

IX WALLACE SCIENTIFIC CONFERENCE

One Health
Una Sola Salud



Proceedings

**Review
and
editing**

Fernando Casanoves and
Danilo Pezo, CATIE
Laura Benegas, CATIE
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Tropical Agricultural Research and Higher Education Center
Turrialba, Costa Rica
2026

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SETTING THE STAGE

OPENING SESSIONS



Scaling up healthy science-based pathways for resilient agri-food systems

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Abstract

Agri-food systems constitute the largest human-managed interface between ecosystems, plants, animals, and people, and should therefore be understood as a critical global biosecurity infrastructure. They are also the largest managed biological network in the world, concentrating animals, reshaping landscapes, and moving biomass and commodities across borders and continents. As a result, they create both opportunity and vulnerability, especially through the spread of transboundary pests and diseases that move through the same trade architecture as agricultural products. Although Latin America and the Caribbean remain major net food-producing regions, current agri-food systems are under severe systemic stress. Agriculture continues to drive a large share of global deforestation, contributes substantially to greenhouse gas emissions, accelerates land degradation, and places mounting pressure on water resources. Addressing these challenges requires science-based, healthy, and resilient pathways that integrate innovation, policy, and territorial management. Habitat destruction and landscape fragmentation have increased contact among wildlife, domestic animals, and humans, intensifying the risks of disease emergence and transmission. This makes landscape and territorial approaches essential for understanding ecological corridors, identifying threats, and reducing vulnerability. Transboundary pests and diseases such as TR4 in bananas, African swine fever, screwworm, bird flu, and coffee rust illustrate the scale of the threat to food systems, trade, rural livelihoods, and national economies. The re-emergence of screwworm in particular shows the importance of early warning systems, long-term vigilance, and sustained investment in science, technology, and innovation. A broader narrative of agriculture is therefore needed—one that goes beyond primary production and recognizes food systems as interconnected networks linking production, supply chains, consumption, post-consumption processes, nutrition, health, socioeconomic outcomes, environmental impacts, and food loss and waste. Within this perspective, several drivers of change are shaping the transition

toward more functional food systems. These include biotechnology and genomics, digital agriculture and artificial intelligence, precision agriculture, regenerative agriculture, agroforestry, changing consumer preferences, rising middle-class demand for processed foods and animal proteins, and evolving policies and market models. At the same time, reducing food waste, improving post-harvest technologies and infrastructure, strengthening food safety, addressing pesticide residues, and promoting healthier and more balanced diets are increasingly important. Scaling transformation also depends on strengthening national innovation capacities. Countries that invest more in research and innovation are better positioned to accelerate food system transformation, expand productivity, and increase exports. However, innovation alone is insufficient unless systems are de-risked through blended finance, insurance, improved forecasting tools, labor diversification, extension services, and incentives tailored to farmers' decision-making realities. Youth and women must be more actively engaged, and a new generation of farmers supported through entrepreneurship and incubation models. The transition to resilient agri-food systems also requires greater use of agrobiodiversity, crop wild relatives, biofortified crops, sustainable rice intensification, healthy soils, agroforestry, pollination services, and silvopastoral systems. These approaches can generate multiple co-benefits, including higher productivity, improved nutrition, biodiversity conservation, carbon sequestration, and climate resilience. Yet many sustainable practices require longer periods to generate financial returns, making payments for ecosystem services, carbon markets, targeted credit, guarantees, and other essential incentive mechanisms. Further research is still needed on soil health, bio-inputs, genetic improvement, economic trade-offs, consumer behavior, regulatory frameworks, and the links between environmental stress and the resurgence of pests and diseases. Advancing this agenda will depend on stronger cooperation among research institutions, governments, farmers, and the private sector to scale tested solutions for healthier, more resilient, and more sustainable agri-food systems.

Health in the context of nature and climate crisis; a central focal point of the agenda and why it matters

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Abstract

The One Health concept is not new. It has been around for a few decades or so. It was developed to promote sustainable collaborative partnerships and to push the boundaries on the need for optimal health for people, animals, plants, the environment, and the whole planet. At its heart is the recognition that human health and animal health are interdependent and bound to the health of the ecosystems in which they exist. Understanding the complexity of the interactions between people, animals and plants is critical to addressing future health risks and challenges. It has demonstrated, and continues to demonstrate, such strengths. However, the practical application of this approach in our day-to-day work remains challenging. We need to see more action by those who are in positions where they can implement the approach, for example at the Science-Policy Interface. But this requires careful collaboration and coordination across multiple actors and sectors. This approach is critical: for example, of the 36 Sustainable Development Goal (SDG) targets, only two were on track in 2023. Those that showed the least or no progress included those strongly related to One Health themes, for example safe drinking water & ecosystem conservation. We need to carefully consider 'How do we transform our relationship with the nature and climate crisis to deliver on One Health? Thus, engaging researchers with different expertise and disciplinary backgrounds is essential where One Health is researched in an interdisciplinary way so that the human-animal-environment interface is not a separate entity but rather part of a coherent whole.

THEMATIC SESSION 1: SOIL HEALTH:



The importance of the soil-biome for plants, human, and environmental health along the farm-size continuum

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Abstract

Plant health is a core factor in One Health and is strongly influenced by the activity of the microbiome in agricultural and forest soils. The soil biome harbors both deleterious organisms and major plant health-promoting organisms, playing key roles in nutrient cycling, plant health, food production, environmental quality, and nutritional security. In highly degraded soils of the subtropics and tropics, pesticides are often needed to produce healthy crops because the antagonistic potential associated with plant health- and growth-promoting organisms is not fully functional. Improving this antagonistic potential can enhance plant resilience to biotic and abiotic stresses and strengthen One Health outcomes. Likewise, improving soil suppressiveness to pests and diseases can reduce pesticide inputs, lower mycotoxin levels, and increase yields, all of which are important for human well-being. This contribution presents research on stimulating antagonistic potential in soils and its importance for targeted biological control. It also addresses why One Health is not adequately reaching smallholder farmers at the lower end of the farm-size continuum. Results from a program aimed at improving food production and One Health across this continuum in Southern Africa are discussed, together with the pitfalls encountered. The main conclusion is that one size does not fit all; however, specific components of agroecological systems can be managed to make different farm sizes more adaptable and to move production systems toward One Health.

Keywords: Biocontrol, aflatoxin, antagonists, plant diseases, suppressiveness

Soil health and sustainable agriculture

Abstract

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Rhizosphere microorganisms sustain soil health and crops, but data are needed to understand links with pests such as phytoparasitic nematodes. Moreover, the effects of farming systems on the rhizosphere microbiota are still partially explored. To this end, methods such as metabarcoding NGS sequencing of the 16S rRNA and ITS regions, or density-dependence modelling, were applied. Greenhouse tests showed that nematocides affect soil bacterial diversity at finest taxonomic levels. A Canary Islands study on banana also showed that cropping affects soil microbial profiles, with specific links between nematode feeding groups and bacteria. In Costa Rica, the microbial profiles of conventional, fallow, and organic banana systems showed, when compared with non-cultivated controls, that cultivation and management type influence the rhizosphere abundance of bacteria and fungi. The organic crop showed a higher diversity than the conventional one, with the organic control as most biodiverse, whereas nematodes were associated with bacteria specific for each herbivore or feeding group. The organic management had the lowest impact on rhizosphere diversity, with a potential for sustainable production and agroecosystem resilience. A further metabarcoding study on durum wheat in Italy compared an organic with a conventional crop, sampling root soil before and after heading. Although bacterial diversity did not vary significantly in time, correlations confirmed positive or inverse links among nematode feeding groups and bacteria, almost unique for each guild. Positive correlations showed plant growth promoting bacteria, and taxa involved in N_2 and nutrient cycling, denitrification and ammonia oxidation. In conclusion, the selective association of bacteria to nematode feeding guilds reflects functional services acting at the rhizosphere interface, sustaining soil health with an impact on production. Field data indicate, however, that practices for biodiversity and soil conservation do not match intensive cropping systems or monocultures. Specific management choices are then locally needed to sustain yields in the long term.

Keywords: bacteria, fungi, metabarcoding, nematodes, rhizosphere.

Tropical experiences on the use of beneficial native microorganisms in agricultural production with a One Health approach

Abstract

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This presentation examines the use of beneficial native microorganisms (MAPs) in agricultural production through a One Health lens, drawing on experiences from Cuba, Senegal, Burkina Faso, and Côte d'Ivoire. MAPs are bioproducts obtained by multiplying native microorganisms collected from old-growth or wooded areas, where microbial inocula are rich, diverse, and well adapted to local soil and climate conditions. Because they contain multiple microbial species, MAPs can simultaneously provide bio-stimulation, biofertilization, biocontrol, sanitation, and environmental restoration services. Their low-cost, farm-level production also makes them especially attractive for producers engaged in agroecological transition, while raising an important question: are MAPs a “Swiss army knife” for restoring health in agroecosystems, or a potential source of pathogens? Results on microbial composition show that MAPs contain very high diversity. In Senegal, samples collected across arid and humid zones contained more than 300 bacterial species and around 30 fungal and yeast species, regardless of origin. Fermentation strongly increased probiotic groups such as *Lactobacillus* and *Bacillus*, while liquid fractions showed a marked reduction in diversity compared to solid fractions. Literature-based analysis of Cuban and Senegalese datasets further suggests that over half of the most abundant species may promote plant growth through phytohormone production and nutrient solubilization, while many others show fungicidal, bactericidal, insecticidal, nematocidal, virucidal, or bioremediation potential. However, nearly one-third of the identified species may also pose risks to human, animal, or plant health, particularly under conditions of weak immunity or poor-quality control. Case studies illustrate the broad functional potential of MAPs: nematocidal activity in Cuba; higher yields and thrips control in Côte d'Ivoire; improved productivity, reduced pest pressure, and enhanced soil microbial biomass in Burkina Faso; increased milk production in Cuba without altering milk quality; wastewater sanitation in slaughterhouses; and improved iron

and zinc availability from organic residues, enhancing food and feed quality. Overall, MAPs show strong promise for improving agroecosystem health, but their effectiveness and safety depend on better quality assurance, accessible field-level testing, and deeper understanding of long-term impacts and batch variability.

