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Report

Secondment of training in agroforestry and agroecological research

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(March 25th to June 25th, 2023)

Pisa, June, 2023

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Thanks

I thank God and my dear wife Lorena, my daughters Denissita and Carlita, my granddaughter Lucía, my son-in-law Paco, my mother Charito, and my entire family for this time away and waiting.

I express my gratitude to Dr. Paolo Barberi for his leadership, trust and unconditional support, as well as to all the Group of Agroecology (GOA), with a gender and biodiverse approach: Tiziana, María, Martina, Stefano, Alessandro, Gabriel, Geovanny, Gilbert, Federico, Mario, Mateo, Alberto. Really great leadership, human quality, positive attitude that are important values for an excellent job.

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SUMMARY

In 2023, The Undertrees project planned to carry out training and career development (W2) processes, therefore the general objective of this secondment was to exchange experiences to strengthen training in agroforestry and agroecological research. The specific objectives were: analyze primary and secondary information on agroforestry and agroecology and exchange experiences on advances in agroforestry and agroecological research. This secondment was carried out at the Escuola Superiore San't Anna (SSA), Pisa Italy under the direction of Dr. Paolo Barberi through seminars, workshops, field days, literature review and knowledge exchange with experts on agroecology issues and agroforestry.

The activities carried out were: review of a scientific article and submission to the journal, review of a second scientific article for possible submission in July and delivery to the director of the Univerty of Cordoba (UCO), Spain of the first draft of the doctoral thesis, in addition to the analysis of databases and applications of new methodologies for the analysis of ecosystem and agroecosystem services (CISES), participation in at least 9 international seminars, at least 10 visits to trials of agroecological practices, meetings with the Project coordinators and participation in the Undertrees workshop. Among the results, the review of at least 23 scientific articles on issues of agroecological transition, agroforestry and agroecology. It is concluded that this training promoted and enhanced contacts with specialists in these topics, the skills and knowledge will be applicable to the research that it carried out in the Ecuadorian Amazon.

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1. BACKGROUND.

The Ecuadorian Amazon has an area of approximately 12 million of hectares and it is a fragile region with high biodiversity, agrobiodiversity and diversity of people and/or nationalities. Therefore, agriculture must be developed based on agroforestry systems and in a holistic or agroecological way. In this region, there are conventional, organic and agroecological agricultural production systems, which need research and training processes to improve profitability because they contribute to food security, mitigation of climate change and production with conservation, for good living of the farmers.

The Undertrees project was approved in March 2020 but due to problems derived from the pandemic, it had a period of stand by. However, taking advantage of virtual technology, virtual conferences were held for a period until it restarted its activities from the year 2022. In this context, the Instituto Nacional de Investigaciones Agropecuarias (INIAP), through the Amazon Research Site (EECA), has coordinated research and thecnology transfer activities in agroforestry systems in the Ecuadorian Amazon within the framework of the UNDERTREES project, which are summarized in participation in various conferences about research advances in agroforestry systems with fruit crops and agrobiodiversity, publication of a scientific article and the secondment by two researchers for a period of one month in SSSA in September 2022.

I was admitted to carry out a secondment at Scuola Superiore Sant´Anna (SSSA) from 25-03-2023 to 24-06-2023; therefore, participating in actividities of the Proyect MSCA-RISE UNDERTREES (Grant Agreement n 872384) connected with WP2 Training and Career Development. I am currently doing the systematization and publication of papers for my doctoral thesis titled: The agroforestry systems with cocoa (*Theobroma cacao* L.) as an agroecological transition strategy to family farming in Ecuador. Therefore, the objectives of the Secondment were the following:

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2. OBJECTIVES:

2.1. General objective:

Exchange experiences to strengthen and improve the knowledge in agroforestry and agroecological research.

2.2. Specific objectives:

2.2.1. Analyze primary and secondary information on agroforestry and agroecology.

2.2.2. Exchange experiences on advances in agroforestry and agroecological research.

3. METHODOLOGY:

The methodology and activities will be carried out based on the specific objectives:

3.1. Analyze primary and secondary information on agroforestry and agroecology.

3.1.1. Analysis of data obtained from in cocoa production systems.

3.1.2. Identification of tools (strategies) that can be applied to the adoption of agroforestry systems with crops of agricultural interest.

3.1.3. Review of two manuscripts for subsequent submission to scientific journals.

3.2. Exchange experiences on advances in agroforestry and agroecological research.

3.2.1. Exchange of experiences in the agroforestry area with project experts.

-Seminars; Field visits

3.2.2. Presentation of research activities carried out in the Amazon, Ecuador

- Meeting with Manager; Workshops

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4. RESULTS.

4.1. Identification of tools (strategies) that can be applied to the adoption of agroforestry systems with crops of agricultural interest.

4.1.1 Evaluation of ecosystem services (ES) in cocoa agroforestry systems in the Ecuadorian Amazon.

Background.

The CICES is a methodology to classify the final ecosystem services (ES), which are those ecosystems contribute to human well-being. These services are final because they are the products of ecosystems (whether natural, semi-natural, or highly modified) that most directly affect people's well-being. The conceptual model resembles the waterfall model and the current version corresponds to V5.1, which was developed from 2016 and is based on the version V4.3 developed in 2013 (CICES, 2018).

The definitions of ES used in published articles were compared with the definitions of CICES classes, in which it was determined that Cultural and regulatory ES are studied more frequently than provisioning ES; these findings can be used to help to improve CICES to provide a more robust and comprehensive framework for ecosystem assessments (Czúcz et al., 2018).

Agroforestry is a great alternative for environmental protection and sustainable development, especially in ecologically fragile areas because it provides multiple ES to promote the restoration and transition of degraded areas; however, agroforestry ecosystem services (AFES) have limitations due to the vulnerability, structure, function and ecological assets, in addition to the management of services that are very important for decisions that improve the capacity of AFES supplies and sustainable agroforestry management (Xiao, J and Xiong, K., 2022).

According to the Agroecosystems Services (AES) case studies, five topics are proposed that highlight the usefulness of a combination of multidisciplinary methods, based on the objectives of sustainable agricultural development and future studies such as damage to agroecosystems (AEDS) should be prioritized; AES trade-offs and synergies; the supply, demand and AES flows because it could help solve the problem of low comprehensive profits, mismatches between supply and demand and significant trade-offs between AES.

