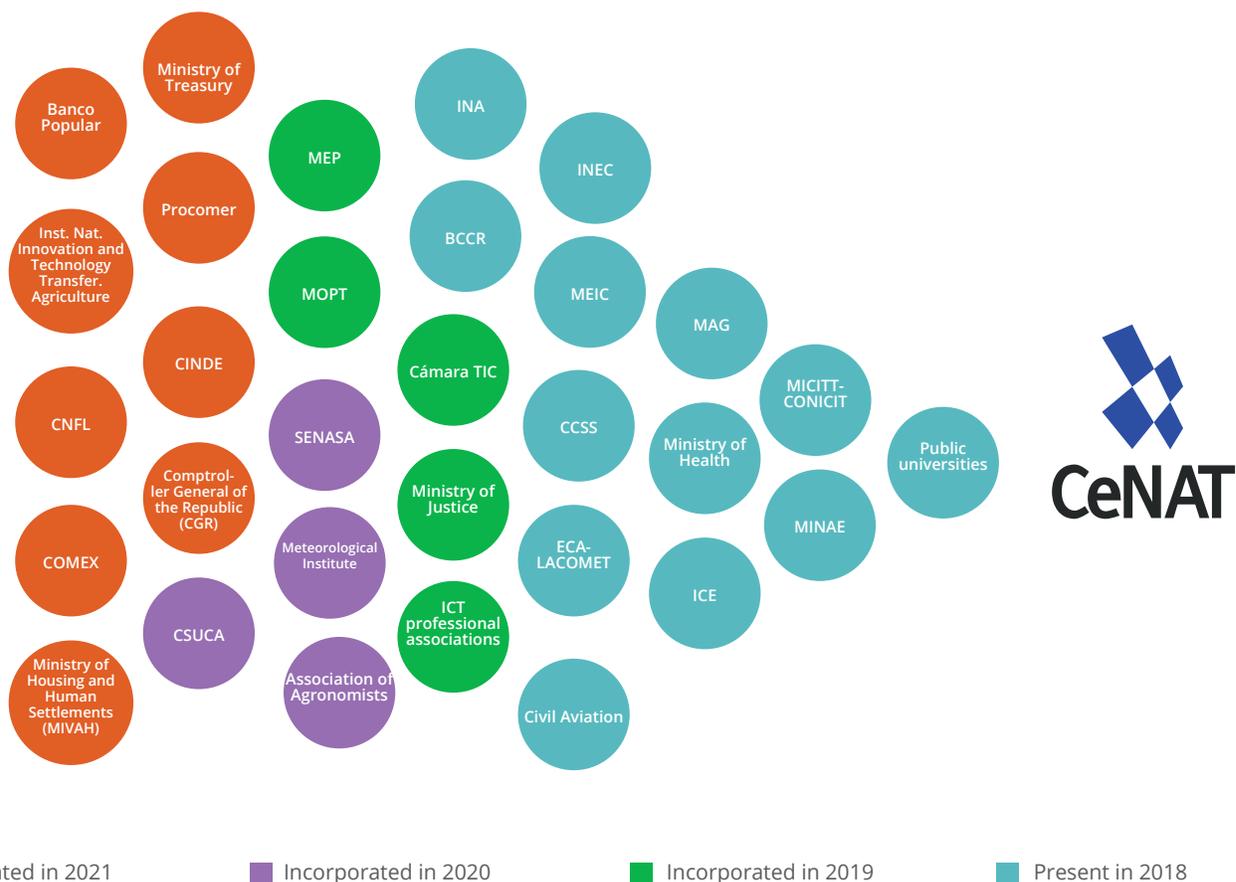


CeNAT
Centro Nacional de Alta Tecnología

■ Institutions incorporated in 2021

Linkage of CeNAT with Institutions

Institutions that maintained ties with CeNAT in 2021



Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

Institutions, organizations, and companies linked to CENAT in 2021



- Incorporated in 2021
- Incorporated in 2021
- Incorporated in 2020
- Incorporated in 2019
- Present in 2018