Keywords: agroecology, biocontrol, biosafety

Living Soils of the Americas: soil health, carbon sequestration, and the transformation of agricultural systems

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Abstract

This presentation discusses the *Living Soils of the Americas* initiative, launched in 2021 as a partnership between IICA and The Ohio State University to advance soil health as a central pillar of sustainable agriculture, climate mitigation, and food security across the Americas. Supported by member states, research centers, and private-sector partners, the initiative has highlighted at major global forums the evidence that farmers across the region are already transforming conventional agricultural systems into more sustainable production models with measurable ecosystem benefits. At the core of the initiative is the recognition that soil carbon is a key indicator of soil health and ecosystem functioning. Carbon, described as the “molecule of life,” is stored in soils over long periods, but is released to the atmosphere as CO₂ when soils are disturbed and degraded. Maintaining and restoring soil carbon is therefore essential not only for climate regulation, but also for water regulation, fertility, resilience, and food production. This is particularly urgent given that more than 70% of the world’s soils show some level of degradation, while agricultural lands across the Americas are estimated to have 30–35% degradation. The presentation emphasizes that the technologies needed to reverse this trend already exist and have been used for decades, including conservation agriculture, no tillage, mulching, crop diversification, permanent soil cover, root maintenance, improved biodiversity management, water management, and crop-livestock integration. However, large-scale transformation depends on enabling policies, scientific evidence, and farmer participation. Brazil’s Low Carbon Agriculture Program is presented as a successful policy example, demonstrating how public financing, science-based targets, and climate policy alignment enabled the recovery of degraded pastures, expansion of integrated systems, and significant mitigation outcomes. Building on regional evidence compiled through the initiative, the speaker notes that these practices could generate a mitigation potential of more than 13 gigatons over

the next 20 years, while increasing food production and generating major economic returns. The *Living Soils of the Americas* initiative is thus presented as a platform for linking science, policy, and practice to promote healthier soils, more resilient farming systems, and a stronger contribution of agriculture to climate adaptation, mitigation, land restoration, and food security.

Keywords: soil carbon, climate mitigation, sustainable agriculture, land restoration

Carbon balance in regenerative livestock systems of the Paraguayan Chaco: toward a One Health perspective

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Abstract

Livestock systems in the semi-arid region of the Paraguayan Chaco play a key role in both the economy and the ecological dynamics of the territory. This study presents an exploratory assessment of greenhouse gas (GHG) emissions and the carbon balance in three cattle ranches managed under the regenerative intensive rotational grazing (PRIR) approach, located in Agua Dulce, Alto Paraguay. Although the number of evaluated establishments was limited, the analyzed sites covered more than 20 000 ha, of which 62% are represented by forests and live fences. These are situated in a homogeneous edaphoclimatic landscape, representative of around 600,000 ha of farms associated with APAD. GHG emissions were estimated using the GEI-CATIE tool, following Tier I and II methodologies from the IPCC. Carbon stocks in aboveground biomass and soils (0–30 cm) were evaluated through field sampling and allometric models. Exploratory results indicate that the three ranches (APAD, Don Celso, and La Conquista) achieved positive net carbon balances (-738.20; -16 257.98; and -40 608.28 t CO₂e year⁻¹, respectively), allowing them to offset 100% of their emissions primarily through soil organic carbon (90%) and to a lesser extent through aboveground biomass (10%), underscoring the dominant role of soil carbon in these regenerative systems. These positive balances are associated with areas planted with silvopastoral and forest integration systems, pointing to potential improvements in herd health and better soil-animal-human interaction (i.e. improved soil health supports forage quality, reducing disease burden and improving productivity, ultimately benefiting animal and human health) an important element for achieving one health in livestock systems. The findings underscore the importance of maintaining tree cover through various silvopastoral arrangements and highlight the co-benefits of regenerative grazing for climate change mitigation. The results provide valuable information for a better understanding of carbon emissions and removals dynamics in

livestock-dominated landscapes in the Paraguayan Chaco. It is recommended to expand the geographic and temporal scope of monitoring, incorporate biological indicators of soil health, monitor other benefits associated with tree cover such as profitability improvements, and strengthen the tracking of the applied methodology in more regions of Paraguay to refine and validate these initial results.

Keywords: Regenerative grazing, carbon sequestration, greenhouse gases, soil health.

Bioinputs and circular economy in resilient agroecosystems: evaluating Gold Green® biofertilizer in *Phoenix* spp. and its role in enhancing soil health

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Abstract

Agricultural intensification in humid tropical systems often leads to soil acidification, nutrient leaching, and declining fertilizer use efficiency. Bio-inputs derived from livestock residues may contribute to circular nutrient flows and regenerative soil management. This study evaluated the agronomic performance of the biofertilizer Gold Green® in juvenile *Phoenix* spp. under field conditions in Sarapiquí, Costa Rica, where baseline soil was strongly acidic (pH 4.8) with low base saturation and very low available phosphorus. Dolomitic lime (1500 kg ha⁻¹) was applied three months prior to planting to correct soil acidity. Experimental measurements began 30 days after transplanting (approximately four months after liming), allowing partial stabilization of soil chemical conditions before treatment evaluation. The trial followed a completely randomized design with two treatments and five replicates. Treatments consisted of: (i) Gold Green® (50 cc L⁻¹, biweekly drench application) and (ii) conventional granular fertilization (12-12-17-2, single application). Each experimental unit (60 m²) included 20 randomly selected plants; mean values per unit were used for statistical analysis (n = 5). Measured variables included plant height, leaf emission, leaf greenness (visual scale), and root biomass. Data were analyzed using ANOVA ($\alpha = 0.05$), and associations were explored using Spearman correlation. Leaf greenness was significantly higher under Gold Green® (42.6 ± 1.8) compared to conventional fertilization (35.2 ± 2.1 ; $p < 0.0001$). Root biomass was also greater under the bio-input treatment. A positive association was observed between root biomass and leaf greenness (Spearman $\rho = 0.74$; $p = 0.090$), indicating a trend consistent with coordinated root-shoot vigor, although statistical significance was limited by replication. Soil chemical indicators were assessed using composite baseline and endline samples under uniform liming management; therefore, changes in pH and exchangeable acidity are interpreted as shared liming effects rather than treatment-specific responses. No inferential statistics were conducted for soil chemistry. Under stabilized

liming conditions, Gold Green® enhanced specific plant vigor parameters compared to conventional fertilization within the experimental timeframe. These findings support the potential role of livestock-derived bio-inputs as components of circular and regenerative nutrient management strategies in humid tropical systems, while highlighting the need for expanded replication and treatment-level soil monitoring in future research.

Keywords: soil health, bioinputs, circular economy, agroecology, regenerative practices

Evaluation of the efficiency of three grasses (*Paspalum fasciculatum*, *Zea mays*, *Urochloa decumbens*) as trap plants for the production of native Amazonian mycorrhizal inoculum

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Abstract for research proposal

Ecuadorian Amazonian soils are highly weathered and dominated by iron and aluminum oxyhydroxides, resulting in severe phosphorus (P) limitation due to strong fixation processes. This constraint significantly restricts agricultural productivity and has increased reliance on synthetic phosphate fertilizers, generating economic and environmental concerns. Arbuscular mycorrhizal fungi (AMF) represent a strategic biological alternative by enhancing phosphorus acquisition and improving soil nutrient dynamics. However, limited evidence exists in the Ecuadorian Amazon regarding efficient host species capable of functioning as trap plants for the multiplication of locally adapted native AMF inoculum. This research proposal aims to comparatively evaluate the functional and multiplicative efficiency of *Urochloa decumbens*, *Zea mays*, and *Paspalum fasciculatum* as trap plants for native AMF inoculum production and to assess their influence on key biological and chemical soil indicators. A completely randomized design with six replicates per treatment will be established. The substrate will consist of a sterilized soil: sand mixture (2:1), inoculated with a native AMF consortium collected from secondary Amazonian soils. The trap culture will be maintained for 16 weeks under controlled environmental conditions without additional phosphorus fertilization. Root colonization, spore density, mycelial biomass, and infective potential will be quantified, along with available phosphorus, Fe/Al-bound P fractionation, soil organic carbon, and phosphatase activity. These variables will be integrated into a multivariate mycorrhizal efficiency index to identify the species with the greatest potential for sustainable bioinoculant production adapted to Amazonian conditions.

Keywords: arbuscular mycorrhizal fungi; phosphorus availability; bioinoculants; trap plants; highly weathered soils; Amazon; sustainable agriculture.

Ecological, metabolomic, and edaphic evaluation for the production of *Croton lechleri* in Archidona, Ecuador

Abstract for research proposal

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The Ecuadorian Amazon currently faces significant challenges related to sustainability, which involves the conservation of its biodiversity and the ancestral cultures that inhabit it. *Croton lechleri*, commonly known as dragon's blood, is a tree belonging to the Euphorbiaceae family, native to the Amazon, whose latex has traditionally been used for medicinal purposes by indigenous communities. The growing interest of the pharmaceutical and cosmetic industries in the properties of the latex has driven increased exploitation of natural populations, as well as the establishment of plantations. However, there is still limited information regarding the associated microbiome and its relationship with the chemical composition of the latex, which are fundamental aspects for the development of appropriate production practices. The present project aims to add value to the latex and to determine the optimal edaphic conditions for the establishment of the dragon's blood-producing tree (*Croton lechleri*). This approach seeks to understand the dynamics of water, organic matter, and nutrients associated with productivity in order to guide improved agronomic management. The study will be conducted in the Archidona canton, Napo province, using soil samples from 45 reference trees established by the company Alphyn, which will be described to a depth of 0–120 cm, considering aspects such as morphology, structure, root presence, water dynamics, stoniness, biological activity, and bulk density. Likewise, samples will be collected for routine laboratory analyses (texture, pH, carbon, nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients) at the 0–20 and 20–40 cm intervals, and chemical characterization of the latex will be performed with antimicrobial tests, with the purpose of expanding scientific knowledge about this natural resource. The information obtained in the field and laboratory will allow interpretation of soil conditions for the development of microbiota and plants, including drainage, acidity, fertility, effective depth, and overall productivity.