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The AES should place greater emphasis on the recovery of the ecological function and the achievement of ecological benefits, which will help to achieve multiple Sustainable Development Goals (SDGs) whose management will promote the articulation among environment, society and economy in agroecosystems and will strengthen the links between AES and SDGs and future research. Finally, complementing with an approach to planning and governance of the agricultural landscape, which is worth exploring in the future management of agroecosystems (Liu et al., 2022).

INIAP carried out a study to evaluate the environmental impact and economic performance of cocoa agroforestry systems in the Ecuadorian Amazon through an life cycle assessment (LCA) approach, Organic management reduces all environmental impacts except the soil footprint, and improves economic/environmental efficiency but economic profitability is the weaknesses point for cocoa production in this region (Caicedo et al., 2022), therefore the objectives of this study were:

Objectives.

General:

Evaluate the ecosystem services in cocoa agroforestry systems in the Ecuadorian Amazon.

Especifics:

- Determine the components of the CICES methodology for the evaluation of ecosystem services in cocoa agroforestry systems.
- Analyze ecosystem services in cocoa agroforestry systems: organic and conventional.

Methodology.

The methodology was used according to the specific objectives:

- Determine the components of the CICES methodology for the evaluation of ES in cocoa agroforestry systems by the CISE V5.1 model. Various sources of information such as scientific articles and respective links were reviewed.

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Therefore, the following sections: division, group, classes, codes and a brief description were determined.

- Analyze ES in cocoa agroforestry systems, both organic and conventional, of 90 cocoa-producing farms in six provinces of the Ecuadorian Amazon. Three indicators were used in provision, three indicators in regulation & maintenance and one indicator in Culture. Finally, an analysis of the relationship with the SDGs of agriculture was carried out. (**Figure 1**)

Figure 1. Location of the 90 farms of the cocoa producers in the Ecuadorian Amazon.

Results.

Table 1 shows the indicators within the framework of the ES Provisioning sections, with respect to the cultivation of cocoa, trees and other crops. In terms of regulation and maintenance, indicators of Organic Material (OM), Freshwater Ecotoxicity (FWE) and Global Warming Potential (GWP) and Cultural were observed, through an ancestral family system, managed by women for the production of agroforestry systems for food security and trade.

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Table 1. Ecosystem services of cocoa agroforestry systems in the Ecuadorian Amazon, through the CISE methodology.

SECTION	CODE 4.3.	INDICATORS		
			OSAF	CSAF
Provisioning	1.1.1.1	cocoa (yield. ha^{-1})	440	523
	1.1.1.1	crops (#. ha^{-1})	10	10
	1.2.1.1	forest (#. ha^{-1})	27	10
Regulation & Maintenance	2.3.3.1	OM (%)	7	4
	2.3.4.1	FWE (kg 1.4-eq. ha^{-1})	10	49
	2.3.5.1	GWP (kg CO2- eq. ha^{-1})	27	189
Cultural	3.1.2.3	Chakras[2] (%)	46	44

Source: database of 90 farms with cocoa agroforestry systems in the Ecuadorian Amazon. OSAF= Organic Agroforestry System; CSAF= Conventional Agroforestry System; FWE= Freshwater Ecotoxicity; GWP= Global Warming Potential; OM= Organic Material

The **Figure 2** shows the relationships and interactions of ES with agroforestry ecosystem services and the SDGs.

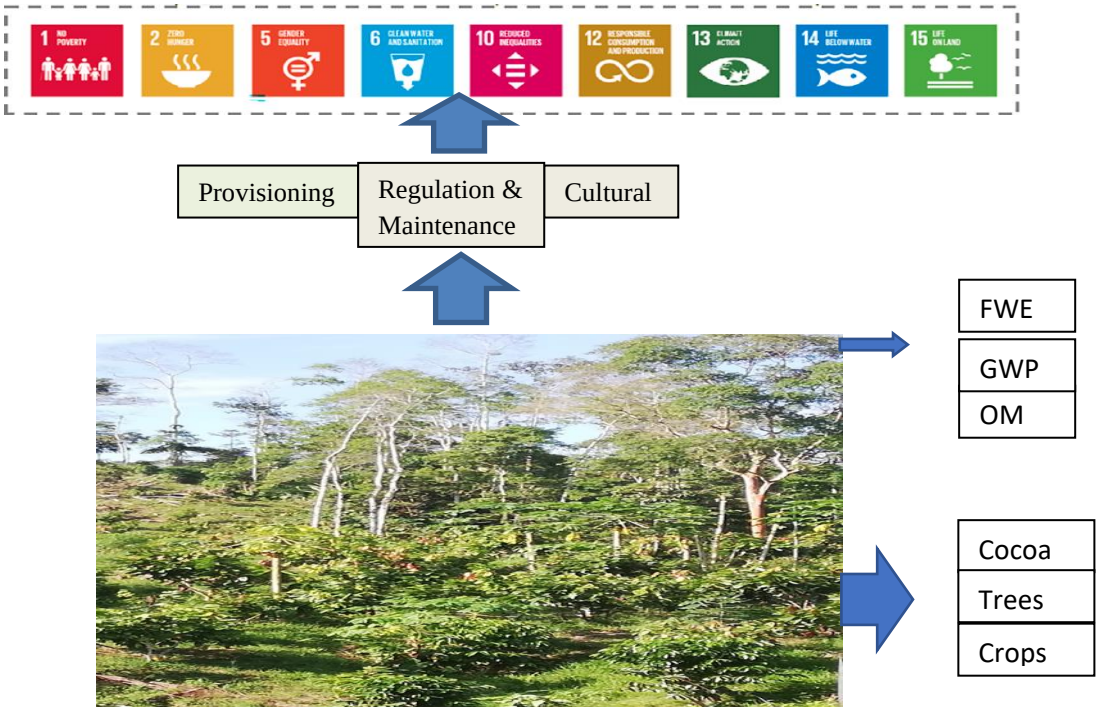

Figure 2. Relationship between ecosystem services and SDGs

[2]Chakras are highly diversified ancestral agroforestry systems where the family, especially the woman, produces a wide variety of foods, including cocoa and other products such as medicines, fibers, wood for self-consumption and local sale (Caicedo et al., 2022).