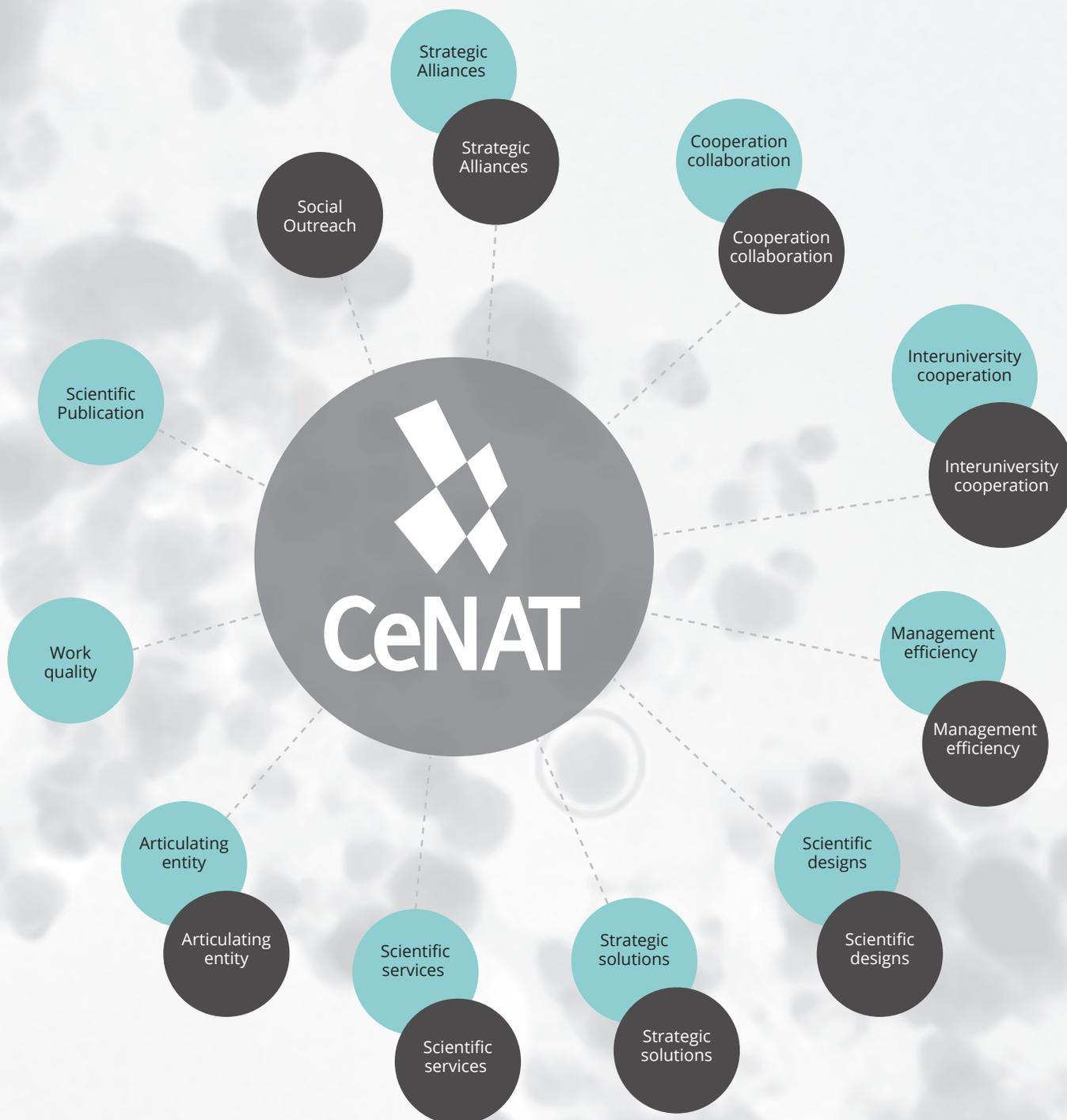


Institutions, organizations, and companies unlinked from CENAT in 2021



- Stopped having a relationship in 2021
- Non-governmental Institutions
- Incorporated in 2021
- Incorporated in 2020
- Incorporated in 2019
- Present in 2018

Perception of what the institutions have done with CeNAT



■ 2021 ■ 2019

Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.

- CeNAT at the forefront of research
- CeNAT as an ally to meet institutional objectives
- CeNAT supports country goals
- CeNAT supports reliability of the data (2)
- CeNAT in the development of joint projects (4)
- CeNAT in scientific training
- CeNAT in institutional relation strengthening
- CeNAT as an innovative institution
- CeNAT conducting joint research
- CeNAT is closer to the academy
- CeNAT as organizer of scientific events
- CeNAT in participation in international projects (2)
- CeNAT in joint publications
- CeNAT in solutions to global problems
- CeNAT socializes the use of information

Expectations of CeNAT institutions in the next 5 years



- CeNAT as support to the productive sector
- CeNAT in municipal collaboration
- CeNAT as support in purchasing services
- CeNAT as Prototyping support
- CeNAT in community projection
- CeNAT in institutional projection
- CeNAT in scientific publications
- CeNAT in scientifically-correct relationship
- CeNAT in PINN-funded services
- CeNAT with permanent relationship (2)
- CeNAT in upscaling of technology transfer (3)
- CeNAT in research projects (3)
- CeNAT does not compete for research funds (3)
- CeNAT as strategic partnerships (4)
- CeNAT in effective collaborations (7)

Source: Information for the year 2021 provided by the Laboratories and Areas of CeNAT.



Indicators of

**institutional
work**

Indicators of
institutional work

Impact Reached in 2021 by CeNAT



13 465 Facebook Followers



490.354 Average reach of Facebook posts



49 Nationalities of Facebook followers



102 Media presence



3 Registered patents



7 Registration processes



2 Researchers in the United States Invention Registration

Impact in 2021

75

Scientific Publications



496

People using simulation cluster

55

Projects developed within the triple-helix framework: Academic, Government, and Private Sectors.

181

Student interns in academic development projects

89474

Usage hours in simulations and data processing



23

Scholarships

430

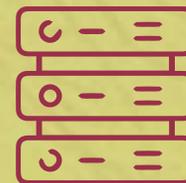
Accounts with access to computing infrastructure services

110 Knowledge transfers



4351 People benefited by knowledge transfer from the laboratories

3 Chemistry Olympics supported by CeNAT





125,161 Students and professors from public universities with access to the Edu-Roam network

106 Participating countries in the Eduroam network

2 billion Logins to the Eduroam network in international territories

515 Wireless Internet Zones (Zii) through which free Internet access is provided to the population

5 Eduroam deployed in the headquarters and campuses of the 5 Public Universities

6000 Technical assistance to producers in Variability and Climate Change

28 Articulation with strategic sectors

31 Link with inter-institutional networks

358 Cluster Performance Days

139

Number of ventures that applied to the OPEN LAB program

245

Number of entrepreneurs in the database of the OPEN LAB program

14

Number of ventures incubated in the OPEN LAB program

41

Number of entrepreneurs incubated in the OPEN LAB program

3

Number of projects led by women OPEN LAB

567

Number of entrepreneurs supported thanks to open community programs (virtual sessions) OPEN LAB





FunCeNAT and

**Financial
Results**

FunCeNAT and
Financial Results



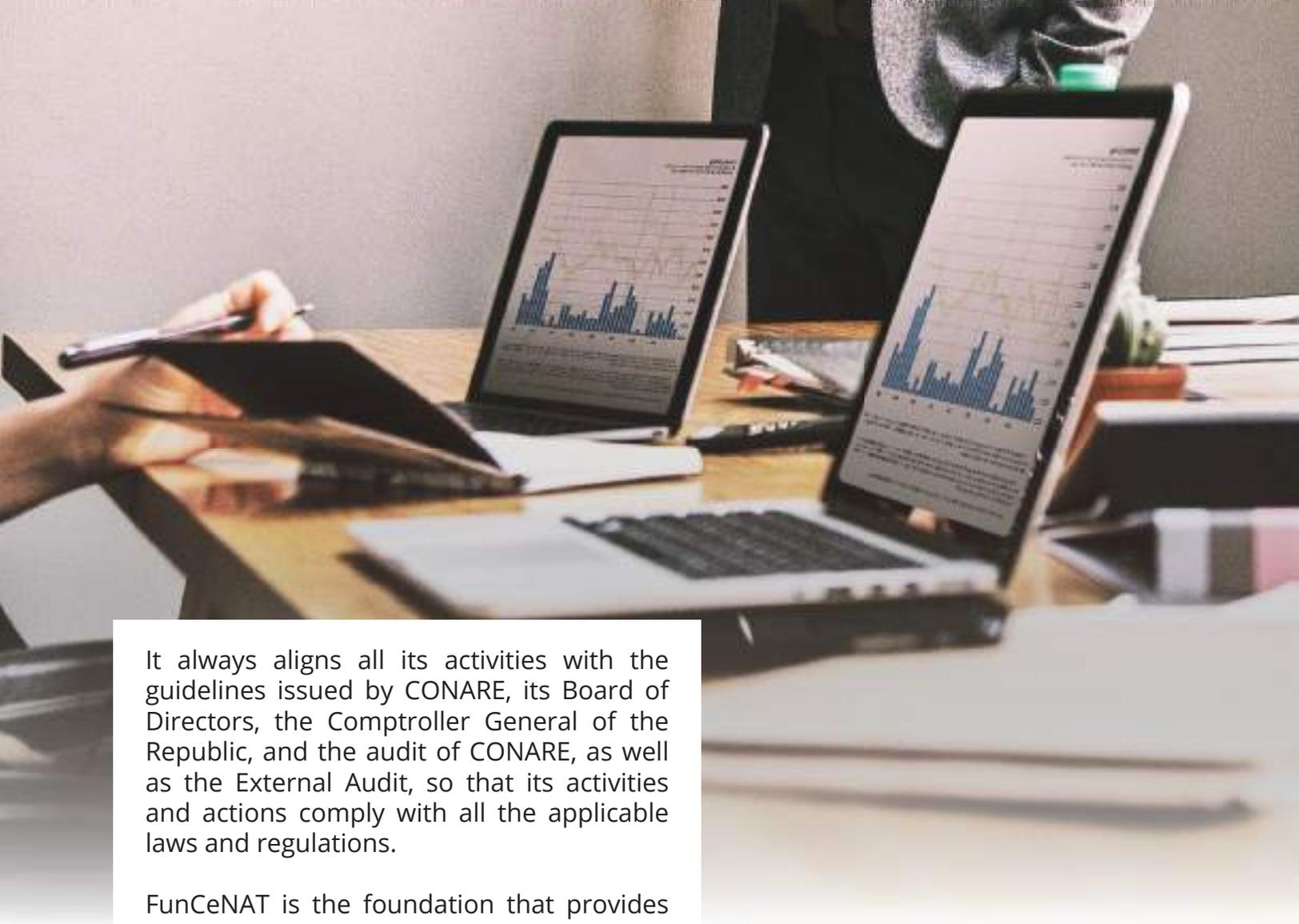
FunCeNAT was established in November of 1997, under the Law of Foundations No. 5338 with the name of Fundación Centro de Alta Tecnología.