Keywords: Agronomic handling, sustainable practices, latex, soil, productivity, Amazon region

Biochar-stimulated sporulation in trap culture to produce arbuscular mycorrhizal fungi-enriched substrates

Abstract for research proposal

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Amazonian soils are characterized by low phosphorus (P) availability, representing a major limitation for agricultural productivity and the sustainability of agroecological systems. In this context, arbuscular mycorrhizal fungi serve as promising bioinputs to enhance nutrient uptake efficiency. However, producing high quality AMF enriched substrates remains challenging. The objective of this research is to evaluate the effect of biochar on AMF sporulation in trap cultures to obtain substrates with higher infective potential. We hypothesize that biochar incorporation will result in higher spore density and higher percentage of root colonization compared to the no-biochar control, thereby increasing overall infective potential defined as the combined metric of spore density per unit substrate and percentage root colonization. The study will be conducted at Ikiam Amazon Regional University using a completely randomized experimental design with 4 to 6 replicates per treatment. Trap cultures will be established with a sterilized base substrate soil-sand mixture and *Zea mays* (maize) as the highly mycotrophic host plant, under controlled greenhouse conditions. Biochar will be previously characterized for pH, water retention capacity, and available P content, and incorporated at a rate of 2–5 % v/v by thorough mixing into the substrate prior to planting. The trap culture will last 120 days, with sampling at 60 and 120 days after planting. Mycorrhizal spore density will be quantified using wet-sieving and decanting techniques, and root colonization percentage determined by the gridline intersect method under microscopy. This research seeks to generate scientific information on biochar as a complementary material in mycorrhizal propagation systems, contributing to sustainable, locally adapted strategies for improving soil fertility and strengthening agroecological production in the Amazon region.

Keywords: arbuscular mycorrhizae, biochar, trap crops, phosphorus, Amazonian soils

Harnessing biodiversity and agro-industrial residues in Costa Rica: local solutions to promote sustainable agriculture through novel biostimulants

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Abstract

Current agricultural activity faces the challenge of producing more food on less available land, with high prices of fertilizers and pesticides, which are also highly polluting the environment and with risks to human health. Agriculture in Costa Rica, like other developing countries in Latin America and the Caribbean, needs environmentally, socially, and economically sustainable alternatives for agricultural production. CENIBiot-CeNAT dedicates efforts to research and development of products derived from biodiversity and agro-industrial residues using biotechnological tools. Bacterial and fungal species have been discovered for biological control, and new microbial biostimulants have been developed. In addition, the development of biostimulants obtained from agro-industrial residues has proven to be as efficient as agronomic management with chemical fertilizers and pesticides in coffee and vegetable productions. We work together with policy makers to scale up our findings to farmers in Costa Rica. We are interested in extending our research through collaborations with other colleagues worldwide working on SDGs related to nature-based solutions and revalorization of residues of the agroindustry to convert them into new products for a sustainable production in agriculture.

Keywords: agro-industrial residue valorization, microbial biostimulants, biotechnological innovation, Nature-based solutions

THEMATIC SESSION 2: PLANT HEALTH



Plant health and ecotoxicological approaches

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Abstract

This keynote examines plant health through an ecotoxicological and One Health lens, with emphasis on the impacts of pesticides on biodiversity, ecosystem functioning, agricultural landscapes, and human well-being. Biodiversity is not confined to protected areas or national parks, but is also embedded in cultural and agricultural landscapes where farmland birds, insects, plants, soil organisms, and semi-natural habitats interact. Evidence from Europe indicates pronounced declines in farmland birds and insect biomass over recent decades, while forest bird indicators have remained comparatively stable, suggesting that agricultural intensification, rather than climate change alone, is a major driver of biodiversity loss. Pesticides emerge as a key contributor to this decline. Studies across European farms show that higher agricultural yields are associated with fewer weeds, beetles, and birds, and that pesticide use explains much of this biodiversity reduction. Pesticides are rarely applied as isolated substances; rather, they occur as repeated sequences and mixtures. Monitoring in agricultural fields, field margins, vineyards, vegetable systems, and apple-growing landscapes has revealed the persistent presence of multiple pesticides throughout the year and across entire landscapes, including protected areas and mountain ecosystems. This creates a “chemical landscape” in which invisible contamination may help explain biodiversity losses even in apparently suitable habitats. The analysis further distinguishes between direct, indirect, and sublethal effects. Insecticides affect non-target organisms through shared physiological pathways, whereas herbicides alter plant communities and reduce floral resources, with cascading consequences for pollinators and food webs. Low concentrations and mixtures can impair behavior, reproduction, development, and population viability. Pesticides also influence soil microbiomes and nutrient cycling, linking plant health, soil health, ecosystem services, and human health within a broader One Health framework. Current

pesticide regulation may not adequately reflect ecological reality, as it typically evaluates single compounds, short exposure periods, and direct effects, while neglecting mixtures, chronic exposure, indirect food-web effects, and landscape-scale contamination. These concerns are directly relevant to debates on pesticide reduction, integrated pest management, organic agriculture, drinking-water protection, and the export of pesticides banned in Europe.

Keywords: plant health, ecotoxicology, pesticides, biodiversity decline, chemical landscapes, soil microbiome, integrated pest management, One Health

Evaluation and epidemiological understanding of the efficacy of new agroecological practices to manage black leaf streak disease of banana

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Abstract

Black leaf streak disease (BLSD) due to *Pseudocercospora fijiensis* is the main constraint of banana production for export; the resulting yield loss is mainly managed through frequent aerial fungicide applications. To reduce the future fungicide use, the study aims to evaluate the efficacy of the cultivation of a resistant variety and the intercropping between banana and cocoa to manage BLSD and to identify the effect of light conditions on epidemiological factors. The efficacy of these two agroecological practices was studied experimentally in La Montana research station, in CATIE, Turrialba from October 2024 to December 2025. The BLSD severity on the resistant hybrid developed through conventional breeding by CIRAD was evaluated in a trial of three blocks of 28 plants over two years in comparison with a susceptible commercial variety. The efficacy of the intercropping of the same two varieties with cocoa was evaluated during the same period on second plot. The effect of the intercropping was studied by comparing BLSD severity and by identifying climatic and epidemiological factors related with BLSD severity. The effect of light contrasted conditions on two epidemiological parameters was also evaluated through artificial inoculations of spores under greenhouse conditions. The varietal resistance showed a reduction of 30% of BLSD severity explained by a slower symptoms growth and a reduction of sporulations capacities. The intercropping allowed to reduce 26 to 44% of BLSD severity. A reduction of 20 to 50% of light intensity was measured in the intercropping system. Whereas no difference in spore infection efficacy was found under greenhouse light conditions, slower lesion growth was measured on inoculated plants in comparison with shade conditions. This study confirmed, under high BLSD pressure, the strong resistance of an innovative hybrid and demonstrated for the first time the efficacy of banana-cacao intercropping to manage BLSD explained by an effect of light on lesions growth, offering producers viable agroecological alternatives.

Keywords: varietal resistance, intercropping, light, sustainable control

ECOFFEE initiative: public and private sectors joining forces for reducing pesticide use in coffee production

Abstract

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One of the determinants of ecosystems and human health in coffee landscapes is the widespread use of pesticides, therefore a systemic, multi-stakeholder and multi-level approach is needed to drastically reduce pesticide use. In 2020, some of the largest coffee roasters and traders, alongside academic centers, gathered in a pre-competitive initiative, led by CIRAD, to explore alternatives to reduce pesticide use in coffee production worldwide. The first phase (2020-2022) focused on identifying the technical challenges to be addressed. The results of this first phase allowed us to build a first database on pesticide residues in coffee and soil of Arabica and Robusta coffee plantation in contrasting production systems, with the identification of the 10 most concerning active substances for the environment and human health. Based on these results, the ongoing second phase of the ECOFFEE initiative (2023-2027) explores scenarios for agroecological transitions to reduce the dependence of coffee production systems on pesticides. It relies on three interconnected activity areas: 1. An experimental network of farm trials deployed in Brazil and Costa Rica to evaluate, from an agronomic, ecological, and economic perspective, strategies based on integrated management of diseases, pests, and weeds for reducing the use of pesticides; 2. A geographical and social extension of the initiative based on multi-stakeholder dialogue platforms of the national coffee value chains in these countries, to identify obstacles and levers and to propose collaborative actions towards an effective reduction of pesticide use, involving different stakeholders and combining with an innovation hunt through an ad hoc experts committee; 3. The search for new modes of governance involving public and private sectors, to engage key stakeholders towards transformative changes. The present communication will resume key lessons of 5 years of the ECOFFEE initiative and will propose future avenues for an ambitious phase 3 in line with the One Health approach.

Keywords: agroecological transition, pesticide reduction, governance, public-private partnership.

Evaluation of the push–pull method for controlling *Spodoptera frugiperda* in maize in Tena, Ecuador

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Abstract for research proposal

In the Ecuadorian Amazon, strategic subsistence crops play a key role in rural livelihoods. According to ESPAC (2020), these crops represent between 2.9% and 5.9% of the total cultivated area, including maize (*Zea mays* L.) monocultures. However, maize production is severely affected by infestations of *Spodoptera frugiperda* (fall armyworm), which cause yield losses ranging from 15% to 63% for at least 60% of farmers. This situation promotes the intensive use of chemical insecticides, generating risks to human health, environmental contamination, and ecological imbalance. The push–pull system is an agroecological pest management strategy based on the use of repellent plants (push) and attractive plants (pull) to reduce pest infestation while enhancing functional biodiversity. This study aimed to evaluate the effect of the push–pull method on *S. frugiperda* infestation in a maize crop established in the community of San Luis, Puerto Napo parish, Tena canton, Napo province. The experiment was conducted under a completely randomized design with five treatments and three replications, including combinations of repellent plants (*Vigna unguiculata* and *Phaseolus vulgaris*) and attractive plants (*Tripsacum laxum* and *Cenchrus purpureus*), as well as a maize monoculture control. The presence of *S. frugiperda* and the activity of macrofauna and microfauna were evaluated every 15 days. It is expected that at least one push–pull treatment will significantly reduce fall armyworm infestation and improve crop performance. This study provides technical evidence for the development of more sustainable and resilient agroecological and agroforestry systems in the Amazon region.

Keywords: agricultural health, agroecology, integrated pest management, Amazon region.