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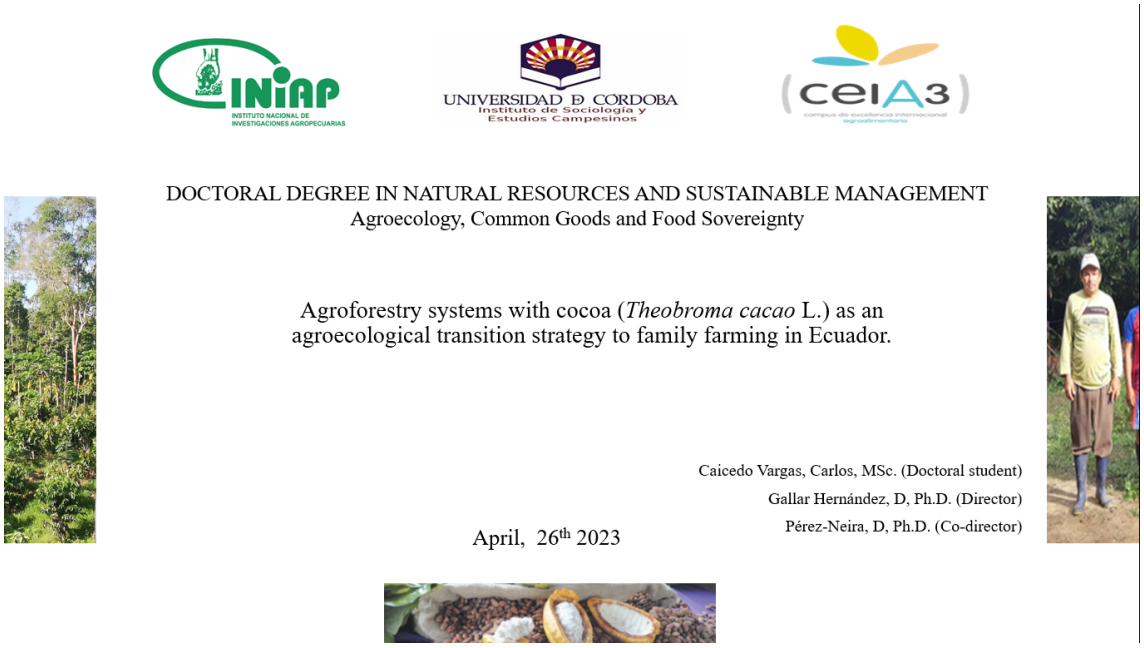
4.2. Review of two manuscripts for subsequent submission to scientific journals

4.2.1. Summary of final thesis (in revision)



This research responds to three hypotheses: 1) What are the characteristics of energy metabolism, economics, and management styles of cocoa production systems in the Ecuadorian Amazon?; 2) What are the environmental and economic impacts when comparing organic and conventional agroforestry systems in the Ecuadorian Amazon? and, 3) What are the characteristics of the eco-productive, socio-economic, political-cultural dimensions and the situated proposals: prioritization of problems and action proposals for the agroecological transition in the Ecuadorian Amazon? The research methodology was mixed (quantitative, qualitative and participatory), the same one was applied according to each of the specific objectives. The collection of primary information was carried out with producers and managers of the Associations of the Napo provinces. (Kallari, Wiñak and Tsatsayaku), Orellana (San Carlos and Asosumaco) and Sucumbíos (Aprocel). First, the LCA methodology was used with 279 producers from 86 communities in the region, economic analysis focused on the impact categories of energy and GHG emissions, and cost-benefit analysis. The management styles and their characterization were carried out with the use of hybrid hierarchical k-means clustering, secondly, from this group of farms, primary information was collected from 90 farms (44 conventional and 46 organic) that perform medium or good management of their farms. After that, the environmental performance of cocoa production was evaluated using the

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LCA methodology with a cradle to farm gate approach, estimating 12 impact categories and five indicators of environmental and monetary efficiency based on three functional units (kg cocoa, kg sold and ha). Additionally, an economic feasibility analysis was carried out, particularly profitability. This was based on the theoretical framework of agroecology and agroecological transition processes. In addition, based on a mixed research methodology (quantitative, qualitative, and participatory), through nine interviews with managers/technicians, 279 surveys, and the application of the flowchart technique in six participatory workshops, the ecological-productive, socioeconomic, and political-culture dimensions of agroecology were analyzed in six associations, grouped into two blocks due to their relative homogeneity in terms of management style, ethnicity, form of marketing and territorial vision: Kallari, Tsatsayaku, Wiñak (KTW), Asosumaco, San Carlos and Aprocel associations (ASA). The results, in response to the first question, showed that, a food production of 14 million tons (413 kg/ha) was estimated (mainly cocoa, plantain, cassava, etc.) with an energy consumption (CED), a carbon footprint (CF) and a Net Margin of 38 TJ (1,124 MJ/ha), 2.68 Mt CO2-eq (79.41 kg CO2-eq/ha) and 16.12 million $ (476 $/ha). The cluster analysis showed three differentiated management styles. Likewise, the results showed how agroforestry systems with good agroecological practices constitute the productive alternative that allows improving the economic viability of the chakras, obtaining energy sustainability and low gas emissions. In the same way, in response to the second question, organic management allows reducing the environmental impact in all the categories analyzed (emissions, energy use, eutrophication, etc.) except the land footprint (ha/kg), as well as improving the environmental and economic efficiency of agroforestry systems (energy return or intensity of emissions per unit of added value, etc.). The economic analysis shows how conventional agroforestry (CA) systems are more profitable ($/ha) than organic agroforestry (OA), although the difference is not statistically significant and that, in both systems, the sale of co-products allows to improve the profitability of the farms. Despite the low impact of both systems, economic profitability is undoubtedly one of the weak points of cocoa production in the Ecuadorian Amazon. Finally, the answers to the third question, the results showed the strengths and weaknesses of the families of producers and their organizations in the eco-productive, socioeconomic and political-cultural dimensions, in the management of their agroecosystems and in the implementation of practices agroecological; in their marketing strategies; their perception and environmental

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sensitivity; your quality of life; the state of participation and individual and collective empowerment as producer organizations, including the gender perspective, and also emphasizes the intervention alternatives proposed by producers and their organizations for scaling out and agroecological scaling up in the territory.

Keywords: farming styles, agroecology, profit, climate change, expand, sustainability, LCA, energy, profit, peasant economy, agroforestry, cocoa, scaling up.