The Foundation has the mission of managing public and private resources, as well as providing support in the organizational management of each of the divisions that make up CeNAT, as promulgated by Law N° 7806.

Law No. 7806 of May 25, 1998, expressly recognized FunCeNAT as the entity that would hold the legal duty to administer the resources required for the execution of the projects developed through CeNAT. Article 3 of this law provided:

“Article 3°- The State and its institutions are hereby authorized to transfer resources to the Centro Nacional de Alta Tecnología, whose administration and management will be handled by the Fundación Centro Alta Tecnología, with legal identification N° 3-006-213777. The public funds that the Foundation administers by virtue of this law will be kept under the supervision of the Office of the Comptroller General of the Republic”.

The Foundation acts as a service platform that meets the needs of CeNAT, as well as the public and private projects it manages. For this reason, FunCeNAT actively collaborates in the work of the areas, laboratories, programs and projects, providing support in administrative management in an efficient and transparent way, in sound financial management, in the organizational development at national and international levels, as well as legal support in the actions that the Laboratories, Programs, and Projects undertake. Through its work, it strengthens the link with CONARE, in addition to supporting communication and inter-sectoral articulation.



It always aligns all its activities with the guidelines issued by CONARE, its Board of Directors, the Comptroller General of the Republic, and the audit of CONARE, as well as the External Audit, so that its activities and actions comply with all the applicable laws and regulations.

FunCeNAT is the foundation that provides ongoing support to CeNAT laboratories and programs based on four organizational development pillars, namely:

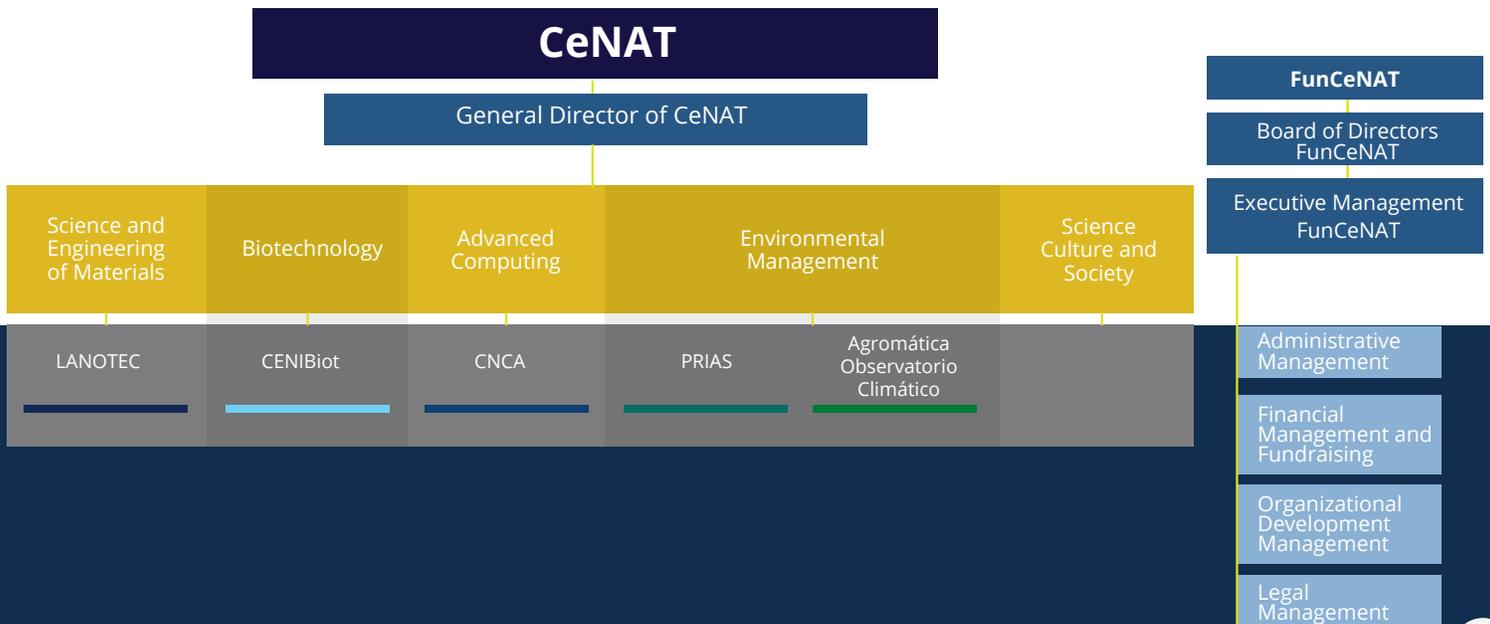
**Administrative
Management**

**Legal
Management**

**Human Talent
Management**

**Financial
Management
and Fundraising**

The operational structure of CeNAT showing its workflow is presented below.





Financial Statements



DESPACHO DE CONSULTORES Y ASESORES
CONTADORES PÚBLICOS AUTORIZADOS Y PRIVADOS

Sociedad de Responsabilidad Limitada Cédula Jurídica: 3-102-272831

Independent Audit Report

To the Managing Board of Fundación
Centro de Alta Tecnología

We have carried out the audit of the attached balance sheet of Fundación Centro de Alta Tecnología (FunCeNAT) as of December 31, 2021, of the related statements of comprehensive activities and accumulated surplus and of cash flows that are relative to the twelve-month period ended at that date.