Adaptation to three production systems of two vanilla species (*Vanilla odorata* and *V. tahitensis*) in the Ecuadorian Amazon

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Abstract

The Ecuadorian Amazon is biodiverse, yet agricultural diversification is constrained by limited investment capacity and uncertainty regarding the performance of high-value crops under humid tropical conditions. Vanilla represents a promising alternative for sustainable production; however, technical evidence on the adaptation of native and introduced species in Amazonian environments remains limited. This study evaluated the vegetative adaptation of *Vanilla odorata*, a native species, and *V. tahitensis*, an introduced species, under three production systems: agroforestry, greenhouse, and shade-net cultivation. The trial was conducted at the Laboratory of Agroecological Studies of Universidad Regional Amazónica Ikiam, in Tena, Ecuador. A total of 163 vanilla cuttings were established by late November 2024 and monitored during the vegetative establishment phase. The agroforestry system used cacao trees (*Theobroma cacao*) as live tutors; the greenhouse system included guadua tutors and drip irrigation; and the shade-net system used shade net mesh to reduce rainfall impact and provide shade. Phenological and growth variables, including plant height, internode length, number of internodes, number of leaves, leaf area, and leaf area index, were analyzed using ANOVA, Tukey's post hoc test, and Kruskal-Wallis tests. Results showed differentiated responses between species and production systems. The greenhouse system promoted the greatest vegetative development, particularly in *V. tahitensis*, which showed higher plant height, number of internodes, number of leaves, leaf area, and leaf area index. The agroforestry system achieved high sprouting percentages in both species, reaching 82.35% in *V. odorata* and 71.43% in *V. tahitensis*, while requiring less infrastructure than greenhouse cultivation. The shade-net system showed more limited performance, especially for *V. odorata*, probably

due to excessive rainfall and humidity, although plant viability was maintained. Overall, both species showed adaptation potential under Amazonian conditions. Greenhouse cultivation favored vegetative growth, whereas agroforestry emerged as a lower-cost, environmentally compatible alternative for smallholders and conservation of native vanilla species.

Keywords: Wild vanilla, Microclimates, Adaptation, Viability, Intensive systems.

Evaluation of trapping methods for insect pests associated with soursop (*Annona muricata*) cultivation in ASOPROINCAM, Ahuano, Tena, Napo, Ecuador

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Abstract for research proposal

Insect pests represent one of the main constraints to soursop (*Annona muricata*) production under tropical conditions, particularly affecting fruits at early developmental stages. Previous studies report that, in the absence of adequate monitoring and management strategies, yield losses may exceed 40% of annual production, causing significant economic impacts on smallholder farming systems. Despite its importance, information on the entomofauna associated with soursop crops in the Ecuadorian Amazon remains scarce. This study evaluates the effectiveness of five low-cost agroecological trapping methods based on fermented and saline attractants for monitoring insect pests in soursop cultivation. The research is conducted in ASOPROINCAM, Ahuano (Tena, Napo, Ecuador), using a Completely Randomized Design with weekly monitoring over an eight-week period. The evaluated treatments include fermented ripe fruit, fruit macerate with molasses, fermented fruit with yeast, fermented saline attractant, and a combined trap integrating fermented fruit, salt, and molasses. The research is grounded in agroecological principles, considering that “ecological pest management based on biodiversity and biological control enhances the resilience of agroecosystems”. The number of insects captured per trap and the percentage of damaged fruits are used as evaluation variables. The results are expected to identify the most efficient trapping method and its relationship with fruit damage, providing the first local baseline on insect pest dynamics in soursop crops in the Amazon region. This study contributes to the development of environmentally friendly, affordable, and replicable pest monitoring strategies for sustainable tropical fruit production systems.

Keywords: agroecological trapping, soursop, fermented attractants, sustainable agriculture

Evaluation of germinated lentil (*Lens culinaris*) extract as a natural promoter of in vitro rooting of *Vanilla planifolia*

Abstract for research proposal

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Vanilla planifolia Andrews is an orchid of high economic value whose conventional propagation is limited by low rooting rates, clonal heterogeneity, and high phytosanitary susceptibility. While in vitro micropropagation offers an efficient alternative, the use of synthetic plant growth regulators, particularly auxins, raises agroecological concerns. This study evaluates aqueous extracts of germinated and non-germinated lentils (*Lens culinaris* Medik) as natural promoters of in vitro rooting in *V. planifolia*, based on the hypothesis that germination increases the biosynthesis of natural auxins such as indole-3-acetic acid (IAA). The research will be conducted in laboratories at the Ikiam Amazonian Regional University (Tena, Napo). A completely randomized factorial design will be used, employing in vitro shoots of *V. planifolia* cultivated in modified MS medium. Four main treatments will be evaluated: (T1) germinated lentil extract, (T2) non-germinated lentil extract, (T3) positive control with indole-3-butyric acid (IBA), and (T4) negative control without regulators. Each extract treatment (T1 and T2) will include three concentration levels: 5%, 10%, and 15% (v/v). The positive control (T3) will evaluate three IBA concentrations: 1.42, 2.85, and 5.70 μM (equivalent to 0.25, 0.5, and 1.0 mg L^{-1}). The negative control (T4) will be a single level without regulators. Each treatment-level combination will consist of 10 replicates, totaling 195 experimental units. Response variables will be evaluated at 15, 30, and 45 days of culture. The extracts will be sterilized by 0.22 μm filtration. The main hypothesis postulates that the germinated lentil extract, particularly at intermediate concentrations (10% v/v), will significantly increase the rooting percentage and reduce callus formation compared to the non-germinated extract and the negative control, approaching the performance of IBA at 2.85 μM . Response variables will include: rooting percentage, number and length of roots per explant, time to root induction, and callus incidence. To support the mechanism, the IAA content (or proxy

compounds) in the extracts will be quantified by HPLC or spectrophotometry. This study will generate scientific evidence to establish agroecologically sustainable micropropagation protocols for *V. planifolia* in the Ecuadorian Amazon, reducing dependence on synthetic inputs and promoting a clean and accessible propagation model for local producers.

Keywords: Vanilla planifolia, micropropagation, in vitro rooting, germinated lentil, natural auxins, agroecology.

Evaluation of curing methods on vanillin content in *Vanilla odorata* from the Ecuadorian Amazon

Abstract for research proposal

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The limited scientific information available on the curing performance of *Vanilla odorata* in the Ecuadorian Amazon restricts the technical optimization of its postharvest processing and the standardization of quality parameters. In fresh pods, vanillin is predominantly present as glucovanillin, and its commercial value depends on the efficiency of enzymatic conversion during curing. In this study, efficiency is defined as the percentage of vanillin (% dry weight) obtained after curing relative to the initial glucovanillin content quantified in fresh pods, integrating both formation and post-curing stability. The objective is to compare traditional, industrial, and laboratory curing methods applied to *Vanilla odorata* cultivated in Napo, Ecuador, using vanillin concentration (% dry basis) as the primary comparison metric and conversion efficiency as a secondary indicator. A completely randomized design with three treatments and three independent replications will be employed. Prior to curing, glucovanillin in fresh pods will be stabilized, extracted, and quantified by HPLC-UV. After curing, vanillin will be extracted and quantified under validated chromatographic conditions. The traditional method will involve hot-water scalding followed by sweating under insulated conditions and gradual sun-drying over several weeks. The industrial method will apply controlled thermal scalding, chamber sweating, and oven drying with regulated temperature and airflow. The laboratory method will include controlled enzymatic hydrolysis and accelerated drying under regulated conditions. Data will be analyzed using ANOVA and Tukey's test ($p < 0.05$) to determine statistically significant differences in vanillin content and conversion efficiency. It is hypothesized that controlled enzymatic treatment may maximize conversion, while gradual traditional curing may favor compound stability. The findings will provide evidence-based criteria for optimizing curing strategies of *Vanilla odorata* under Amazonian production conditions.

Keywords: *Vanilla odorata*, curing methods, vanillin content, glucovanillin conversion, HPLC-UV analysis, conversion efficiency

Evaluation of substrates in the development of the fungus *Favolus tenuiculus* at the URAI facilities

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Abstract for research proposal

Favolus tenuiculus is an edible wild mushroom of great ecological, nutritional, and cultural importance in the Ecuadorian Amazon, due to its role in the decomposition of organic matter and its contribution to the food security of local communities. However, its production under controlled conditions is limited by the lack of information on the most suitable forest substrates for its cultivation. The present study aims to evaluate the effect of three forest substrates: pigue (*Piptocoma discolor*), laurel (*Cordia alliodora*), and guaba (*Inga edulis*) wood chips on the growth, development, and yield of the *Favolus tenuiculus* mushroom under controlled conditions at the facilities of the Ikiam Amazon Regional University (URAI). The research will be conducted using an experimental approach, with a completely randomized design with three treatments and ten replicates per treatment. Variables such as primordium emergence time, time to harvest, yield, and quality of the carpophores obtained in each substrate were evaluated. It is expected that at least one of the substrates evaluated will significantly favor the development of the fungus, allowing for the identification of a sustainable alternative for its cultivation. The results will provide relevant technical information for the agroecological production of edible wild mushrooms, promoting the sustainable use of forest resources, the conservation of traditional knowledge, and the strengthening of sustainable production systems in the Ecuadorian Amazon.

Keywords: edible fungi, forest substrates, agroecology, Ecuadorian Amazon, sustainable production.

SPAD calibration model for non-destructive Chlorophyll Estimation in *Theobroma cacao* L. under Amazonian agroecological conditions

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Abstract for research proposal

Theobroma cacao L. is a cornerstone of agroforestry systems in the Ecuadorian Amazon, contributing to biodiversity conservation and sustainable livelihoods. Monitoring its physiological status, particularly chlorophyll content, is essential for optimizing photosynthesis and nutrient management. Conventional spectrophotometric methods, although precise, are destructive, costly, and require specialized infrastructure. The SPAD-502 portable meter offers a non-destructive alternative, but its readings are relative and demand species- and context-specific calibration. This study aims to establish a robust calibration model between SPAD index values and actual chlorophyll concentrations (Chl a, Chl b, and total) in cacao leaves under Amazonian agroecological conditions. We hypothesize that SPAD readings present a consistent and significant correlation with spectrophotometric chlorophyll quantification, enabling reliable estimation in field settings. The research will be conducted in the Chakra Amazónica of Ikiam University, Napo, Ecuador. Adult plants of a single cacao clone will be sampled to minimize genetic variability. Between 35 and 40 plants will be randomly selected, with one physiologically mature leaf per plant (third or fourth leaf level). Three SPAD readings (basal, middle, apical) will be taken per leaf using a SPAD-502 Plus meter. Immediately after, 0.1 g of fresh tissue will be extracted in 80% acetone, centrifuged, and analyzed by UV-Vis spectrophotometry at 663 nm and 645 nm. Chlorophyll concentrations will be calculated using the Lichtenthaler & Wellburn method. Calibration will be performed using regression models (linear and polynomial), with validation through cross-validation procedures. Model performance will be assessed using R^2 , RMSE, and standard error of estimation. Acceptable robustness will be defined as $R^2 \geq 0.80$ and RMSE within biologically interpretable ranges. Expected

results include the development of a reliable calibration equation linking SPAD values to chlorophyll concentrations. This will validate SPAD as a practical, non-destructive tool for cacao monitoring in Amazonian systems. The societal contribution lies in bridging laboratory precision with farmer-level accessibility, strengthening sustainable agroforestry management and reducing dependence on destructive methods.