4.2.2. Article submission to a scientific journal for peer review:

Agroecology as a means to improve the energetic and economic metabolism of cacao production in the Ecuadorian Amazon

Abstract

Cacao is one of the most important crops in Ecuador, particularly in the Ecuadorian Amazon where there are more than 33,800 ha devoted to it. Most cacao is produced under traditional management in agroforestry systems called chakras. Despite the socioeconomic and environmental importance of these systems, there are no previous studies that provide a comprehensive picture of the economic and environmental functioning of cacao production at the aggregate level for the Amazon, or identify the different management styles in the region. Consequently, the objectives of this study are focused on addressing these two gaps in the literature, namely: a) to analyze the energetic and economic metabolism of cacao production in the Ecuadorian Amazon and b) to investigate the technical-economic management styles existing in the region. For this purpose, primary information was collected from a statistically representative sample of cacao areas distributed among 279 producers in 86 communities in the region and life cycle analysis (LCA) methodology and cost-benefit analysis were used to study its energetic and economic metabolism. At the Amazon level, food production was estimated at 14 million tons (413 kg/ha) (mostly cacao, plantain, cassava, etc.) with an energy consumption (CED) of 38 TJ (1,124 MJ/ha), a carbon footprint (CF) of 2.68 Mt CO_2-eq (79.41 kg CO_2-eq/ha), and a net margin of 16.12 million $ (476 $/ha). Cluster analysis was also used to find differentiated management styles and from its results three alternative scenarios were considered. The results show how agroforestry systems with good agroecological practices constitute the productive alternative that allows the improvement of the economic viability of the chakras, energetic sustainability and low

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emissions. The paper also discusses the need to promote actions and public policies for the upscaling of agroecological management in the Ecuadorian Amazon.

Key Words: Styles of farming; Profit; Climate change; Upscaling; Sustainability; Agroforestry.

4.3. Exchange of experiences in the agroforestry area with project experts.

4.3.1. Seminars

These seminars were held with specialized speakers (**Table 2**) and allowed to know and understand the advancement of science around agroecological principles and the importance of the practices and processes that they generate in favor of biodiversity and agrobiodiversity. The following are the most important:

- Superfoods for the food security of the population.
- The management of genetic and functional biodiversity and agrobiodiversity. through the evaluation of native materials such as genetic polymaterials.
- Organic soil management, through crop rotation and use of biostimulants.
- Research processes with people.
- The importance of agroforestry in cocoa production systems.
- The threats of climate change for the economy and life.

Table 2. List of Seminars in SSSA and others.

#	Issue	Seminar topics	Author
1	Wednesday, April 12 th 2023	Gaia and prometheus in the Anthropocene: long-run planetary impacts of humans economic systems.	Dr. Elisa palagi and Dr. Matteo Coronese (Institute of Economics).
2	Wednesday May 3rd 2023.	Tef (Eragrostis tef) in Ethiopia-an averview.	Solomon Chanyalew, Ph. D. Ethiopian Institute of Agricultural Research (EIAR).
3	Wednesday, May 10th 2023.	On-farm participatory research to increase resilience of organic farming systems: plan breeding for diversity considering the holobiont plant concept	Dr. Véronique Chable. INRAE Rennes, Francia.
4	Wednesday, May 10th 2023	Explain diversity in organic lentil (Lenscullinaris) cultivation: germplasm collection and cultivar mixtures.	Eliza Lorenzetti Ph.D. Thesis Presentation Seminar.

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5	Monday and Trursday, May 15 th and 16 th 2023.	Cocoa Agroforestry in West and Central Africa: from definition and to innovation and implementation pathways.	Université Montpellier,
6	(Thursday 18th May 2023.	The gasotrnsmitter Nitric oxide: sensing and signalling during development and stress in Arabidopsis.	Óscar Lorenoz, Ph. D.
7	Wednesday, May 31st 2023.	Effects of vermicomposting and relay intercropping on plant-soil-microbial interactions and associated agroecosystem services.	Gilbert Koskey. Ph. D. In Agrobiodiversity. SSSA, Pisa.
8	Wednesday, May 31st 2023.	Bioestimulants for sustainable agriculture. Yousef Rouphael .	Universitá Degli Studi Di Napoli Federico II
9	Friday, Jun 16th2023	"Soil biodiversity exploitation towards a more sustainable agriculture and soil health",	Dr Stefano Mocali, del CREA Firenze

4.3.2. Short Seminar

Thursday, May 4th, 9h00-13h00

Room 4: Pisa University

9h00-11h00 Dr. Alberto Mantino

Lesson: Introduction to Agroforestry Research; Basic concepts of agroforestry; Agroecosystem.

Types of agroforestry systems; Agroforestry emans traditional landscapes; Ecosystem Services.

Land sharing y Land sparing; Innovations of Systems Agroforestry.

11h00-13h00 Dra Anna Panozzo University of Padua

Tree crop interactions in silvopastorable agroforestry systems: principles and experimental results; Introduction, history, names, types; Interactions of trees with crops; Experimental results

Thursday, May 10 th 2023

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Room H2 @POLO PIAGGE, Universyti Pisa

14h00-16h00

Advances in Agroforestry Systems; Experimental designs and results; What is Agroforestry Systems? (Burgess and Rosati, 2018); Transititon to sources sustainable animals production (IFAD, 2010); Agroforestry systems and farmers potential los of grown production due to: Effect of tree presence of alfalfa yield and quality; AGROFORCES; Agroforestry to carbon sequestration an Ecosystem services; Effect of tree presence and soil on soybean and sorgun yield and quality; Dependent variables: Biomass, Grain and Yield; Independent variables: Tree distance, Rigth avalability, clay presence (clay), sand presence and presence pH e SOM; Multivariate Analysis

16h00-18h00

Effect of tree presence and soil on soybean yield and quiality; Net Biome Production (NBP) "change in carbon stocks after episodic C losses"; Method suitable for a shortem balance; Net margin with grant (€. ha^{-1}); Fixed cost of tree plantation included; Mean values (mean± SEM) of meteorogical parameters and termal indexes amoung investigated positions in Pisa-Italy (reference period enero-september 2020). Case estudies: Grazing trial conducted on a real farm (Spring, 2021); Pasture-silvopastoral: Semi-extensive agrosilvopastoral system in Toscany: GWP of beef cattle of sources various (Kg CO2 eq/kg LBW sold) (Metodology: LCA)

4.3.3. Workshops, field days

4.3.3.1. Support

Support in the monitoring and evaluation of agroforestry research trials, crop rotation, application of biostimulants. Recording of variables related to weeds, shade, cover, height of crops/trees (Photo 1, 2, 3 and 4).