Management's accountability for the financial statements:

FunCeNAT's Management is responsible for the preparation and reasonable presentation of the financial statements, in accordance with the International Financial Reporting Standards and for the internal control it deems necessary to allow the preparation of financial statements to be free of material errors, both fraud and mistakes.

Auditor's accountability:

Our responsibility is to issue an opinion on such financial statements, based on our audit. We perform our audit in accordance with International Standards on Auditing. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves the execution of procedures to obtain audit evidence supporting the amounts and disclosures in the financial statements of FunCeNAT. The selected procedures depend on the judgment of the auditor, including their risk assessment for significant error, whether caused by fraud or error. In conducting these risk assessments, the auditor takes the internal controls of the Organization relevant to the reasonable preparation and presentation of the financial statements into consideration, in order to design audit procedures that are appropriate to the circumstances. An audit also includes an assessment of the accounting policies used and the reasonableness of the accounting estimates made by the Administration, as well as the general assessment of the presentation of the financial statements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a reasonable basis for our opinion.

Opinion:

In our opinion, the Balance Sheet of the Fundación Centro de Alta Tecnología (FunCeNAT) as of December 31, 2021, the related statements of income and accumulated surplus and cash flows that are relative to the twelve-month period ended at that date, reasonably present, in all their important aspects, the financial situation in accordance with the International Financial Reporting Standards.

Tel.: 2253-2410
Fax: 2281-2971
www.prendasvargas.com
Apdo Postal 168-2120
San José, Costa Rica

Matters that do not affect opinion:

- 1- Our audit was conducted with the purpose of presenting an opinion on the financial statements of FunCeNAT as of December 31, 2021, and for the twelve-month period ended at that date. The supplementary financial information for the periods ended December 31, 2021, shown in the Annex is presented for additional analysis purposes and is not required as part of the basic financial statements. This supplementary information was subject to the same audit procedures applied to the audit of the financial statements as of December 31, 2021 and for the twelve-month period ended at that date and, in our opinion, it was reasonably presented in all significant respects when considered in relation to the financial statements, taken as a whole.
- 2- In relation to the pandemic caused by the virus known as COVID-19, as of the date of the opinion of the external auditors on the financial statements of FunCeNAT as of December 31, 2021, the Administration of the organization was unable to reasonably estimate the duration and the severity of this pandemic, so it is unaware of the future effects it may have on the financial situation of FunCeNAT and the projects it manages and, although it estimates that its effect has been slight and will remain that way in the short term, it carries out the respective analyzes to determine any situation that may affect it, adopting measures to mitigate the possible effects, so the attached financial statements should be read considering the effects mentioned in Note 10 - Contingency due to COVID-19 pandemic, where mention is made of the national emergency situation throughout the territory of the Republic of Costa Rica caused by the COVID-19 pandemic.

Prendas, Vargas y Córdoba, Ltda.



Marcelo Prendas González
Certified Public Accountant, card No. 822



Loyalty Policy No. 0116 FIG 7, expiring on September 30,
2022. Stamp of Law N° 6663.

San Jose, March 11, 2022.

FUNDACIÓN CENTRO DE ALTA TECNOLOGÍA (Nonprofit Organization)

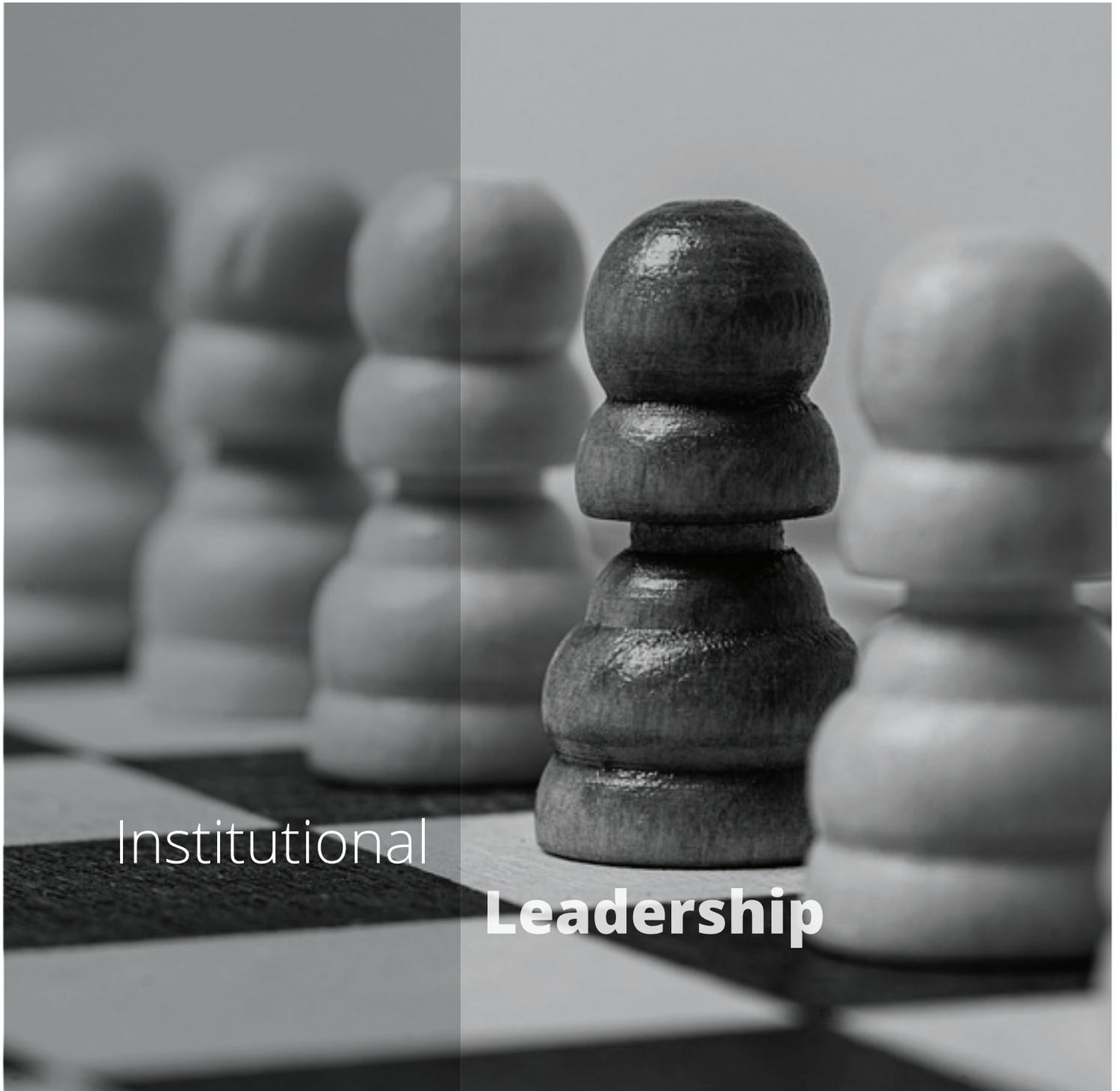
BALANCE SHEET
As of December 31, 2021 and 2020
(Amounts shown in colones)

