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Instituto de Cultivos Tropicales-ICT, Technological advances and effective solutions to increase cocoa productivity and minimize the impact of climate change in Peru

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Resumen

El Perú, es en la actualidad, el segundo mayor productor de cacao orgánico en el mundo, con 120 mil ha y producción de más de 92 mil toneladas de grano. En la Región San Martin, cuando el Instituto de Cultivos Tropicales-ICT fue creado (1993), existían alrededor de 2,143 ha de cacao y en la actualidad existen cerca de 41,984 ha de cacao, con una productividad de 950 kg/ha, esto gracias a los esfuerzos de muchas instituciones, principalmente el ICT, con el soporte de instituciones de Estados Unidos de America, que fue el encargado de generar y validar tecnología de cacao en San Martin y el Perú. Producto de esto es la capacitación de más de 25,000 agricultores de diferentes partes del país en el manejo técnico del cultivo de cacao y diversificación de cultivos, bajo diferentes metodologías de capacitación. Entrenamiento de más de 1300 profesionales peruanos y extranjeros de varias organizaciones (PDA, DEVIDA, ACOPAGRO, UNSM, ROMERO TRADING, INIA, GRSM, GIZ, CAC, GOLD GREEN, PEAM, PEHCBM, ADRA, CACVRAE, APROCAV, INDACO, APPCACAO, Alianza Cacao-Perú, etc.) en metodologías participativas de escuelas de campo (ECA) en el cultivo de cacao y otros como café, palma aceitera, sacha inchi, etc. También se financio y apoyo la realización de 53 tesis (pregrado, maestría y doctorado), prácticas pre-profesionales e internados de más de 320 estudiantes de diversas universidades e institutos tanto nacionales como extranjeros; Además de la implementación de 5400 ha de cacao, en áreas de influencia con el cultivo de coca. El ICT cuenta con tres estaciones experimentales: El Choclino, Juan Bernito y Bello horizonte, donde se encuentran modernos laboratorios de suelos, tejidos vegetales, biología molecular y fitopatología que ayudan al desarrollo de las investigaciones y la extensión para mejorar la productividad del cacao. Cuenta con el banco de germoplasma mas grande del Perú, con más de 900 genotipos, entre internacionales, silvestres y nacionales, con el fin de seleccionar variedades tolerantes a los principales problemas que afectan la cacauicultura en el Perú y el mundo. El ICT continua desarrollando proyectos en busca de aumentar la productividad del cultivo de cacao sosteniblemente, con el soporte de entidades nacionales (INNOVATE, CONCYTEC, INCAGRO) e internacionales (USDA-ARS; University of Florida, USA; Universidad Estadual de Santa Cruz, Brasil; CEPLAC, Brasil). Actualmente, desarrolla investigaciones relacionadas al mejoramiento genético, plagas y enfermedades, estrés abiótico, metales pesados, biología molecular, fertilidad y conservación de suelos, calidad de grano, manejo integrado de plagas y enfermedades, Sistemas de producción agroforestal, transformación y calidad del grano. La cacauicultura en el Perú y el mundo tiene un aliado estratégico en el ICT para la mejora de su productividad sostenible, contribuyendo con la seguridad alimentaria y medio ambiente.

Instituto de Cultivos Tropicales-ICT

Peru is currently the second largest producer of organic cocoa in the world, with an area of 107 thousand hectares and production of 81.7 tons of beans, of which in San Martin Department are 38% (40,700 hectares), with production of 38.3Tm. When ICT was created in 1993, the area of coca in the area of influence was 51.600ha and cocoa 2,143 ha; at present the situation is opposite, less of 2,979 ha coca and 41,984 ha of cocoa and with a technological gap of cacao of Less than 5% (Figure ???), that is to say with yields of more than 950 kg / ha, the first in the world in adoption of technology, thanks to the efforts of many institutions, mainly the Instituto de Cultivos Tropicales (ICT), which has been generate and validate technology for cocoa in San Martin and Peru. The technology was transferred to technicians and farmers of different programs, through its extensive extension and training program, which takes the greatest strength from 1998 onwards, when the ICT moves to Tarapoto from Tingo María, by a terrorist threats from "Sendero Luminoso" for relation of ICT with US Embassy.