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Photo 1. Trial of agroforestry systems.

Photo 2. Biostimulants trials in legumes.

Photo 3. Crop rotation trials.

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Photo 4. Evaluation of de weeds.

4.3.3.2. Visits to farms

Visit to farms: Centro de Lombricultura de Toscana (CLT), production of earthworm humus and vermicompost nationwide with a large production capacity (Photo 5).

Photo 5. Teachers, students and visitors to CLT.

2) Poggio Di Camporbiano: agricoltura biológica dal 1988, examples of circular economy, solar energy, biogas, sustainability (crops, livestock, trees), value chain, diversification of production, semi-artisanal agro-industry, short circuits, ecotourism, food security, value chains (Photos 6,7,8 and 9).

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Photo 6. Production diversification.

Photo 7. Food security.

Photo 8. Value added.

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Photo 9. Short circuits.

4.3.3.3. Participation in field day

Participation in the sixth edition of "AGROECOLOGÍA: al centro". It was a field-scientific day to show the advances and results in situ of various agroecological practices. It was a very well-organized event with the participation of academics, researchers, producers and businessmen. (**Table 3**)

Table 3. Topics of Agroecology and agroecological practices.

#	AGROECOLOGÍA: al centro	Agroecological practices
1	Valutazione agronomica delle cultivar di *Cicer arietinum* L. più adatte alla consociazione con frumento tenero Gabriele Nerucci, Federico Leoni, Stefano Carlesi, Gemini Delle Vedove, Alessandra Virili, Elisa Marraccini, Anna Camilla Moonen	Agrobiodiversity, intercropping
2	**ORGANi-CA** Permanent living mulches for ecosystem services in ORGANIc vegetable systems under Conservation Agriculture Federico Leoni, Stefano Carlesi, Daniele Antichi, Christian Frasconi, Anna Camilla Moonen	Permaculture (cover soil+(legume clover) +eggplant
3	MISCUGLI FUNZIONALI CON APPROCCHIO TRAIT-BASED E BIOSTIMOLANTE Elisa Lorenzetti	Biostimulant (lentil+mixed lentil)
4		Agroforestry (poplar+corn+ soy)

	AGROFORCES **AGRFORestry for Carbon sequestration and Ecosystem Services**	
5	**Effetto biostimolante del te di vermicompost su 9 cultivar di cece e studio dell'interazione con i microrganismi del suolo a livello di rotazione colturale** María Muñoz Arbeláez, Gilbert Koskey, Luciano Avio, Luciana Angelini, Paolo Bàrberi	Agrobiodiversity (nine variety of chickpea+ Biostimulant)
6	**Prova Varietale Vicia-Lathyrus** Massimo Sbrana, Lorenzo Tramacere, Daniele Antichi	Agrobiodiversity
7	**ARNINO Long Term Experiment (L.T.E)** *Alberto Mantino, Stefano Carlesi, Lorenzo Tramacere, Massimo Sbrana, Giovanni Pecchioni, Daniele Antichi, Marcello Mele*	Agroforestry: sorghum, triticum (crops)+ pasture+ (poplar tree)
8	**La consociazione di lenticchia e cereali utile alla modellazione di sistemi colturali diversificati** Alessandro Triacca, Stefano Carlesi, Federico Leoni, Moritz Reckling, Claas Nendel, Anna-Camilla Moonen	Intercropping (lentil+checkpea+oats+triticum)

4.4. Presentation of research activities carried out in the Amazon, Ecuador

4.4.1. UNDERTREES First Proyect Conference and Mit Term Meeting

Background.

The UNDERTREES Project held its First conference and half-term meeting on Thursday, March 30 and Friday, March 31, 2023, in the city of Pisa-Italy, after its formal restart from January 2022. The project, activities and objectives were threatened as of 2020 due to the problems generated by the pandemic. However, specific activities have been carried out to interact with the advances in agroforestry research in each of the institutions directly or indirectly linked to the project. The objectives of the Project UNDERTREES are: 1) SO1. To develop harmonised methodologies to assess ecosystem services underlying agroforestry systems, at field and landscape scale, in several biogeographical areas. 2) SO2. To assess the social and economic effects resulting from the introduction and adoption of agroforestry systems by a participatory research approach, developing guidelines to support policymaking and decision processes at farm and landscape level. 3) SO3. To compile a handbook with recommendations to design research and teaching curricula in the field of agroforestry as well as training activities at technical, managerial and academic level based on a comprehensive holistic framework. Therefore, the objectives of the workshop were the following:

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Objectives:

General

To show research advances in agroforestry systems and monitor and evaluate the objectives and activities of the project.

Specifics:

- To show research advances in agroforestry systems
- To evaluate the progress of the project, objectives, goals and activities.
- To analyze problems and alternatives.

Metodology.

The workshop was held on Thursday, March 30, and Friday, March 31, 2023, at the Scuola Superiore Sant'Anna headquarters, in the city of Pisa. On the first day, the progress of research in agroforestry systems by the direct and indirect executors of the different institutions and countries were presented through conferences. On the second day, the progress of each of the project objectives was evaluated, as well as the problems and alternatives to achieve the proposed goals.

Progress and/or results

Eigth institutions participated: Italian universities (2); Spain universities (2); United Kingdom universities (2); Chile (1); Ecuador research institute (1). The conferences were the folowing (**Table 4**):

Table 4: Topics of first day, meeting Undertrees, Pisa. Thursday, April 30, 2023.