Keywords: Amazonian agroecology, agroforestry systems, spectrophotometry

Nitrogen dynamics with *Arachis pinto*i in cocoa agroforestry systems in Altotena, Napo, Ecuador

Abstract for research proposal

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Amazonian soils have edaphic limitations such as high acidity and low nutrient availability, which restrict the sustainability of production systems, especially cocoa cultivation (*Theobroma cacao* L.). In the province of Napo, conventional cocoa management has increased dependence on synthetic fertilizers, leading to soil degradation and environmental risks. In response to this problem, agroforestry systems with cover legumes such as *Arachis pinto*i represent a sustainable alternative due to their ability to biologically fix nitrogen and improve soil fertility. The objective of this study is to evaluate nitrogen dynamics under the influence of *A. pinto*i in cocoa agroforestry systems in the community of Altotena, Tena canton, Napo province. The research is justified by the need to generate scientific information that will strengthen the agroecological management of cocoa, improve soil sustainability, and reduce dependence on external inputs. From an environmental perspective, the study will contribute to soil and Amazonian ecosystem conservation; socially, it seeks to support more resilient production systems; and scientifically, it will contribute knowledge about nitrogen dynamics in tropical agroecosystems. The methodology will be developed using a completely randomized design, with agroforestry cocoa plots with and without *A. pinto*i cover, and four replicates per treatment. Soil variables such as pH, organic matter, electrical conductivity, cation exchange capacity, and available nitrogen will be evaluated. Likewise, the biological activity of *Rhizobium* sp. will be estimated through the nodulation of *A. pinto*i, and nitrogen in the soil and its absorption by cocoa will be quantified through periodic sampling and laboratory analysis. The incorporation of *A. pinto*i is expected to increase nitrogen availability, improve soil properties, and contribute to the sustainability of cocoa agroforestry systems in the Ecuadorian Amazon.

Keywords: *Theobroma cacao* L., biological fixation, sustainability.

Evaluating the impact of land use and crop management under “One Health” framework

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Abstract

The use of land and its management can affect soil, plants, animals, humans and environmental health as a whole. One Health's framework considers that the health of all components of the environment is linked. Farmers and rural communities interact closely with their environment and affect its health through their practices. Also, we argue that directly involving farmers and community members in a co-diagnostic of agroecosystems' health will help the appropriation of the concept of One Health. It is also an opportunity to generate knowledge on practices' effects on system's Health which would allow actors to be better informed in their decision-making process. To these ends, within a 2-year collaborative project, we propose the establishment of two initiatives in Costa Rica: i) a field-network to discuss and study farming practices and their impact on various health components, and ii) a study with two communities on how land use changes affect wildlife contacts with humans and domesticated animals and how it could affect their health. Voluntary farmers participating in the field network will be involved in the diagnostic of their production system's health through a series of interviews completed by biophysical measurements and indicators of soil, crop, water, environmental and human health. By the end of the project, farmers will receive a personalized summary of the diagnostic, and will be invited to a workshop to explore design options to improve agroecosystem's health. The second initiative will aim at establishing a participatory diagnostic of the threats associated with the coexistence between people, domesticated animals, wildlife, economic activities and nature. This will be done through workshops and field schools with the aim to develop a collaborative management system for the territory taking into account the interconnection of health. This project, which applies a One Health approach, will contribute to an appropriation of One Health by communities and farmers.

Keywords: agroecosystems, farming practices, System's Health Diagnostic

THEMATIC SESSION 3: ANIMAL HEALTH



The contribution of animal health to the One Health approach

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Abstract

This keynote addresses the central contribution of animal health to the development and operationalization of the One Health approach. A large proportion of human infectious diseases and emerging pathogens originate in animals, and this reality has become increasingly important in a changing world marked by environmental disruption, political instability, food system pressures, and growing risks related to pandemics, antimicrobial resistance, and biosecurity. Examples such as avian influenza, SARS-CoV-1, and COVID-19 illustrate the profound health, social, and economic costs of infectious diseases of animal origin, reinforcing the need to shift from reactive disease control toward preparedness and prevention. The analysis traces the institutional evolution of One Health at the international level, from early collaboration among FAO, WHO, and the World Organisation for Animal Health, to the later inclusion of UNEP and the emergence of a more integrated quadripartite framework. This evolution expanded the focus from human and animal health toward a broader systemic perspective that includes ecosystems, environmental health, food safety, livelihoods, science-policy integration, and investment. Within this framework, the “4Cs” — collaboration, communication, coordination, and capacity building — are presented as essential principles for implementing One Health in practice. Two animal health examples illustrate the complexity of One Health research and action. The first focuses on bovine tuberculosis in Africa, showing how disease transmission must be understood through livestock–wildlife interfaces, food chains, community practices, milk and meat consumption, and local risk perceptions. Studies in Uganda, Botswana, Zimbabwe, and South Africa demonstrate that epidemiological evidence, participatory approaches, and social practices are all necessary to assess zoonotic risk. The second example addresses antimicrobial resistance in pig production systems in South Africa, where genomic analyses revealed potential transmission

pathways among pigs, farm workers, and the farm environment. The contribution also discusses international and regional initiatives, including PREZODE, PREACT, ASICA, CaribVET, event-based surveillance tools, participatory training, serious games, podcasts, and One Health communities of practice. Effective One Health implementation requires bottom-up engagement, stronger regional networks, integration of social sciences, and practical tools that connect research, policy, surveillance, and community action.

Keywords: zoonoses, bovine tuberculosis, antimicrobial resistance, livestock–wildlife interface, surveillance, CaribVET

Relationship between technological level and greenhouse gas emissions on livestock farms of Panama and the Dominican Republic

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Abstract

Livestock farming plays an important role in national economies and is a significant source of greenhouse gas (GHG) emissions. The implementation of good livestock practices (GLP) and the adoption of silvopastoral systems (SPS) are essential to reduce emissions and improve the profitability of production units. This study aimed to evaluate the relationship between technological level and GHG emissions per unit of product on livestock farms. A total of 62 farms in Panama and 64 in the Dominican Republic were selected, and biophysical and socioeconomic information was collected. Based on biophysical variables analyzed through cluster analysis, farms were classified into high (HTF), medium (MTF), and low technological level (LTF). In Panama, 23% of farms were classified as HTF, 56% as MTF, and 21% as LTF. In the Dominican Republic, 52% were HTF and 48% were LTF. Farms with higher adoption of GLP and SPS (HTF) exhibited lower GHG emissions per unit of milk and meat compared to LTF. Enteric methane was the main GHG emitted in both countries, accounting for 94% of total emissions. In Panama, emissions per unit of milk produced decreased significantly as the technological level increased, from 4.5 to 2.3 kg CO₂e kg⁻¹ of milk ($p < 0.05$). In the Dominican Republic, emissions decreased from 1.7 to 1.5 kg CO₂e kg⁻¹ of milk, although this difference was not statistically significant ($p > 0.05$). In contrast, for meat production, emissions per unit of product were lower on farms with lower technological levels. In Panama, emissions ranged from 18.2 to 12.0 kg CO₂e kg⁻¹ of meat sold ($p < 0.05$), and in the Dominican Republic from 8.2 to 7.7 kg CO₂e kg⁻¹ of meat sold ($p > 0.05$). This trend is explained by the fact that low-technology farms sold more animals for meat, whereas high-technology farms were more oriented toward milk production. The promotion of GLP and SPS is therefore crucial for improving productivity and reducing GHG emissions in livestock systems. Additionally, these practices may generate co-benefits for human, animal, and ecosystem health, contributing to the One Health approach.

Keywords: Good practices, enteric methane, emission intensity

One Health coexistence at wildlife–livestock interfaces in the Osa peninsula

Abstract

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Interface zones between protected areas and productive landscapes in the Osa Peninsula constitute critical settings for bi-directional zoonotic disease transmission due to land-use change, habitat fragmentation, and increasing interactions among wildlife, domestic animals, and humans. This study aimed to assess habitat use and the presence of infectious agents with zoonotic potential in subpopulations of white-lipped peccary (*Tayassu pecari*) inhabiting the buffer zone of Corcovado National Park, with emphasis on the community of Rancho Quemado, located along a key migratory route of the species. Between 2020 and 2024, an integrative One Health approach combined community-based participatory monitoring, camera traps, GPS telemetry, and non-invasive fecal sampling conducted in collaboration with a local biological monitoring group. A total of 188 fecal samples were analyzed using RT-PCR to detect influenza A virus and metatranscriptomic sequencing to identify additional infectious agents. Influenza A virus was detected in 0.26 of the analyzed samples, and multiple viral, bacterial, and protozoan genera with zoonotic potential were identified, suggesting possible transmission pathways among wildlife, domestic dogs, livestock, and humans. Qualitative methods, including interviews, focus groups, and participatory workshops, documented local perceptions, productive practices, and health-related risk factors. Based on these findings, a Conservation, Coexistence and One Health Plan was co-developed with the community, incorporating improvements in animal management, strengthened sanitary surveillance, environmental education for children, and sustained engagement with women to address their aspirations and needs. This initiative has evolved into a broader project integrating ecological, social, and evolutionary variables influencing disease dynamics across different land uses, while engaging key groups such as women, farmers, and children, and addressing vectors, wildlife, and

domestic animals. These results demonstrate that preventing emerging infectious diseases in biodiversity-rich regions requires participatory and transdisciplinary frameworks integrating human, animal, and environmental health while strengthening local capacities for long-term prevention and coexistence.

Keywords: Zoonotic transmission, community-based monitoring, landscape change, participatory prevention, emerging diseases

Estandarización de técnicas parasitarias y moleculares para la detección y caracterización de *Toxocara* sp.