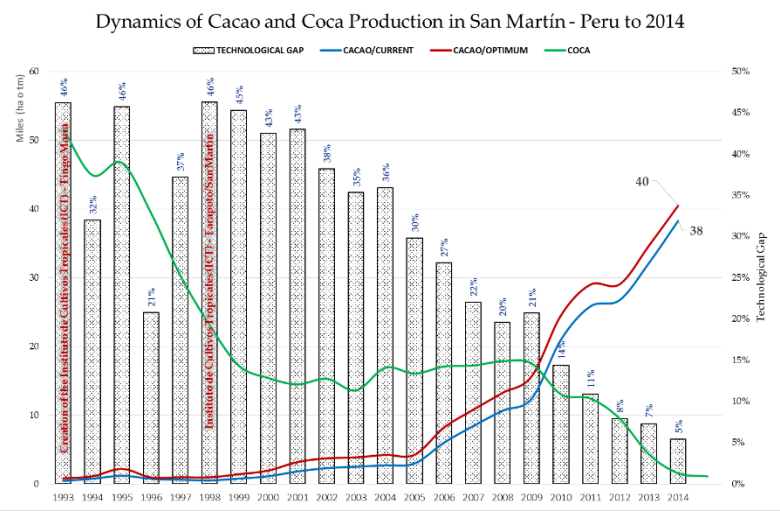

Figure 1. Dynamic of cocoa and coca production in San Martin Peru to 2014

The ICT began its activities at Tingo María in 1993 with evaluation of coca leaf yields and arrangements of smallholder production systems in conjunction with USDA / ARS-DEA -UNAS-NAS / US Embassy; This program then became a major research project and extension of alternative crops that took effect from 1998, as previously mentioned. When the ICT moved to Tarapoto, there the ICT start the implementation of experimental stations and modern and well-equipped laboratories of Soil, water, phytopathology, biotechnology (molecular biology and tissue culture) and production, to support for research and agricultural extension in the Amazonia, then begins the process of generation and validation of technology mainly for cocoa.

These units are also a tool to strengthen the capacities of farmers, technicians, students and professionals, in this mission and under the methodology of Intensive courses, more than 3500 farmers from different parts of the country, mainly from our Amazonia have been trained in the technical management of cocoa cultivation and crop diversification. In addition, in the program of training of trainers, more than 1300 Peruvian professionals from various organizations and projects have been trained in participatory methodologies (PDA, ACOPAGRO, UNSM, ROMERO TRADING, INIA, GRSM, GIZ, CAC, GOLD GREEN, PEAM, PEHCBM, ADRA, CACVRAE, APROCAV, INDACO, APPCACAO, Alianza Cacao-Peru, etc.), graduating as Facilitators of Farmer Field School (FFS) in the cultivation of Cacao, Coffee, Palm Oil, Palm Heart and Livestock. As a training institution, it provides facilities to more than 220 students from various universities and technological institutes in the country to carry out previous internships, undergraduate, master's and doctoral theses at national and international level with aims for academic complementation. And, annually the institution receives approximately 900 visitors nationally and internationally with the purpose of exchanging experiences.

The process of technical assistance and training that ICTs perform and carry out with field technicians, look for the technification of the productive systems and develop of competences in the agricultural products. The trainings have specific objectives in the process of support to the farmer and are carried out in a participatory and experiential way to set ideas and train leaders in tropical crop management practices with an emphasis on cocoa cultivation. Such as Plantation design, Nursery, Planting systems, Grafting, Pruning, Phytosanitary control, Profit, Cocoa products processing, Soil conservation, Fertilization, Agroforestry systems, among others, promoting the active participation of women.

Collaborative efforts of the Instituto de Cultivos Tropicales (ICT) with support of INL and USDA-ARS, in cacao improvement research programs has contributed in formulating these winning research projects. All scientist of Sustainable Perennial Crops Laboratory from USDA-ARS as Drs. Lyndel Mehinhard, Virupax Baligar, Dapeng Zhang between others will be providing technical support on these projects.

It is also of great scientific support in investigations that are being developed to improve soil quality and increase productivity of cocoa through the evaluation of quality parameters in different cropping systems. Your contribution is crucial in modern trends of research and restated raised by ICT.

ICT Peru research activities on Alternate Crop are result of US Congressional intent to provide economic incentives to farmers in coca (narcotic) growing regions

The implementation of alternative development of ICT, articulates with the Research and Technology Transfer, the proposals in research aimed at promoting the development of efficient production systems that will change the attitude of the farmer Huallaga Valley and Monzon towards adoption of legal economic activities.