#	Topics	Responsibles
1	Recent área changes of Agroforestry systems in Europe	UEX
2	Assesing soil organic carbon stocks in extensive livestock farms: holistic vs conventional managment	UEX
3	Soil properties modelling using machine learning algorithms at small basin scale	UEX (Webex)
4	Agroforestry systems to reduce GHG emissions in cool temperature and Mediterranean cimates	AFBI

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5	Innovation in enabling green transitions for climate smart agriculture	SUA (Webex)
6	Agroforestry services-supply chain ideas-mulching, peat replacement, contribution to soil fertility from tres.	CAWR
7	Agroecological transition of conventional livestock systems in Mediterranean areas.	UNIPI
8	Agroforestry policy.	USC
9	Synergies from learning between EU-funded projects on agroforestry.	CAWR
10	Wrap up-towards a holistic framework.	CAWR, SSA, USC, OVISUR

Friday, April 31th, 2023

- Reports by Work Package: WP2, 3, 4, 5, 6
- Trainning, Transfer of Knowledge & Networking
- Scuola Superiore Sant´Anna (Martina Re-SSSA)
- Coventry University (Liliane Binego-CAWR)
- Agri-Food and Biosciences Institute (Rodrigo Olave-AFBI)
- Universidad de Extremadura (Susanne Schnabel-UEX)
- Instituto Nacional de Investigaciones Agropecuarias (Carlos Caicedo-INIAP)
- Dissemination and Comunication activities (Francis Rayns (CAWR)
- Meeting between seconded staff members and the REA Representative
- Rodrigo Olave (AFBI); Natasha Crumlish (AFBI), Nelly Paredes (INIAP), Yadira Vargas (INIAP; Liliane Binego (CAWR); Anthony Gabourel Landaverde (UEX); Jesus Barrena González (UEX); Martina Re (UEX)
- Project Management and catch-up plan for Project implementation, SSSA

The important achievements for INIAP were the following:

- Presentation of activities progress in secondments.
- UNDERTREES financed three INIAP-EECA secondments.
- Coordination with the University of Extremadura, Pisa, Sant´Anna and the United Kingdom to carry out internships, research trials in Ecuador, Spain and United Kingdom.

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- Coordination with the University of Extremadura for specific activities of database analysis and land use mapping.
- Exchange of experiences in agroforestry research, to obtain knowledge of new methodologies and approaches.

Conclusions and recommendations.

- ✓ There are advances in methodologies for evaluating ecosystem services.
- ✓ At least ten secodments were made according to the plan.
- ✓ There are at least six "LabLives" in Europe, UK, South America and Africa.
- ✓ It is expected to continue with the project until 2024 despite the difficulties caused by the pandemic and covid-19.
- ✓ It is recommended to finance the publication of scientific articles.
- ✓ New project administrators will be selected.

4.4.2. Meetings with managers

- Date: March 27th; Time: 9:00-10:00

Participants: Martina Re, Paolo Barberi; Place: Sant' Anna technical room

Greetings, welcome and instructions to work with Martina and Alberto

- Date: April 26th, 2023; Time: 12:30 p.m.-2:00 p.m.

Participants: Alberto Mantino, Martina Re, Carlos Caicedo; Place: Sant'Anna technical room

A presentation was made of the activities carried out to date, especially on the progress of the doctoral thesis.

The following activities were recommended for the month of May:

- Participation in agroforestry classes on May 04th and 11th, 2023 at the University of Pisa
- Participation in visits to farms of agroforestry producers on May 24th and 25th, 2023 (activities postponed due to Alberto's illness for the end of June)
- Review of the database of my thesis on the three clusters of 90 farms with production variables, number of trees, OM and CO2
- CISES V 5.1 software application.

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- Commitment from the Undertrees project to finance the two scientific articles

- Date Monday, June 5th 2023; Time: 11:00-11:30

Participants: Paolo, Sara and Carlos; Place: Sant' Anna technical room

Paolo introduced Sara as the new manager of the UNDERTREES project starting in June. We also exchanged some ideas about what we could continue to do within the framework of the project, such as the secondments, formation of the agroecological network in Ecuador and other agroforestry and agroecological research activities.

- Date Thursday, June 6th 2023; Time: 11:00-12:30

Participants: Sara and Carlos; Place: Sant' Anna technical room

A presentation was made of the activities carried out to date, especially on the progress of the doctoral thesis and the secondment.

The strategies carried out until the Undertrees was approved, its stoppage, its restart and the future were analyzed (2024).

The following commitments were set:

- To build an agroecology network in Ecuador.
- To manage the finance for a comprehensive project.
- Sara will help with her contacts to obtain financing sources.
- The idea would be to have a specific Ecuador Undertrees project.
- Commitment from the Undertrees project to finance the publication of two scientific articles.

- Date: Wednesday June 7th; Time: 1:00 p.m. to 1h30

Participants: Sara, Daniele, Carlos; Place: San't Anna technical room

Greetings

The criteria on the third disbursement deposit for the secondment of Carlos Caicedo is requested, Daniel informed that it has already been requested and that the invoices must be delivered until June 21th, 2023.

It is reported that all fund allocation and feeding activities are in normal state.

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4.4.3. Meetings managers-(different institutions)

Susanne Schnabel, about activities of research and secondments in Spain and Ecuador (2024).

Rodrigo Olave, about activities of research and secondments in Ecuador (2023).

Alberto Mantino, about secondments in Ecuador (2024).

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5. CONCLUSIONS

- The exchange of experiences was fulfilled to strengthen the knowledge in agroforestry and agroecological research; primary and secondary information on agroforestry and agroecology was analyzed, and experiences were exchanged on advances in agroforestry and agroecological research.
- Several topics covered were: the analysis of agroecosystem services, ecosystems, multivariate analysis, molecular biotechnology, value chains, circular economy, ecotourism, sustainable companies, biodiversity management, organic soil management, genetic biodiversity, and functional biodiversity.
- It is concluded that this training promotes and improves contacts with specialists in the above topics, and the skills and knowledge will be applicable to the research that is carried out in the Ecuadorian Amazon.
- The Undertrees project will allow the following: 1) strategic national and/or international alliances; 2) opportunities to generate innovations in current institutional activities; 3) generate proposals for research and technology transfer in agroforestry, agroecology, biodiversity, soils.
- The Undertrees project will finance the publication of scientific articles related to agroecology and agroforestry.

6. RECOMMENDATIONS

- Further activities could be planned based on specific expected results agreed between the participants.
- In this phase, the formation of an agroforestry network in Ecuador should be financed.
- Opportunities for competitive funds should be socialized to strengthen current activities.

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7. REFERENCES

7.1. Analysis of secondary information

These activities focused on searching for bibliography through Google Scholar and Science Direct on issues of agroecological transition, agroforestry and CISES methodology. At least 23 papers and reports on these topics were determined. (Table 5).