Resumen

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Los parásitos zoonóticos presentes en perros y gatos, como *Toxocara canis* y *Toxocara cati*, representan un riesgo, especialmente en espacios recreativos donde las personas conviven con sus mascotas. Estos helmintos son responsables del síndrome de Larva Migrans Visceral. El objetivo del estudio fue estandarizar técnicas moleculares para su detección y caracterización al comparar su sensibilidad con métodos parasitológicos convencionales. Para evaluar la sensibilidad diagnóstica se inocularon muestras de heces (1 g) y tierra (10 g), libres de parásitos, con huevecillos de *T. canis* y *T. cati* en concentraciones desde 1×10^4 hasta un huevecillo. El método parasitológico se realizó mediante concentración por flotación con soluciones saturadas de azúcar y sulfato de zinc. La extracción de ADN se efectuó con el kit GENEJET, para lo cual se utilizó lisis mecánica previa y se verificó su calidad por electroforesis y espectrofotometría A260/A280. Se estandarizó una PCR específica para el género *Toxocara*, dirigida a la región intergénica IT1-IT2 de la subunidad ribosomal 5S y la diferenciación entre especies se obtuvo mediante análisis RFLP interpretados con el software TotalID. Los métodos parasitológicos recuperaron entre 80% y 60% de los huevecillos inoculados, siendo la solución saturada de azúcar capaz de detectar hasta un huevecillo en el inóculo directo. Sin embargo, la sensibilidad disminuyó con las matrices de heces o tierra lavadas y tamizadas, con límites entre 1×10^2 y 1×10^1 huevecillos. La PCR mostró alta sensibilidad y detectó hasta 10 fg de ADN y un huevecillo, aunque presentó inhibición al incluir matrices. La adición de 50 µg de BSA mejoró la amplificación en muestras inhibidas, lo que permitió detectar entre 1×10^3 y 1×10^0 huevecillos según el tamaño del amplicón. Estos resultados facilitarán la selección del método parasitológico más adecuado y la optimización de la PCR para establecer límites mínimos de detección en heces y suelos, lo cual fortalecerá los estudios epidemiológicos en áreas compartidas por humanos y mascotas.

Palabras clave: *Toxocara canis*, *Toxocara cati*, diagnóstico molecular, PCR-RFLP, concentración-parasitológica, zoonosis

Enhancing toxicological assessment with backscattered-electron ultrastructural imaging: insights from a microplastic toxicity study

Abstract

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The list of contaminants of emerging concern (CECs) is rapidly expanding as new evidence accumulates on the potential adverse effects of diverse chemicals on humans and animals. Many of these compounds, such as plastics, have been widely used for decades across various sectors, including agriculture. Although several studies suggest that CECs may contribute to health disorders, the harmful effects of some substances may be overstated or understated, making accurate assessment of their true impact a major challenge. Conventional histology, routinely used in toxicological studies, cannot detect subtle subcellular alterations, while transmission electron microscopy, though capable of ultrastructural analysis, is limited by a restricted area of study and low throughput. In this study, we assessed the potential of a new ultrastructural imaging approach based on backscattered electron (BSE) detection in a scanning electron microscope (SEM) to investigate the effects of polyethylene terephthalate (PET) microplastics on the small intestine. Eight-week-old pigs received 1 g of PET particles daily for 28 days. After euthanasia, samples of the duodenum and jejunum were processed by a modified Deerinck et al. (2010) protocol. Ultrathin sections collected on silicon wafers were imaged using a Sense BSD detector in a Gemini 450 SEM. The pathological alterations observed in PET-treated animals were restricted to the villi and correlated with the presence of a thick mucus layer on their surface. Areas without excessive mucus showed epithelial integrity despite microvillar shortening or loss, whereas mucus-covered areas exhibited numerous damaged cells and epithelial discontinuities. BSE imaging enables efficient assessment of entire intestinal wall sections, automated acquisition of large numbers of cells - such as the full epithelial lining of a mucosal region, and visualization of fine details like microvillar structure. This method significantly improves the reliability of toxicological studies. Supported by the Ministry of Science under the "Regional Initiative of Excellence" program.

Keywords: contaminants of emerging concern, polyethylene terephthalate, intestinal epithelium, domestic pig model, One Health

Characterization of *Yersinia enterocolitica* strains isolated from Shetland ponies and potentially pathogenic to humans

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Abstract

Yersinia enterocolitica as a causative agent of yersiniosis – a zoonosis with growing epidemiological significance, poses a significant threat to public health. Due to the fact that the reservoir of *Y. enterocolitica* may be animals of various species and the lack of literature data on their occurrence in Shetland ponies, the aim of the study was to characterize the strains isolated from these animals. Biotyping, serotyping, molecular examinations (triplex PCR, phylogenetic analysis) and a standardized disk diffusion method to assess the sensitivity of the isolated strains to antibiotics were used. Five tested strains belonged to biotype 1A and in majority to serotype O:8. Examined *Y. enterocolitica* were characterized by the presence of *ystB* gene amplicons and phylogenetic analysis showed the occurrence of three different phylogenetic groups – genotype 1 prevailed. A sequence alignment analysis of nucleotide sequences classified as G1 revealed 100% similarity with the *Y. enterocolitica* D88145.1 (National Centre for Biotechnology Information – NCBI, *Y. enterocolitica* DNA for Yersinia Heat-stable Enterotoxin Type B, complete cds) sequence. The examination of sensitivity to antibiotics of the isolated strains showed the presence of multidrug resistance – all strains demonstrated resistance to at least three antibiotics. The only antibiotic to which the isolated strains were sensitive was ciprofloxacin. The results show that *ystB*-positive, multidrug resistant *Y. enterocolitica* strains are present in Shetland ponies and direct contact of children and adults with these animals may pose a potential threat. To the authors' knowledge, this is the first study in world literature on the occurrence and characteristics of *Y. enterocolitica* strains in Shetland ponies, very important in the aspect of One Health. Study funded by the Minister of Science under the Regional Initiative of Excellence Program.

Keywords: biotype, serotype, virulence markers, phylogenetic analysis, antimicrobial resistance

Assessment of cobalt concentrations in dog hair and their potential biological impact

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Abstract

Cobalt is an essential trace element involved in the synthesis of vitamin B12, a cofactor crucial for neurological function, hematopoiesis, and metabolic regulation in mammals, yet its reference levels and variability in dogs remain insufficiently characterized, creating a need for reliable biomarkers to support nutritional assessment and early detection of trace element imbalances. This study aimed to quantify cobalt concentrations in dog hair and evaluate interindividual variation in a population of household dogs living under typical environmental conditions in the Warmian-Masurian region. Hair samples were collected in April 2022 from 100 adult dogs of various breeds, sexes, ages, and body conditions, all fed commercial diets and maintained in domestic settings. Approximately 2 g of hair was obtained from the ventral abdomen of each animal and analyzed using inductively coupled plasma mass spectrometry (ICP-MS), a technique providing high sensitivity for detecting trace elements in biological matrices. Cobalt was detected in all samples, with concentrations ranging from 0.011 $\mu\text{g g}^{-1}$ to 0.200 $\mu\text{g g}^{-1}$ and a mean value of $0.032 \pm 0.022 \mu\text{g g}^{-1}$, indicating notable variability among individuals. The results demonstrate that cobalt is consistently present in the hair of dogs and that its levels likely reflect combined dietary and environmental exposure. These findings support the use of hair mineral analysis as a non-invasive tool for evaluating cobalt status in dogs and contribute baseline data relevant to veterinary nutrition, environmental monitoring, and the study of trace element homeostasis in companion animals.

Keywords: cobalt, dogs, hair analysis, ICP-MS, trace elements, nutrition

Participatory pasture research for sustainable livestock systems in Honduras

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Abstract

Within the framework of the Livestock Farmer Field Schools (FFS) of the MAF-Ganadería-HN project, a participatory pasture adaptation study is being implemented based on a diagnostic assessment conducted with producers from 79 FFS (approximately 2 000 participants). The main limitation identified on livestock farms was the scarcity of forage, associated with inadequate management and the progressive degradation of pastures, which limits productivity and increases the climatic vulnerability of the activity. The study includes a two-year evaluation period and has currently been established for four months, comprising 12 trials distributed across four agroecological zones. A randomized complete block design is being used, with three replications per site and 4 × 4 m plots. Six treatments are evaluated: local control pasture, farmer-defined elite material, *Urochloa brizantha* cv. Marandú, *Megathyrus maximus* cv. Mombasa, *Urochloa* hybrid cv. Camello, and *Urochloa* hybrid cv. Cayman. Establishment and management are conducted without fertilizer application to assess the performance of the materials under real farm conditions.

Evaluations integrate qualitative criteria defined by producers (growth, ground cover, color, and palatability) with biophysical measurements such as fresh and dry matter yield, plant height, and soil cover. Preliminary results indicate that Cayman and Mombasa have been consistently better rated by producers compared to local control and the elite material. This perception aligns with initial productivity data, showing that both materials produce between three and five times more forage than the local control pasture.

In addition, bromatological analyses will be conducted to determine the nutritional quality of the forages, and soil studies will be carried out to characterize the edaphic conditions of the experimental sites, thereby strengthening the technical basis for future recommendations.

Keywords: participatory evaluation, pasture adaptation, climate resilience, enteric emissions

Methodology for the establishment and implementation of an MRV system to assess sustainability in livestock farms

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Abstract

The design, validation, and implementation of an integrated Monitoring, Reporting, and Verification (MRV) system is proposed to assess sustainability in livestock farms in Honduras. The system focuses on quantifying greenhouse gas (GHG) emissions and removals, and generating technical evidence to support both climate and production policies. Given the socioeconomic importance of the livestock sector and its substantial contribution to national emissions, transitioning toward sustainable production systems aligned with the Nationally Determined Contributions (NDCs) is a priority. The proposed MRV system goes beyond a carbon-centric approach by incorporating indicators across environmental, productive, economic, and social dimensions. This multidimensional framework provides essential information to guide technical decisionmaking, improve farm management, and strengthen governance within the livestock sector. From a One Health perspective, the MRV system integrates variables related to the interdependence of animal, human, and ecosystem health, including soil quality, tree cover, manure management, fertilizer use, and protection of water sources. This approach supports the reduction of environmental risks, the improvement of natural resource quality, and the enhancement of rural food security. Furthermore, monitoring animal welfare, productivity, and resource use efficiency promotes more resilient livestock systems capable of producing safe and nutritious food. Implementing the MRV system will generate reliable data to evaluate sustainability and encourage climate-smart and regenerative practices, contributing to emission reductions, increased carbon sequestration, and greater resilience to climate change. Overall, the MRV approach—based on multidimensional indicators and aligned with the One Health paradigm—constitutes a strategic tool to advance the transition toward sustainable livestock systems.