Contribution to Cocoa Productivity in Peru

During the past years, ICT contributed directly to the installation of over 5,453 hectares of cocoa in areas where coca crop was predominant, other activities develop is showed in the Table 1

Tabla 1. Activities of Technical Assistance of ICT 2002-2013

ACTIVITIES	**Unit**	**TOTAL**
Project Beneficiaries (per year)	Unit	1,500
Possible area of land to expand cocoa	ha	18,122
Installation of new areas	ha	5,453
Rehabilitation of plantations	ha	5,641
Renovation of plantations	ha	525
Surveillance of restored areas	ha	2,466
Follow-up of Renovated Areas	ha	1,850
Monitoring of growing areas	ha	8,472
Assistance of production areas (post-harvest)	ha	13,845
Control of cocoa in production areas	Unit	10,042
Demonstrative plots installed	Unit	291
Clonal gardens installed	Unit	257
New crops (2012 - 2014)	ha	34
Guinea pig Modules (rotary)	Unit	95
Hens Modules (rotary)	Unit	90

The 2014, the ICT has installed 680 hectares new of cocoa crops in the Huallaga and Monzon Valley. But, only in the Monzon Valley, the project has installed 442 hectares of cocoa crops, among new and rehabilitated plantations in degraded lands which were formerly coca crops, representing 5.5% of the total of eradicated coca crops in this area. The 90% of the producers of Monzon have decided each year to plant crops that guarantee market and compensatory price. (INEI agricultural investigation 2012).

ICT contributed to the expansion of cocoa areas in San Martin and Huánuco, installing more than 5453ha of new areas with sustainable planting systems.

CACAO EN PERU	1993	2004	2007	2012	2013
Total Area (ha)	28,238	50,879	59,835	91,497	97,613
Rendimiento Kg/ha	530	509	529	683	736
Total Producción (t)	14,970	25,921	31,387	62,492	71,838
Norte (ha)					
Tumbes, Piura, Amazonas, Cajamarca, Loreto	2,466	5,413	8,087	9,739	10,270
	8.7%	10.6%	13.5%	10.6%	10.5%
Centro (ha)					
San Martín, Huánuco, Junin, Pasco, Ucayali	11,222	18,137	22,581	47,330	56,361
	39.7%	35.6%	37.7%	51.7%	57.70%
Sur (ha)					
Ayacucho, Cuzco, Madre de Dios, Puno	14550	29991	29132	34429	30982
	51.5%	58.9%	48.7%	37.6%	31.70%

According to this figure, 7,737 hectares of eradicated coca should be replaced by 23,211 hectares of coffee and/or cocoa crops to ease the change of attitude from a predominating unlawful coca culture towards legal coffee o cocoa culture.

The proposals of the ICT , looking to improve control strategies for fungal diseases of cocoa, establish and evaluate different management systems of cocoa for social economic and environmental sustainability of agroforestry systems, traditional systems, recovery of degraded soils , mix of other economically viable products preserving the environmental management, in genebanks, selects and sets cacao genotypes to assess genetic and productive potential, and the organoleptic characteristics of taste, color, aroma and fat, resistance to abiotic factors, from of the Amazon basin and the cocoa areas of Peru.

Their actions promote the development of alternative systems and efficient production, to change the attitude of farmers towards the adoption of legitimate economies, properly articulating the links in the production chain of tropical crops. Science and technology today allows you to use various production systems promoting productive development with the recognition of soil fertility, integrated pest management, genetic improvement, and enabling sustainable environmental, economic and social stability in the current areas of illicit crop.

ICT, Tarapoto, San Martin, Peru:

Funding and Support-ICT-INL/Department of State/ US Embassy, Lima Peru From 1998 to 2014:

The ICT provided funds to Purchase three experimental farms ["Juan Bernito" (15 ha), "Choclino" (34 ha), and "Bello Horizonte" (16 ha)] for conduct and implement the collaborative research experiments on Sustainable Production Systems of Tropical Tree Crops.

INL Provides matching funds until 2014 to support the project Development of Huallaga and Monzon Valleys to development of technology transfer and Research of tropical crops as sustainable alternative to replace the coca plantations in collaborative efforts with USDA-ARS and also train farmers and students in best and economically sustainable cacao and tropical fruit trees management (US$ 700,000 average/year).

External Funding - Indirect Support to Collaborative specific high priority Research for Peruvian agriculture:

FINCYT approved project on. **Heavy metals (Cd, Pb, Ni, Fe, Cu, Zn and Mn) in soils and cocoa plants (*Theobroma cacao* L.) and identification of genotypes with low cadmium and accumulation in producing areas of Peru** (US$193,490) 2014. Research will be carried in Collaborations with University of Florida, Fort Pierce FL and USDA-ARS Beltsville MD. By 30 months (22 Nov-2013 / 22 May-2016). By 24 months (14 Nov-2013 / 14 Nov-2015).