Table 5. Bibliographic references

Title	Key Words	Link/DOI
Agroecology for adaptation to climate change and resource depletion in the Mediterranean region. A review.	Aguilera et al., 2020	https://doi.org/10.1016/j.agsy.2020.102809
Building agroecology with people. Challenges of participatory methods to deepen on the agroecological transition in different contexts	López-García et al., 2021	https://doi.org/10.1016/j.jrurstud.2021.02.003
Syntropy and innovation in agriculture	Andrade et al., 2020	https://doi.org/10.1016/j.cosust.2020.08.003
Agroforestry: A primer. Design and management principles for people and the environment	Gassner and Doble, 2022	https://doi.org/10.5716/cifor-icraf/BK.25114
Transforming agroforestry in contested landscapes: A win-win solution to trade-offs in ecosystem service in Nepal.	Aryal et al., 2023	http://dx.doi.org/10.1016/j.scitotenv.2022.159301
Laurel Regeneration Management by Smallholders to Generate Agroforestry Systems in the Ecuadorian Amazon Upper Basin: Growth and Yield Models	Cañadas et al., 2023	https://doi.org/10.3390/f14061174
Towards a Common International Classification of Ecosystem Services (CICES) for Integrated Environmental and Economic Accounting	CICES, 2018	https://cices.eu/resources/
Where concepts meet the real world: A systematic review of ecosystem service indicators and their clasification using	Czúcz et al., 2017	https://doi.org/10.1016/j.ecoser.2017.11.018
Agroecosystem services: A review of concepts, indicators, assessment methods and future research perspectives	Liu et al., 2022	https://doi.org/10.1016/j.ecolind.2022.109218
A review of agroforestry ecosystem services and its enlightenment on the ecosystem improvement of rocky desertification control.	Xiao et al., 2022	https://doi.org/10.1016/j.scitotenv.2022.158538

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Towards an agroecological transition in the Mediterranean: A bioeconomic assesment of viticulture farming	Gil et al., 2022	https://doi.org/10.1016/j.jclepro.2022.134999
Planting trees in livestock landscapes to protect soil and water also delivers carbon sequestration	Iñamagua et al., 2023	https://doi.org/10.1007/s10457-023-00857-9
Campesino a Campesino (peasant to peasant) processes versus conventional extensión: a comparative model to examine agroecological scaling	Bernal et al., 2023	https://doi.org/10.1080/21683565.2023.2164882
Manual para el diseño e implementación de un modelo agroalimentario regenerativo: el sistema Polyfarming	Gracia et al., 2021	https://polyfarming.eu/wp-content/uploads/2021/06/Manual_Polyfarming.pdf
A method better identify the socio-economic determinants of transformations in agroforestry systems	Pédelahore et al., 2022	https://doi.org/10.1007/s10457-022-00762-7
Cambio climático: una amenaza para el bienestar de la humanidad y la salud del planeta. La adopción de medidas inmediatas puede asegurar nuestro futuro	IPCC, 2022	https://www.ipcc.ch/site/assets/uploads/2022/02/PR_WGII_AR6_spanish.pdf
A role for grassroots innovation toward agroecological transitions in the Global South? Evidence from México	Orozco-Melendez et al., 2022	https://doi.org/10.1016/j.ecolecon.2022.107582
Just transitions trough agroecological innovations in family farming in Guatemala: Enablers and barriers towards.	Ortiz et al., 2022	https://doi.org/10.1016/j.eist.2022.11.002
Opening the organisational black box to grasp the difficulties of agroecological transition. An empirical análisis of tensions in agroecological production cooperatives.	Plateau et al., 2021	https://doi.org/10.1016/j.ecolecon.2021.107048
Relational drivers of the agroecological transition: An análisis of Farmer trajectories in the Limagne plain, France.	Polge, E; Pages, H. 2022	https://doi.org/10.1016/j.agsy.2022.103430
Clustering smallholders´farmers to highlight and address their agroecological transition potential in Benin and Burkina Faso.	Tapsoba et al., 2023	https://doi.org/10.1016/j.crsust.2023.100220
Assessing resilience and adaptability in agroecological transitions.	Tittonell, P. 2020	https://doi.org/10.1016/j.agsy.2020.102862
Assesment of the environmental impact and economic perfomance of cacao agroforestry systems in the Ecuadorian Amazon región: An LCA aproach	Caicedo et al., 2022	https://doi.org/10.1016/j.scitotenv.2022.157795

8. CERTIFICATES

CENTRO DI RICERCA SCIENZE DELLE PIANTE
Sant'Anna

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UNDERTREES
AGROFORESTRY RESEARCH

Prof. Paolo Barberi
Scuola Superiore Sant'Anna
Piazza Martiri della Libertà 33, Pisa (IT)

Date: 25-06-2023

To Whom who may concern

Subject: Confirmation of Arrival for Secondment of *(name and surname of Seconded staff)* at *Scuola Superiore Sant'Anna.*

This is to certify that *Carlos Estuardo Caicedo Vargas* from *Instituto Nacional de Investigaciones Agropecuarias (INIAP)* has arrived at *Scuola Superiore Sant'Anna (SSSA)* on 25-03-2023 to participate in the activities of Project MSCA-RISE UNDERTREES (Grant Agreement n° 872384) connected with *WP2 Training and Careeer Development.*

Sincerely,

Prof. Paolo Barberi

CENTRO DI RICERCA SCIENZE DELLE PIANTE
Sant'Anna

UNDERTREES project is funded by the European Union's Horizon programme under grant agreement No 872384

UNDERTREES
AGROFORESTRY RESEARCH

Prof. Paolo Barberi
Scuola Superiore Sant'Anna
Piazza Martiri della Libertà 33, Pisa (IT)
Date: 25-06-2023

Certificate of stay

I hereby confirm that Mr. Carlos Estuardo Caicedo Vargas has steadily stayed at the Scuola Superiore Sant'Anna from 25/03/2023 to 25/06/2023 and has successfully developed research in Agroecological Transition of Cocoa Agroforestry Systems in the Ecuadorian Amazon, that is directly related with his PhD thesis in: "The Agroforestry systems with cocoa *(Theobroma cacao* L.*)* as an agroecological transition strategy to family farming in the Amazon Ecuadorian".

Carlos Estuardo Caicedo Vargas worked full time on these activities.

Sincerely,

Prof. Paolo Barberi

CENTRO DI RICERCA SCIENZE DELLE PIANTE
Sant'Anna

UNDERTREES project is funded by the European Union's Horizon programme under grant agreement No 872384

UNDERTREES
AGROFORESTRY RESEARCH

Prof. Paolo Barberi
Scuola Superiore Sant'Anna
Piazza Martiri della Libertà 33, Pisa (IT)

Date: 25-06-2023

To Whom who may concern

This is to certify that *Carlos Estuardo Caicedo Vargas* from *Instituto Nacional de Investigaciones Agropecuarios (INIAP)* has participated in the Project "Creating knowledge for UNDERstanding ecosystem seRviCEs of agroforEStry systems through a holistic methodological framework" MSCA-RISE UNDERTREES, funded by the European Commission (Grant Agreement n° 872384) like director of this project in Ecuador. The project started in March, 2020 and will last until December, 2024.