ASSETS	2021	2020
Current assets:		
Cash and cash equivalents	¢83 708 044	¢101 853 482
Transitory investments	1 374 681 285	1 151 242 614
Accounts receivable	81 347 862	43 051 701
Total current assets	1 539 737 191	1 296 147 797
Long-term investments	1 262 064 288	1 313 366 516
Furniture and equipment, net amounts	1 927 800	2 782 100
TOTAL ASSETS	¢2 803 729 279	¢2 612 296 413
NET LIABILITIES AND ASSETS		
Liabilities		
Current liabilities		
Accounts payable and accumulated expenses	¢63 650 571	¢186 842 411
Restricted funds projects public funds	1 750 419 058	1 500 554 117
Restricted funds projects private funds	753 191 011	715 094 015
Total Liabilities	2 567 260 640	2 402 490 543
NET ASSETS		
Accumulated surplus	236 468 639	209 805 870
Total equity	236 468 639	209 805 870
TOTAL LIABILITIES AND NET ASSETS	¢2 803 729 279	¢2 612 296 413

FUNDACIÓN CENTRO DE ALTA TECNOLOGÍA (Nonprofit Organization)

INCOME STATEMENT - INTEGRATED AND ACCUMULATED SURPLUS
FOR THE TWELVE-MONTH PERIOD ENDED DECEMBER 31, 2021 AND 2020
(Amounts shown in colones)

	2021	2020
REVENUE:		
Fund Revenue	₡104 423 217	₡97 380 278
Project Management Revenue	55 960 077	55 026 506
Other Revenue	8 303 258	3 509 805
Total Revenue	<u>168 686 552</u>	<u>155 916 589</u>
EXPENSES:		
Remunerations	127 714 838	123 016 680
Services	6 067 299	6 373 108
Materials and Supplies	596 055	1 591 476
Depreciation expense	854 300	1 002 557
Benefits	5 241 105	5 067 552
Training and protocol	1 241 154	4 256 904
Other minor expenses	309 032	451 166
Total Expenses	<u>142 023 783</u>	<u>141 759 443</u>
SURPLUS OF THE PERIOD	26 662 769	14 157 146
ACCUMULATED SURPLUS AT THE BEGINNING	<u>209 805 870</u>	<u>195 648 724</u>
ACCUMULATED SURPLUS AT THE END	<u>₡236 468 639</u>	<u>₡209 805 870</u>



Institutional

Leadership

Institutional
Leadership



Consejo Nacional de Rectores (National Council of Deans)

Francisco González Alvarado
MBA., Chancellor, National University

Luis Paulino Méndez Badilla
Eng., Chancellor, Costa Rica
Institute Technology

Rodrigo Arias Camacho
MBA., Chancellor, State University
for Distance Education

Dr. Emmanuel González Alvarado
Chancellor, National Technical
University

Dr. Gustavo Gutiérrez Espeleta
Chancellor, University of Costa Rica

Scientific Council

Dr. María Laura Arias Echandi
Vice Chancellor for Research,
University of Costa Rica

Jorge Chaves Arce
M.Sc., Vice-Chancellor of Research,
Costa Rica Institute Technology

Dr. Jorge Herrera Murillo
Vice Chancellor of Research,
National University

Rosibel Viquez Abarca
PhD., Vice-Chancellor of Research, State
University for Distance Education

Guillermo Hurtado Cam
Eng., Vice Chancellor of Research
and Transfer, National Technical
University

Strategic Partners

University of Costa Rica

Costa Rica Institute of Technology

National University

Universidad Estatal a Distancia (State Distance Education University)

Universidad Técnica Nacional (National Technical University)

CONICIT

MICITT

Directorate of CeNAT

Eduardo Sibaja Arias

Eng., Director, CeNAT

Karol Palma Odio

Direction Administrative Assistant

Laboratory Directors

Dr. José Vega Baudrit

Director, National Nanotechnology Laboratory

Dr. Randall Loaiza Montoya

Director, CENIBiot Laboratory

Dr. Esteban Meneses Rojas

Director, National Collaboratory of Advanced Computing

Ing. Allan Campos Gallo, MBA

Director, Environmental Management Area

Ing. Cornelia Miller Granados, MBA

PRIAS Laboratory Director



Officers

CeNAT

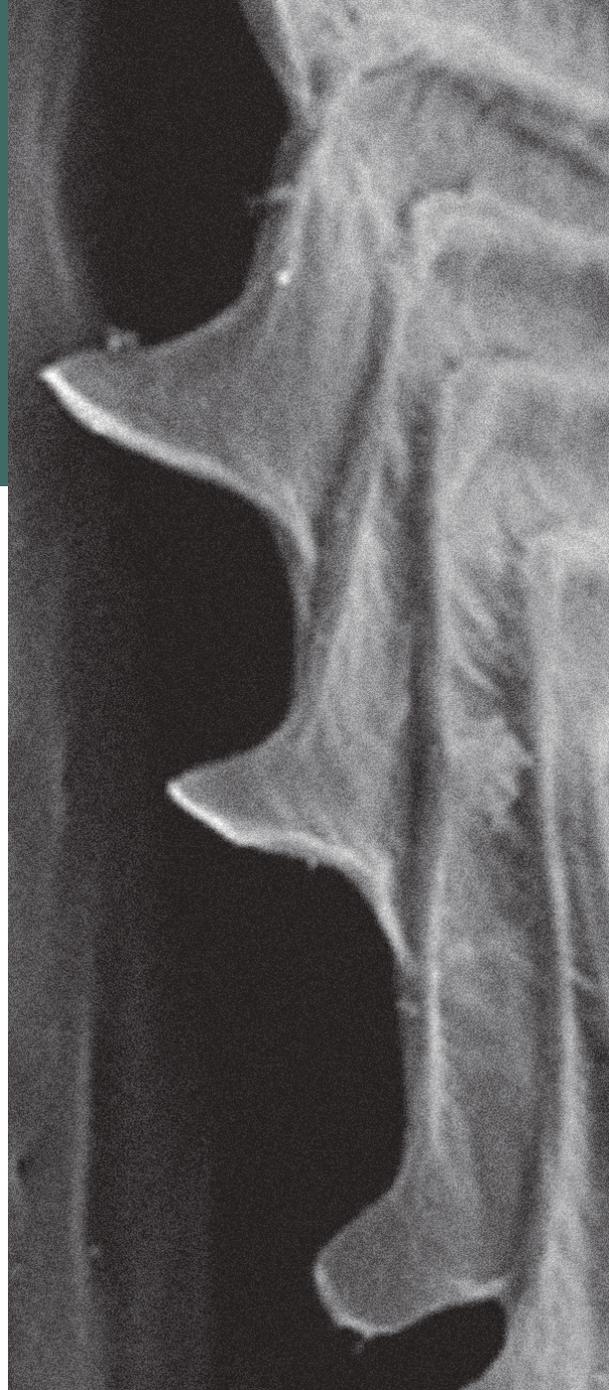
Kimberly Sánchez Calderón
Rubén Padilla Hernández
Sugey Rivera Obando
Karla Vanessa Montero Castro