FINCYT approved project on **Embryogenic capacity determination in floral explants from promising cocoa genotypes (*Theobroma* cacao L.) under the traditional system and temporary immersion system** (US$ 184,542). By 30 months (22 Nov-2013 / 22 May-2016), and the research will carried in collaborations with, Universidad Estatal de Santa Cruz -Brazil and USDA-ARS Beltsville MD how scientific support.

FINCYT approved project on **Valuation of substrates based organic waste in mass production, development and storage of fungi for biocontrol of pest and disease of diverse cultures in San Martin Region**. (US$ 154,026). By 33 months (22 Nov-2013 / 21 Jun. 2016), and the research will carried in collaborations with USDA-ARS Beltsville MD and Foundation PAU, Brazil how scientific support.

FINCYT approved project on **Capacity of tolerance induction to water-stress by *Trichoderma* endophyte and application of organic amendments in genotypes of cocoa with purposes to establishment of commercial plantation in areas adverse** (US$ 164,327) . By 30 months (14 Nov-2013 / 14 Mayo 2016), and the research will carried in collaborations with, Foundation PAU, Brasil and USDA-ARS Beltsville MD how scientific support.

FINCYT: Approved project on **Selection of genotypes of cocoa high yield and disease resistance** (US$ 169,886.94. By 2 years (March 2009 to Feb 2011). Research will carried in collaborations with USDA-ARS Beltsville MD, how scientific support.

INCAGRO, a Peruvian Government consortium, provided a grant of U.S. $ 219,764 /3 years (Project period February 2008 to August 2010) to ICT to collect the Peruvian river basin cacao genotypes. Research will carry in collaborations with, Universidad Nacional Agraria La Molina, USDA-ARS Beltsville MD.

INCAGRO, a Peruvian Government consortium, provided a grant of U.S. $ 219,764 /3 years (Project period February 2002 to December 2003) to ICT to **Recurrent Selection of Plant Matrix cacao with purpose of Productivity and Pest Resistance**. Research will carry in collaborations with, Universidad Nacional Agraria La Molina, USDA-ARS Beltsville MD, ACOPAGRO, CAT-Tocache.

INOVATE-PERU, a Peruvian government funding agency, contributed funds of $91,850 /2 years to ICT (Project period August 2013 to July 2015) to **Validation of technology of listing and endophyte *Trichoderma* arbuscular mycorrhizae on organic and inorganic cocoa fertilization to improve the yield and productivity in San Martin**. Also for graduate students' thesis research to investigate crop management practices on soil quality parameters and cacao yields. Research will carried in collaborations with ICT, Kallpa Association and USDA-ARS Beltsville MD, how scientific support.

INOVATE-PERU, a Peruvian government funding agency, contributed funds of $109,848 /2 years to ICT (Project period October 2012 to September 2014) to **Validate a method for conversion of cocoa plantations using genotypes elites of monoclonal and polyclonal system in the Huallaga basin**. Also for graduate students' thesis research to investigate crop management practices on soil quality parameters and cacao yields. Research will carried in collaborations with ICT, Kallpa Association and USDA-ARS Beltsville MD, how scientific support.

Student Training -Undergraduate and Graduate Student Research

Undergraduate Student Thesis Completed: 44

Master Degree Thesis Completed: 3

PhD thesis Completed: 2

Contribution to Development of Competences in the Cocoa Cultivation and Change of Attitude

Farmers Training

Tabla 2. Development of Competences in Cocoa Cultivation - 1999 - 2014

Activities	**Nº**	**Participants**
Technical Talks	1,593	16,820
Extension Courses	776	20,685
Agricultural tours	185	3,239
Internship courses	123	3,189
Field Days	72	3,261
Diagnostic Workshops	128	3,360
Specialized Workshops for Farmers	36	1,103
Farmer Field Schools	245	5,018
Conventions	4	259
Mega Courses	70	9,925
Training of trainers in FFS methodology	35	935
Training of trainers in Integrated crop	578	21,210
Internships and Lab EE	817	10,838
Total	**4,662**	**99,844**

National Visitors (Give Names Numbers)

- First Lady of Republic. Ms. Nadine Heredia
- Minister of Agriculture, Health, Production, Agriculture, Social Inclusion.
- First Ministers:
    - Juan Jiménez Mayor
    - Cesar Villanueva

- Universities:

  UNALM, UNAS, UNSM, CAYETANO HEREDIA, PUCP, RICARDO PALMA,

- Government agencies such INIA, SENASA, MINAGRI, PRODUCE, MINCETUR, PROMPERU, DIRCETUR, DEVIDA, Alianza Cacao Peru, GIZ.