Keywords: emissions, carbon removal, governance, resilience, One Health

THEMATIC SESSION 4: ECOSYSTEM HEALTH



Wild cats as an instrument of progress and improvement of the livelihoods of livestock families that coexist with them

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Abstract

Without a doubt, one of the main triggers of conflict between humans and wild cats is the predation of livestock by jaguars and pumas. The attention and solution to this problem should normally fall to government authorities responsible for wildlife. However, in Latin America, this has been assumed by NGOs, universities, independent researchers, and other organizations outside the government, resulting in uncoordinated actions with different methodologies and priority areas of action. Despite this, in Costa Rica, thanks to a framework cooperation agreement between the government and the NGO Panthera, the Wild Cat Conflict Response Unit (UACFel; Spanish) was established in 2013. The Unit aims to provide practical solutions and address this problem of predation nationwide in a coordinated, systematic, and organized manner. It is comprised of more than 100 public officials from the National System of Conservation Areas, and is constantly being trained, educated, and consolidated. To date, the project has addressed more than 350 cases of predation across the country and implemented anti-predation strategies in almost half of them, becoming the first public-private partnership in Latin America to address these issues and implement solutions for civil society groups living primarily in rural areas. These strategies prevent predation but also improve the farmers' productive units through improvements in livestock practices and management, adding an extremely important social, economic, and conservation component to this ambitious project. For this reason, a Framework Cooperation Agreement was also signed in 2023 with the Costa Rica Livestock Corporation (CORFOGA), thereby taking the project to a new level. Now, the livestock sector and the conservation sector are working together in coordination, benefiting wild cats and humans alike.

Keywords: jaguar, puma, cattle, coexistence, Costa Rica

Safe roads for all: reducing wildlife-vehicle collisions and ecosystem fragmentation in Costa Rica

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Abstract

Like water, biodiversity can be managed as a flow. A flow that needs special measures to keep its natural movement to coexist with roads. Mitigation measures can make roads safe for wildlife and drivers, by reducing vehicle collisions and reconnecting ecosystems. There is a need to generate strong evidence on the impact of roads on wildlife in biodiverse tropical regions to propose the implementation of mitigation measures. Mesoamerica is a biodiverse region and road expansion and improvement is on the rise. Most of the existing roads in the region were built without Environmental Impact Assessments. So many of the old roads in Costa Rica lack measures to reduce wildlife mortality and to favor biological connectivity. Tapirs, oncillas, an endemic rabbit and many other species; roadkills have been documented on Route 2: Interamericana Sur. Since 2020 road surveys, camera trap monitoring, and interviews are providing information about wildlife distribution and how they are being affected by this road. With the data collected we have an estimate of 3,500 wild animals killed on this stretch of 45 km per year. This information allows us to recommend mitigation measures (clearing of culverts, underpasses, fences for birds and arboreal crossings) to decrease the possibility of road mortality and to ensure connectivity of their populations. The collection of this type of data on an existing road and the subsequent use of this information to request mitigation measures is a new landmark for the country and will be implemented through a collaborative effort between an NGO and several governmental entities.

Keywords: road impact, mitigation, safety, biodiversity

La amenaza invisible: potencial transmisión de enfermedades a felinos pequeños en bosques nubosos de Costa Rica

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Resumen

En los bosques nubosos de Costa Rica habitan cuatro especies de felinos silvestres pequeños: ocelote, caucel, oncilla y jaguarundi, los cuales enfrentan amenazas como la pérdida de hábitat por cambios en uso de suelo (expansión agrícola/urbana) y el riesgo de transmisión de patógenos por parte de carnívoros domésticos (perros/gatos), entre otras. En el bosque nuboso de Monteverde, Puntarenas, la investigación en desarrollo evalúa ese riesgo potencial de transmisión de patógenos, con el objetivo de proponer estrategias de mitigación junto con la comunidad. Mediante encuestas a sus habitantes, se estudia la tenencia de mascotas, su contacto con fauna silvestre y los desafíos que enfrentan en esta temática. Además, se recolectaron muestras biológicas de 78 individuos (28 gatos y 50 perros). Como resultados preliminares, se detectaron mediante pruebas de ELISA comerciales: un gato (3,6%) seropositivo a FIV, un gato (3,6%) positivo a FeLV y cinco perros (10%) seropositivos a *Ehrlichia canis*. Se realizarán análisis moleculares para la detección de material genético de otros patógenos de importancia, para estas muestras y las otras que serán colectadas. Se analizarán datos de fototrampeo sobre animales domésticos y felinos silvestres dentro de áreas protegidas. Como medidas de mitigación, también se están implementando talleres educativos en escuelas con un alcance aproximado de 200 estudiantes y con otras agrupaciones comunales para sensibilizar sobre el bosque nuboso, la importancia de las especies nativas y la amenaza de las introducidas, lo que fomentará la tenencia responsable de mascotas. Además, se realizarán campañas de salud animal (evaluación clínica y medicina preventiva). El estudio sugiere la necesidad de diseñar e implementar estrategias de conservación multidisciplinarias, que incluyen vigilancia sanitaria, educación y participación comunitaria para desarrollar medidas de mitigación del riesgo de transmisión de agentes infecciosos, como planes de manejo de áreas naturales que permitan la coexistencia sin comprometer la estabilidad ecológica de los felinos silvestres.

Palabras clave: Una Sola Salud, conservación, oncilla, Monteverde, tenencia responsable, educación

Biodiversity credits as incentives to promote agroforestry in human dominated landscapes

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Abstract

Agroforestry systems (AFS) are important Nature Based Solutions confronting global environmental degradation as they harmonize productivity with landscape restoration. Complex multistrata AFS hold higher conservation values than more simplified designs and may constitute biodiversity islands (BI) in human-dominated landscapes. Financial incentives are needed to promote AFS, especially for those which provide ecosystem services such as acting as biodiversity islands. We are examining Voluntary Biodiversity Credits (VBC) as an alternative AFS incentive. We focus on AFS with perennial species such as cacao, yerba mate, promoted by PES in Argentina, Brazil, Colombia, and Ecuador. Monitoring methods for baseline and long-term biodiversity gains included remote sensing, drones, camera traps, acoustic sensors, and manual field verification. In the Atlantic Forest region of Argentina, after 35 years of restoration with native trees, the floristic survey recorded 64 tree species and 59 species in the understory, a basal area of 20 m² ha⁻¹ and a carbon stock of 90 Mg ha⁻¹. In another site with yerba mate AFS, an increase in tree species, tree density, and the presence of an understory layer contributed to a higher species richness of forest birds. The promotion of diverse shade trees and stratification of tree cover can contribute to a higher bird diversity. In this region the NGO Aves Argentinas uses the Cultivo Amigo de las Aves (Bird Friendly Crop) seal to promote sustainable yerba mate production that contributes to forest and bird conservation, thus our findings can support the promotion of targeted incentives that benefit bird diversity in agricultural landscapes, including VBC. Choice of components and technologies to monitor biodiversity for VBC depends on objectives, target species, ecosystem, and cost-benefit analysis. Use of third-party verifiers can ensure integrity essential for accessing VBC markets. In all cases VBCs need to cater to each specific context, as well as to farmer preferences.

Keywords: ecosystem services, market integrity, monitoring biodiversity, native species, third-party verification, yerba mate AFS

An analysis of monitoring frameworks for biodiversity payments in agroforestry systems

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Abstract

Ecosystems provide essential services such as flood mitigation, pollination, and carbon storage. As climate change and development degrade natural systems, the ecosystem service of biodiversity conservation is increasingly threatened. Like many ecosystem services, biodiversity remains severely undervalued in supply chains. In response, several groups have developed frameworks that pay landowners for practices that protect or enhance biodiversity. These approaches are of growing interest to agroforestry farmers, as agroforestry systems (AFS) can significantly boost biodiversity at the landscape scale. However, many biodiversity crediting frameworks are still in early stages, face major obstacles in scaling, and depend heavily on how effectively they monitor biodiversity on the ground. Monitoring approaches vary widely across payment providers, raising questions about their ability to deliver meaningful conservation outcomes. To assess the integrity of prominent biodiversity crediting programs, our review examined how existing frameworks measure biodiversity change and evaluated their credibility. We also analyzed resources such as the Global Nature Foundation and the IUCN Database of Global Data Sources for Biodiversity Conservation Monitoring, which focus on tracking biodiversity in agrarian landscapes, including AFS. By examining the strengths and limitations of each framework and resource through literature reviews, program assessments, and professional interviews, we aimed to support the development of more effective and trustworthy biodiversity crediting markets—particularly those that benefit and incentivize AFS farmers working to conserve species diversity. We found that few biodiversity crediting organizations design their monitoring protocols according to the most robust scientific recommendations. Yet as biodiversity-measuring technologies become cheaper and more accurate, it may soon be feasible for more crediting entities to implement monitoring methods that better represent biodiversity change

on working landscapes. In turn, this review offers guidance on how AFS can engage with emerging biodiversity markets and how these markets can improve to more effectively measure and support biodiversity outcomes.

Keywords: conservation investment, ecosystem services, ecological surveying, voluntary biodiversity credits

Perception, determinants, and possible solutions to vertebrate crop pests - example of squirrels affecting cocoa

Abstract

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Agroforestry systems (AFS) reconcile biodiversity and production, by combining companion trees with crops. Such combination enhances ecosystem services delivered by biodiversity to producers, but they can also promote ecosystem disservices when wild species feed on crops or transmit diseases. Cocoa is often produced in AFS in Latin America. Regional producers are concerned about the economic losses that rodents and birds feeding on cocoa pods are causing. To quantify the magnitude of the problem and understand producers' perception of such a problem, we combined three approaches: a literature review on vertebrates affecting cocoa plantations; a pests' incidences monitoring in two cocoa farms in the Caribbean region of Costa Rica, each 2 weeks and for 4 months, in plots varying on their forest proximity; and semi-structured interviews with 35 cocoa producers from the two main production regions of the country about farm features, crop management and history and mitigation of cocoa pests. Between 3% and 39% of cocoa losses to vertebrates in Latin America have been reported in the literature. According to the field monitoring, higher incidences of both squirrels' damages (57% of the bitten pods) and cocoa diseases (41% of diseased pods) occurred in plots close to the forest. Interviews showed that 56% of the farmers think that these losses are increasing and 72% of them mention forest degradation as the main factor to explain it. Farmers surrounded by plots reported fewer losses than those surrounded by other landscape elements ($p = 0.024$). We also report a list of solutions currently used by local producers to deal with this problem that are feasible under the current Costa Rican biodiversity legal framework. Finally, we highlight the lack of knowledge about the state of trophic networks and the risk of disease transmission to humans on this context.

Keywords: agroforestry, wild population control, birds, ecosystem disservices, agronomical management, cocoa black pod disease.