LANOTEC

Gabriela Montes de Oca Vásquez
Melissa Camacho Elizondo
Flor Flores Sequeira
Reynaldo Pereira Reyes
Sergio Paniagua Barrantes
Andrea Mariela Araya Sibaja
Carolina Morales Cerdas
Diego Bastista Menezes
Rodrigo Mora Bolaños
Yendry Corrales Ureña
Juan Miguel Zúñiga Umaña

CNCA

Melissa Hernández Sánchez	CNCA
Raquel Miranda Pérez	CNCA-State of the Nation
Diego Jiménez Vargas	CNCA
Jean Carlo Umaña Jiménez	CNCA
Mariela Abdalah Hernández	CNCA
Carlos Gamboa Venegas	CONARE Network
Maripaz Montero Vargas	CNCA-CENIBiot
Fabricio Qurós Corella	CNCA-NATGEO



PRIAS

Marilyn Ortega Rivera	PRIAS
Heileen Aguilar Arias	PRIAS
Christian Vargas Bolaños	PRIAS
Iván Ávila Pérez	PRIAS
David Alonso Romero Badilla	PRIAS
Francini Corrales Garro	PRIAS
María Fernanda Obando Picado	PRIAS-MOCUPP
Jorge Alejandro Rosales Rodríguez	PRIAS-MOCUPP
Yorleny María Calvo Elizondo	PRIAS-MOCUPP
Yerlin Dayana Vargas Solano	PRIAS-MOCUPP
Armando Antonio Vargas Céspedes	PRIAS-MOCUPP
Ketcha Hernández Vargas	PRIAS-MOCUPP
Milagro Jiménez Rodríguez	PRIAS-MOCUPP
Sofía Hernández Hernández	PRIAS-MOCUPP
Marilyn Manrow Villalobos	PRIAS-MOCUPP
Ezequiel Fallas Montero	PRIAS-MOCUPP
Sofía Acuña López	PRIAS-MOCUPP
Jennifer María Fernández Garro	PRIAS-MOCUPP
Francini Corrales Garro	PRIAS-MOCUPP



CENIBiot

Rodrigo Muñoz Arrieta	CENIBiot
Wendoly Arias Salazar	CENIBiot
Mónica Rojas Gómez	CENIBiot
Jessica Montero Zamora	CENIBiot
Max Chavarria Vargas	CENIBiot
Jorge Alberto Araya Matthey	CENIBiot
Emanuel Araya Valverde	CENIBiot
Monica Baizan Rojas	CENIBiot
Daniel Andrés Alvarado Villalobos	CENIBiot
Melissa María Chaves Phillips	CENIBiot
Anibal Mora Villalobos	CENIBiot
Camila Charpentier Alfaro	CENIBiot
Cristofer Orozco Ortiz	CENIBiot
Yosimar González Fernández	CENIBiot
Pamela Alfaro Vargas	CENIBiot
Manuel Felipe Vásquez Castro	CENIBiot
Vanessa María Rivera Mora	CeNAT-CENIBiot



State of the
Nation

Kenneth Obando Rodríguez

Program Coordinators

Agromatics,
Food Safety And
Slow Food

Patricia Sánchez Trejos



Managing Board of Fundación Centro de Alta Tecnología

Luis Paulino Méndez Badilla	President
Francisco González Alvarado	Secretary
Rodrigo Arias Camacho	Treasurer
Rosemarie Ruiz Bravo	Member 1
Maria de los Angeles Aldí Villalobos	Member 2
Emmanuel González Alvarado	First Comptroller
Gustavo Gutiérrez Espeleta	Second Comptroller
Eduardo Sibaja Arias	Director, CeNAT
Gastón Baudrit Ruiz	Legal Advisor OPES-CONARE

Administrative Management FunCenat

Cynthia Cordero Solís, Directora Administrativa	FunCeNAT
Mauricio Segura Chacón	FunCeNAT
Jeannette Vargas Arce	FunCeNAT
Yakelyn Bejarano López	FunCeNAT
Margarita Quan Zepeda	FunCeNAT
María Fernanda Hernández Jiménez	FunCeNAT



Scholars and Collaborators

Joseph Ibrahim Cabraca Vargas	University of Costa Rica (UCR)	CENIBiot
Marcel Jiménez Fallas	University of Costa Rica (UCR)	CENIBiot
Samara López Ramírez	Costa Rica Institute of Technology (TEC)	CENIBiot
Adrian Villalobos Cano	Costa Rica Institute of Technology (TEC)	CENIBiot
Rodrigo Muñoz Arrieta	University of Costa Rica (UCR)	CENIBiot
Silvia Fernández Fernández	University of Costa Rica (UCR)	CENIBiot
Ana Victoria Elizondo Masís	National University of Costa Rica (UNA)	CENIBiot
Daniela Vásquez Vásquez	University of Costa Rica (UCR)	CENIBiot
Antony Torres Solano	University of Costa Rica (UCR)	CENIBiot

Johansell Adrián Villalobos Cubillo	Costa Rica Institute of Technology (TEC)	CNCA
Javier Ernesto Rodríguez Yañez	University of Costa Rica (UCR)	CNCA
Kenneth Geovanny López Pérez	University of Costa Rica (UCR)	CNCA
Luis Pedro Morales Rodríguez	Costa Rica Institute of Technology (TEC)	CNCA
Manuel Zumbado Corrales	Costa Rica Institute of Technology (TEC)	CNCA
María Fernanda Francis Cartín	University of Costa Rica (UCR)	CNCA

Carlos Viquez Núñez	National University for Distance Education (UNED)	GA
Fiorella Calderón Jiménez	Costa Rica Institute of Technology (TEC)	GA
Ingrid Molina Mora	University of Costa Rica (UCR)	GA
Rubén Sánchez Alvarado	National University for Distance Education (UNED)	GA

Gabriel Jiménez Thuel	University of Costa Rica (UCR)	LANOTEC
Katherine Acuña Umaña	University of Costa Rica (UCR)	LANOTEC
Kevin Segura Rodríguez	University of Costa Rica (UCR)	LANOTEC
Lisa Badilla Vargas	University of Costa Rica (UCR)	LANOTEC
Paulina Fernández Méndez	University of Costa Rica (UCR)	LANOTEC
Ximena Horvilleur Gómez	University of Costa Rica (UCR)	LANOTEC
Yeymi Torrez Sequeira	University of Costa Rica (UCR)	LANOTEC
Celia Miranda Oporta	Costa Rica Institute of Technology (TEC)	LANOTEC
Rodolfo Hernández Chaverri	National University for Distance Education (UNED)	LANOTEC
Luis Diego Arias Chavarría	National University of Costa Rica (UNA)	LANOTEC
Juan Miguel Zúñiga Umaña	University of Costa Rica (UCR)	LANOTEC
María Isabel Quirós Fallas	University of Costa Rica (UCR)	LANOTEC
Miguel Benavides Acevedo	University of Costa Rica (UCR)	LANOTEC
Josué Cordero Guerrero	University of Costa Rica (UCR)	LANOTEC
Deilin Ureña Portuguez	Costa Rica Institute of Technology (TEC)	LANOTEC
Rodrigo Mora Bolaños	Costa Rica Institute of Technology (TEC)	LANOTEC
Karime Ramírez Jiménez	Costa Rica Institute of Technology (TEC)	LANOTEC