- NGO: FINCAGRO, ConsultAndes, ACDI/VOCA, Helvetas Swiss Intercooperacion, LIBELULA, Creative DC, Chemonics International, Technoserve, Global Connections:

Other organizations

News:

-Journalists from EFE, CANAL N, ATV, El Comercio, Agencia Noticias Periodista XINHUA, TV PERU, Frecuencia Latina.

International Visitors

Visits by representatives of international organizations 653

Total visits received during this period 5,463

Ambassadors:

- Mr. Jeffrey Hovenier, US Ambassador.
- Mr. Michael McKinley, US Ambassador.
- Mr. Josef Berty Indonesia Ambassador
- Mr. Mahahiro Fukakawa, Japan Ambassador
- Mr. Rudolf Koestler, Austria Ambassador
- Mr. Manpreet Vohra, India Ambassador
- Mr. Adrian Paul Hamburger, Lower Countries Ambassador.
- Mr. Namik Erpul, Turquia Ambassador

US Congressional:

- U.S. Senator Bill Nelson of Florida
- Sr. James Steinberg, Subsecretario de Estado de los Estados Unidos de Norteamerica
- Sr. Arturo Valenzuela – USDA
- Dra. Maria Otero. Sub Secretaria de Estado para la Democracia y Asuntos Globales del Gobierno de EE.UU

GUS Govt. Agencies:

- USAID, CICAD-OEA, DEA, USDA, INL, ARS.

International Organization

- Banco Interamericano de Desarrollo, Banco Mundial, Comunidad Andina. Comunidad Andina, FAO, Instituto Interamericano de Cooperación para la Agricultura – IICA, OEA-CICAD, OEA, ONUDD, UNODC – Kabul, UNODC – Kabul, UNODC-Bolivia, UNODC-Colombia, UNODC – Viena, UNODC - Afganistán, UNODC-Perú, COPOLAD, Consorcio, Delegación Unión Europea, Delegación Unión Europea – Bolivia

Country represents:

- Bolivia, Brasil, Canada, Colombia, Dinamarca, Ecuador, Guatemala, Panamá, México, Alemania, Francia, Italia, Namibia, Afganistan, Argelia, Austria, China, EUA, España, Filipinas, India, Indonesia, Japón, Polonia, Reino de los Paises Bajos, Reino Unido, Rusia, Sudafrica, Suiza, Tailandia, Turquia, Venezuela.

Funding from Other Collaborators: National Agricultural University LaMolina (UNALM) Lima

VLIR-UNALM Project from the Belgium Flanders Universities. This is a Farming System Project funded with 7 million Euros/10 years. In this award the Agroforestry System sub-project of the Farming System Project has a budget of U.S. $ 75,000/ year (Project period April 2010 to March 2020). Dr. Alegre has setup an agreement

with ICT to implement a series of management experiments executed by Ph.D. students to work mainly in the research carried in our ICT collaborative efforts.

Some Web of reference

http://elcomercio.pe/wikileaks-peru/258

http://www.inforegion.pe/46338/subsecretario-de-estado-de-eeuu-visito-instituto-de-cultivos-tropicales-en-tarapoto/

https://vimeo.com/channels/totoraproducciones/114983632

http://www.inforegion.pe/142112/ministro-jimenez-visito-instituto-de-cultivos-tropicales-en-tarapoto/

http://infocafes.com/portal/wp-content/uploads/2016/06/CONF252.pdf

http://espanol.technoserve.org/blog/sweetening-the-deal-empowering-peruvian-chocolatiers

http://www.proambiente.org.pe/noticia_nota.php?id=133&aid=0&pagina=1

http://www.viatelevisionperu.com/8961/ict-realizara-primer-seminario-avances-tecnologicos-cacao

https://agresearchmag.ars.usda.gov/2011/sep/cacao

https://www.diariovoces.com.pe/68936/instituto-cultivos-tropicales-e-innovate-culminaron-proyectos-investigacion

http://orton.catie.ac.cr/repdoc/A1857e/A1857e.pdf