The objectives of the UNDERTREES Project are: 1) SO1. To develop harmonised methodologies to assess ecosystem services underlying agroforestry systems, at field and landscape scale, in several biogeographical areas. 2) SO2. To assess the social and economic effects resulting from the introduction and adoption of agroforestry systems by a participatory research approach, developing guidelines to support policymaking and decision processes at farm and landscape level. 3) SO3. To compile a handbook with recommendations to design research and teaching curricula in the field of agroforestry as well as training activities at technical, managerial and academic level based on a comprehensive holistic framework.

Sincerely,

Prof. Paolo Barberi

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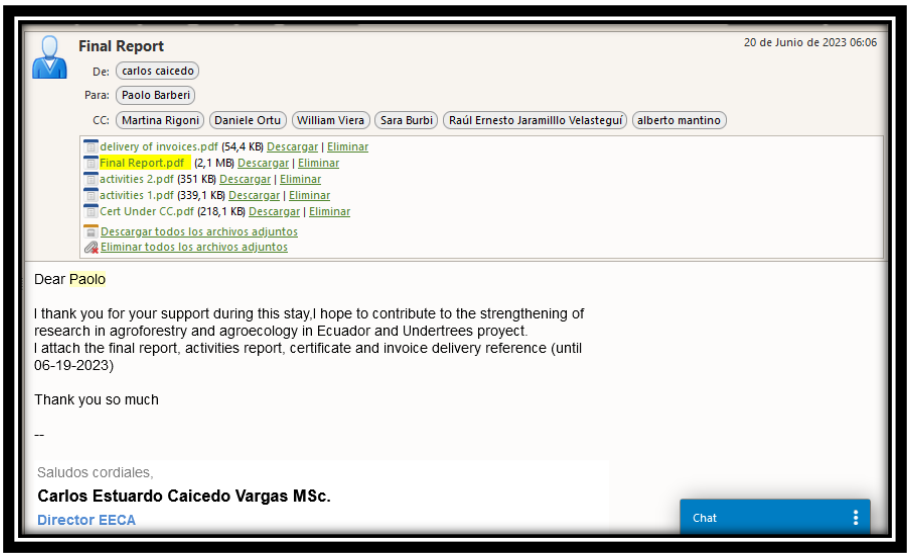


Final Report 20 de Junio de 2023 06:06

De: carlos caicedo

Para: Paolo Barberi

CC: Martina Rigoni | Daniele Ortu | William Viera | Sara Burbi | Raúl Ernesto Jaramilllo Velasteguí | alberto mantino

delivery of invoices.pdf (54,4 KB) Descargar | Eliminar
Final Report.pdf (2,1 MB) Descargar | Eliminar
activities 2.pdf (351 KB) Descargar | Eliminar
activities 1.pdf (339,1 KB) Descargar | Eliminar
Cert Under CC.pdf (218,1 KB) Descargar | Eliminar
Descargar todos los archivos adjuntos
Eliminar todos los archivos adjuntos

Dear Paolo

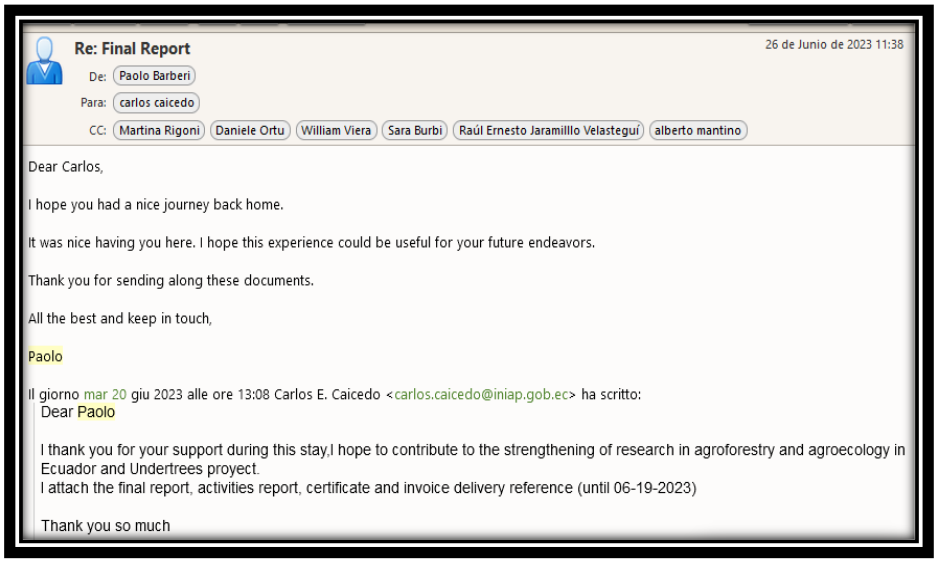
I thank you for your support during this stay,I hope to contribute to the strengthening of research in agroforestry and agroecology in Ecuador and Undertrees proyect.
I attach the final report, activities report, certificate and invoice delivery reference (until 06-19-2023)

Thank you so much

--

Saludos cordiales,
Carlos Estuardo Caicedo Vargas MSc.
Director EECA

Chat



Re: Final Report 26 de Junio de 2023 11:38

De: Paolo Barberi

Para: carlos caicedo

CC: Martina Rigoni | Daniele Ortu | William Viera | Sara Burbi | Raúl Ernesto Jaramilllo Velasteguí | alberto mantino

Dear Carlos,

I hope you had a nice journey back home.

It was nice having you here. I hope this experience could be useful for your future endeavors.

Thank you for sending along these documents.

All the best and keep in touch,

Paolo

Il giorno mar 20 giu 2023 alle ore 13:08 Carlos E. Caicedo <carlos.caicedo@iniap.gob.ec> ha scritto:

> Dear Paolo
>
> I thank you for your support during this stay,I hope to contribute to the strengthening of research in agroforestry and agroecology in Ecuador and Undertrees proyect.
> I attach the final report, activities report, certificate and invoice delivery reference (until 06-19-2023)
>
> Thank you so much