Adriana Fallas Cosío	Costa Rica Institute of Technology (TEC)	PRIAS
Arleth Porras Granados	Costa Rica Institute of Technology (TEC)	PRIAS
Manfred González Hernández	University of Costa Rica (UCR)	PRIAS
Sebastián Sánchez Guzmán	Costa Rica Institute of Technology (TEC)	PRIAS
Armando Vargas Céspedes	University of Costa Rica (UCR)	PRIAS
Joseph Rojas Zamora	Costa Rica Institute of Technology (TEC)	PRIAS



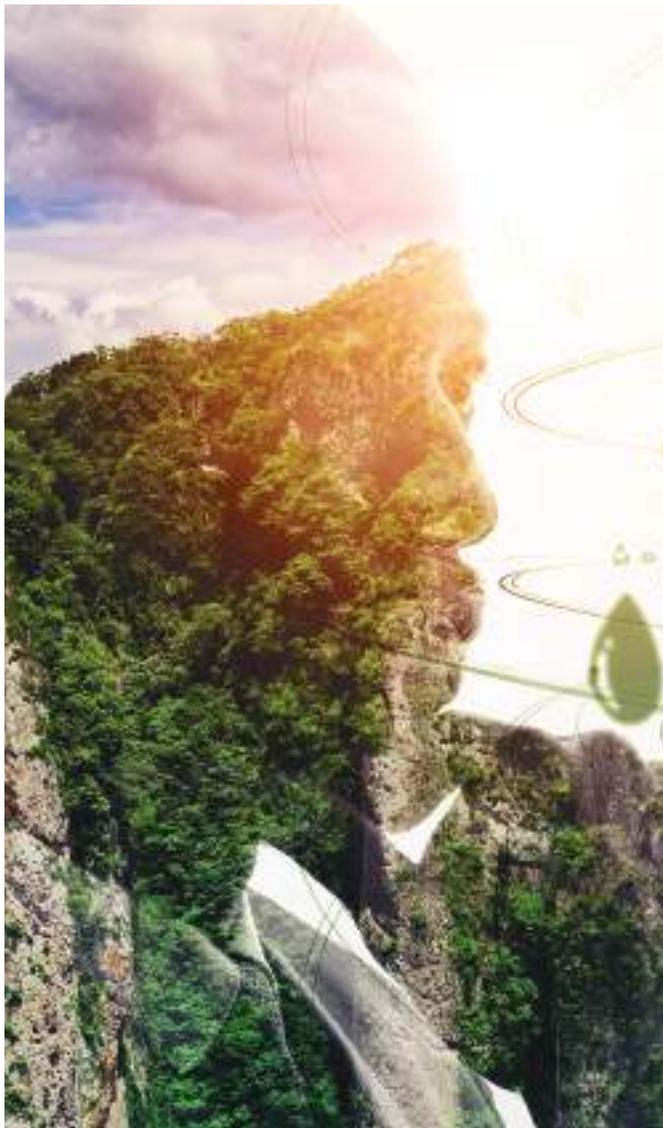
Collaborators

Brian López Campos	CENIBiot	Melissa Gonzalez Sanabria	CENIBiot
Francisco Vasquez Valerio	CENIBiot	Stephanie Berrocal Rodriguez	CENIBiot
Andrés Montoya Cruz	CENIBiot	Sheila Jiménez Mesén	CENIBiot
Andrés Pacheco Peralta	CENIBiot	Ricardo Hernández Moncada	CENIBiot
Marjorie Miranda Angulo	CENIBiot	Gabriel Vargas Jiménez	CENIBiot
Rachel Ardon Rivera	CENIBiot	Katherine Valverde Madrigal	CENIBiot
Saul Sandoval Hernández	CENIBiot	Marcel Jimenez Fallas	CENIBiot
Ximena Ureña Bermúdez	CENIBiot	Allison Bastos Salas	CENIBiot
María Vallejo Salas	CENIBiot	Fiorella Arias Bonilla	CENIBiot
Gabriel Morales Artavia	CENIBiot	Samara López Rámirez	CENIBiot
Daniela Vasquez Vasquez	CENIBiot	Erika Barrantes Murillo	CENIBiot
Valeria Rojas Chinchilla	CENIBiot	Isaac Vargas Solorzano	CENIBiot
Karol Sánchez Sánchez	CENIBiot	Diego Rojas Gatjens	CENIBiot
Pamela Sevilla Cortes	CENIBiot	Michelle Campor Valverde	CENIBiot
Francisco Vasquez Valerio	CENIBiot	Efrain Escudero Leiva	CENIBiot
Jesús Oviedo Ulate	CENIBiot	Alejandra Deras Santos	CENIBiot
Fernando Vargas Castro	CENIBiot	Jason Cambronero Duran	CENIBiot
Susana Morales Vásquez	CENIBiot	Maria Rojas Salazar	CENIBiot
Fabricio Amador López	CENIBiot	Jilma Alemán Laporte	CENIBiot
Erika Barrantes Murillo	CENIBiot	Adriana Castillo Herrera	CENIBiot
Sebastian Bolaños Zumbado	CENIBiot	Carolina Herrera González	CENIBiot
Sofía Sequeira Escorcia	CENIBiot	Jose Pablo Arrieta Alvarado	CENIBiot
Valeria Leandro Arce	CENIBiot	Victor Montoya Sequeda	CENIBiot
Natalin Picado Canales	CENIBiot	Karla Montero Castro	CENIBiot
Carmen Luna Sánchez	CENIBiot	Jeffry Badilla Nuñez	CENIBiot
José Julián Picado Morales	CENIBiot	Daniela Zamora Barrantes	CENIBiot
Noelia Rechnitzer Sandí	CENIBiot	Daniel Alvarado Villalobos	CENIBiot
Jenifer Guillén Rivera	CENIBiot	Joseph Cabraca Vargas	CENIBiot
Layla Nassar Miguez	CENIBiot	Ana Elizondo Masis	CENIBiot
Mariana Elizondo Blanco	CENIBiot	Jorge Araya Matthey	CENIBiot
Aurea Chavarría Dalolio	CENIBiot	Valeria Rojas Chinchilla	CENIBiot

Teresa Salazar Rojas	CNCA
Silvia Echeverría Sáenz	CNCA

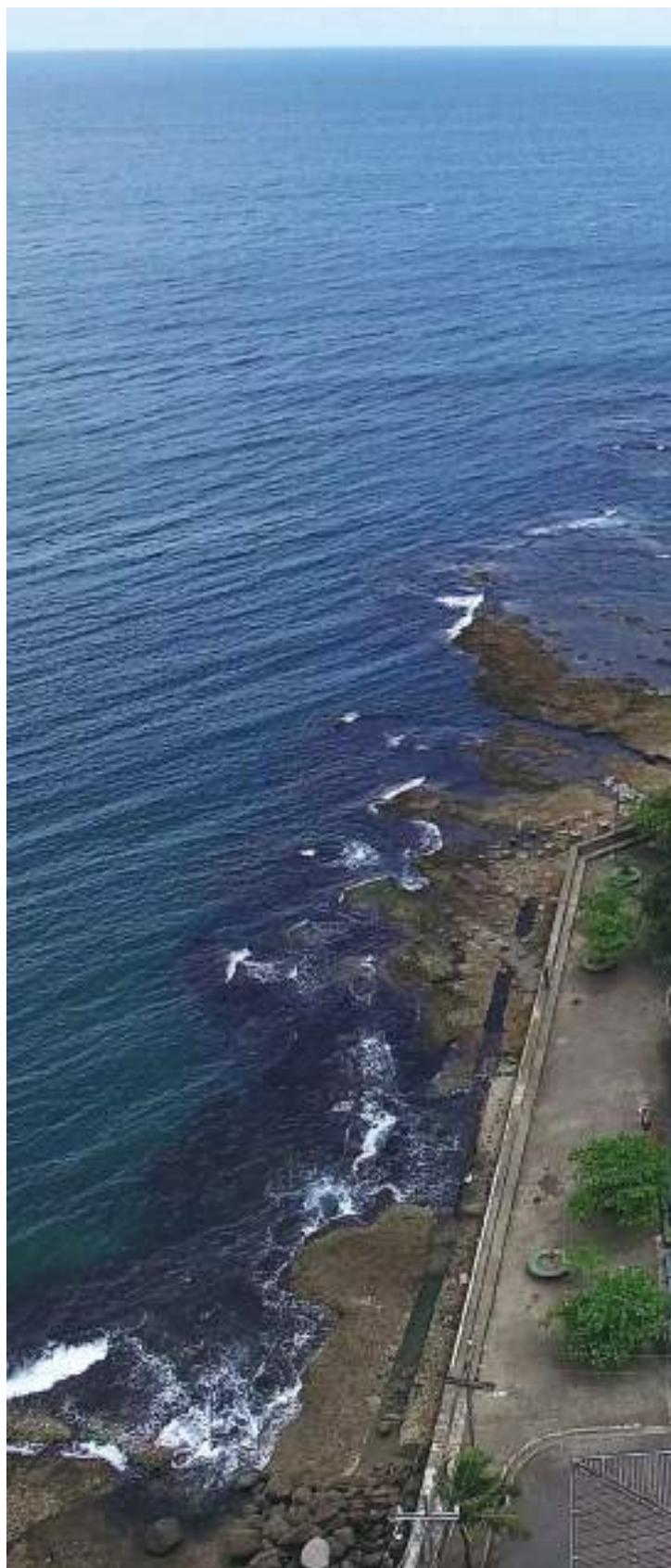
Andrea Rivera Álvarez	GA
Fiorella Calderón Jiménez	GA
Daniel Serrano Delgado	GA
Jazmín Calderón Quirós	GA
Valeria Castro Argüello	GA
Ariela Piedra Abarca	GA
Camila Sánchez Dávila	GA
Irina Katchan Katchan	GA
Martha Montero Vindas	GA
Virna Sandoval Ugalde	GA
Wenfri Grijalba Villegas	GA

Fabiola Araya Rojas	LANOTEC
Irene Castro Lobo	LANOTEC
Dayanna Zamora Herrera	LANOTEC
James Suárez Campos	LANOTEC
Katherine Hernández Barrantes	LANOTEC
Xiomara Marchena Quirós	LANOTEC
Sofía Gómez Solano	LANOTEC
Viviana Orozco Fernández	LANOTEC
Jorge Blen Esposito	LANOTEC
Merlin Bolaños Espinoza	LANOTEC
José Cuadra Hernández	LANOTEC
Elías Gairaud Benavides	LANOTEC
Andrea Chacón Calderón	LANOTEC
Shakira Johnson George	LANOTEC
Adriana Casares Rojas	LANOTEC
Josué Arrieta Alfaro	LANOTEC
Sara Cordero Fuentes	LANOTEC
Joselyn Piedra Chacón	LANOTEC
Jeimmy González Masís	LANOTEC
Walter Montero Román	LANOTEC
Ricardo Quesada Grosso	LANOTEC
Melissa Castro Mora	LANOTEC
Mario González Vásquez	LANOTEC
Rebeca Rodríguez Fonseca	LANOTEC
Nathalia Flores Alonso	LANOTEC
Sofía Lai Velásquez	LANOTEC
Brian López Campos	LANOTEC
Arquímedes Velásquez Díaz	LANOTEC
Ignacio Borge Durán	LANOTEC
Paulo Izaguirre Molina	LANOTEC
Jennifer Calderón Mora	LANOTEC



Cesar Ayerdis Ruiz	LANOTEC
Nathan Oudeville	LANOTEC
Jason Guillaume	LANOTEC
Ariel Goldewicht	LANOTEC
Daniel Rivaldi Chávez	LANOTEC
Omayra Ferreiro Balbuena	LANOTEC
Iván Solís Sandí	LANOTEC
Frander Medina González	LANOTEC
Juan Miguel Zúñiga Umaña	LANOTEC
Nathalia Vargas Valverde	LANOTEC
Camilo Torres Blanco	LANOTEC
María Paula Salas González	LANOTEC
David Marín Ocampo	LANOTEC
Jimena Arias Ulloa	LANOTEC
Luis Diego Alvarado Corella	LANOTEC
Valeria Amores Monge	LANOTEC
Paola Sánchez Navarro	LANOTEC
Andrea Ramírez Anchía	LANOTEC
Beatriz Vega Barquero	LANOTEC

César Castro Azofeifa	PRIAS
Mariana Jiménez Venegas	PRIAS
Gabriela Chaves Brenes	PRIAS
Fabiola Solano Cerdas	PRIAS
Esteban Montenegro Hernández	PRIAS
Daniel Ramírez Umaña	PRIAS



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CeNAT
Centro Nacional de Alta Tecnología

 (506) 2519-5835 | Fax: (506) 2232-0423  /centro.nacional.de.alta.tecnologia

 cenat@cenat.ac.cr  www.cenat.ac.cr

 1.3 km. norte de la Embajada de los Estados Unidos. Pavas, San José, Costa Rica