Cattle ranching and bee conservation in the dry tropics of Honduras: Implications for One Health in biodiverse productive landscapes

Abstract

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Traditional extensive cattle ranching has been a major driver of deforestation and structural simplification in tropical dry forests, reducing habitat heterogeneity and threatening pollinator communities. Bees are particularly sensitive to landscape configuration, as their diversity and abundance depend on floral resources, nesting substrates, and habitat connectivity. This study evaluated how contrasting cattle land-use types influence bee community structure along a tree cover gradient in a fragmented tropical dry forest landscape in southern Honduras. Between June and August 2024, six cattle farms were sampled across three land-use types: (i) treeless pastures, (ii) pastures with trees (>30 trees/ha), and (iii) forest fragments. Nine 50x50m transects were monitored three times during the rainy season using standardized pan traps (red, yellow, and blue) and bottle traps deployed for 48 hours. In total, 5,191 bees were collected, belonging to three families (Apidae, Andrenidae, and Halictidae), representing six identified species and eight morphospecies. Species richness (S) and abundance (N) were calculated per transect, and correspondence analysis was applied to evaluate species-habitat associations. Treeless pastures showed the highest abundance, largely driven by dominance of the generalist species *Apis mellifera*, indicating community homogenization. In contrast, forest fragments supported forest-associated taxa and maintained more stable species richness. Tree-rich pastures exhibited intermediate patterns, dominated by native stingless bees, suggesting improved habitat suitability compared to treeless systems. Bee community composition shifted markedly along the structural complexity gradient. From a One Health perspective, increasing tree cover within cattle systems enhances native pollinator diversity and maintains functional connectivity among dry forest remnants, sustaining pollination services. Additionally, tree-based silvopastoral systems improve

microclimatic regulation and pasture resilience, strengthening soil–plant–animal–human system stability. Integrating trees into livestock landscapes represents a viable strategy for reconciling production and biodiversity conservation in tropical dry regions.

Keywords: silvopastoral systems, pollinators, ecosystem services, dry forest, livestock management

Spatio-temporal patterns of land cover change in cattle farms in three zones of Honduras using Sentinel-1 and Sentinel-2 satellite imagery

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Abstract

Cattle meat and milk production are two of the most important economic activities in Honduras. However, detailed spatial information on cattle farm boundaries and land-use dynamics is limited. This lack of geographic data would have effects on monitoring of land use change and the territorial planning. This study aimed to map cattle farm polygons and measure the vegetation change across three regions: Southern (ZS), Northern (ZN), and Central (ZC). Farm boundaries were collected by trained field facilitators using the Area Measure application, then the information collected was converted from KML to shapefile format, and integrated into different regions. Spatial datasets from Optical Satellite Imagery (Sentinel-2) and Radar Satellite Imagery (Sentinel-1) were processed in Google Earth Engine, where a Random Forest classification (Kappa: 0.986–0.996) was applied to satellite imagery between 2020 and 2024 to establish difference of vegetation from non-vegetation. Using Python Software, continuous vegetation patches larger than 0.5 hectares were calculated to evaluate landscape structure and change. Results show regional variation in vegetation dynamics. The Northern region (n=315; total area= 10 102.88 ha) showed the largest total area of change, while the Central (n=169; total area= 5 873.39 ha) and Southern (n=82; total area= 1 938.73 ha). All regions show patterns of loss and gain of vegetation associated with pasture expansion and cropping. This research provides one of the first spatially explicit assessments of cattle farm distribution and vegetation change in Honduras. The results of this research will be used for monitoring, sustainable livestock management, and land-use planning at regional scales.

Keywords: cattle production, land use/land cover change (LULCC), remote sensing, land management

THEMATIC SESSION 5: WATER HEALTH (ONE WATER FOR ONE HEALTH)



One Health, One Water, and chemical pollution in Costa Rica: closing gaps between environmental quality and public health

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Abstract

Drawing on the interdisciplinary experience of the Instituto Regional de Estudios en Sustancias Tóxicas (IRET), this keynote contribution examines how the principles of One Health and One Water can be applied to understand and address anthropogenic pollution in Costa Rica. One Health is approached as an evolving concept of health that recognizes the interdependence of human, animal, and ecosystem well-being, while also incorporating equity, ecological balance, stewardship, and transdisciplinarity. One Water complements this perspective by emphasizing that all water forms are interconnected throughout the hydrological cycle and must be managed integrally rather than as isolated sectors such as drinking water, wastewater, or surface water. Within this framework, aquatic ecosystems are presented as critical interfaces linking environmental integrity and human health. They regulate climate, purify water, sustain biodiversity, buffer erosion, support food production, and contribute to mental and social well-being. However, these functions are increasingly threatened by anthropogenic pollutants, particularly nutrients, plastics, and toxic chemicals. Chemical pollution is especially challenging because the number, diversity, and transformation pathways of contaminants far exceed current capacities for assessment, monitoring, and removal. This creates a major obstacle for both One Health and truly circular or integrated water management. Costa Rica provides illustrative examples of these tensions. Research on the Virilla River shows that as urban influence increases downstream, water quality declines and antimicrobial resistance becomes more frequent and mobile within bacterial communities, including resistance genes located on transferable plasmids. This suggests that polluted rivers may act as reservoirs and transmission pathways of resistance affecting vulnerable communities, wildlife, and protected areas. At the same time, pesticide contamination has become an acute concern for both drinking water and aquatic ecosystems. Residues linked to intensive agricultural production have been associated with recurrent contamination of water sources,

community-level water insecurity, fish mortality events, ecological risk in Caribbean wetlands, and contamination even in high-elevation sentinel lakes likely affected by atmospheric transport. This contribution argues that these problems are not only technical but institutional and political. Current regulations for drinking water, surface water, effluent discharge, and pesticide registration remain fragmented, with limited feedback between monitoring, risk assessment, and prevention. A One Health–One Water approach therefore requires stronger environmental surveillance, inclusion of antimicrobial resistance in water monitoring, protection of water sources, integration of regulatory frameworks, and explicit pesticide reduction goals. For countries such as Costa Rica, prevention and ecosystem protection are not optional: they are the most realistic and equitable public health strategy.

Keywords: One Health, One Water, chemical pollution, antimicrobial resistance, pesticide residues

Integrated assessment of the Durazno river watershed: a comprehensive study

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Abstract

Improper disposal and overuse of antibiotics pose a threat to global health, leading to calls for increased surveillance due to the rise of antibiotic resistance (1,2). In Costa Rica, untreated wastewater from homes, industries, and agriculture is frequently discharged directly into rivers, introducing antibiotics and generating resistant bacteria within aquatic ecosystems (3). The Durazno River micro-basin (12 km²) in Vásquez de Coronado serves as a source of drinking water, but it is suspected to be microbiologically contaminated due to land-use activities. The Durazno River is part of the Grande de Tárcoles River Basin, the most polluted river basin of the country. Key concerns include water quality and the potential presence of emerging contaminants, particularly extended-spectrum tetracyclines and beta-lactams used in clinical and agricultural contexts, along with antibiotic resistance genes (ARGs). There are concerns regarding the use of certain antibiotics, such as extended-spectrum tetracyclines (ES-TCs) and beta-lactams (BL), in both clinical and agricultural settings. Given that the Durazno micro-basin is situated near urban areas and has various land uses, it is essential to adopt an interdisciplinary approach to assess its water quality. This research project aims to evaluate the water quality in the Durazno micro-basin using 23 physicochemical and three microbiological analyses, also detecting emerging contaminants such as antibiotics and resistance genes, and conducting environmental risk assessments. We have been working in the area since 2021. Based on the physicochemical parameters, the water quality appears to be acceptable according to Costa Rican legislation. However, the CCME-WQI proved to be a more sensitive index, classifying water quality as marginal to poor and revealing clear differences between sites and seasons. Variations in water quality occur between sampling points, which can be attributed to differences in land use or soil types. From a microbiological standpoint, the water is unsuitable for human consumption. The tests also detected doxycycline (DC) and cefotaxime (CT) in concentrations ranging from 2.13 to 11.74 ng L⁻¹ and 0.68 to 1.20 ng L⁻¹, respectively. This marks the first time cefotaxime has been detected in Costa Rican water. The

occurrence of emerging contaminants was higher in areas with livestock or urban activity, confirming the influence of anthropogenic activities. We have found evidence of antibiotic resistance in the surface waters of the Durazno River. Since 2022, we have detected the presence of *E. coli* bacteria resistant to multiple antibiotics, including tetracycline, beta-lactams, and sulfonamides. In some instances, the bacteria have also shown resistance to β -lactam antibiotics and quinolones. These results have been consistent throughout 2024, with some bacteria even exhibiting resistance to as many as six or seven antibiotics simultaneously. This poses a significant risk to the environment, as the contamination can affect the resistome of the river's surface waters. We intend to continue researching and integrating more geological and environmental information in the years to come. Additionally, we are working with CATIE to model the behavior of emerging contaminants and resistance genes, taking into account the water, land use and erodible material in the micro-basin.

Keywords: antibiotic resistance, emerging contaminants, surface water quality, agricultural and urban pollution, Durazno River micro-basin

Hydro-climatic risk and vulnerability mapping of asada-managed watersheds in Costa Rica to strengthen local resilience and soil-water security

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Abstract

In the context of climate variability and its impacts on rural water security, the “Resilient ASADAs” project analyzed hydro-climatic risks and territorial vulnerabilities across 60 micro-watersheds managed by local ASADAs (Rural Water Supply Associations) in the central region of Costa Rica. The objective was to evaluate the territorial, hydrological, and hydro-meteorological conditions of the micro-watersheds supplying their aqueduct systems, generating spatially explicit data to support climate adaptation planning and ensure long-term water supply under changing climatic regimes. A geospatial, hydrological, and hydro-meteorological analytical framework was implemented to assess threats and vulnerabilities related to water resources in the supplying micro-watersheds. This approach combined high-resolution digital elevation models, territorial databases, historical and projected meteorological records (from the National Meteorological Institute and adjusted and validated WorldClim data), and hydro-meteorological hazard modeling algorithms (landslides, sedimentation, non-point source pollution). Indicators analyzed included the Aridity Index (AI), Climatic Balance (CB), Non-Point Source Pollution Index (ICNP), sediment export potential, and landslide susceptibility, synthesized into a Total Vulnerability Index (TVI). Climate change scenarios (SSP2.6 and SSP8.5) were integrated to project precipitation and temperature trends up to 2040. Results revealed a significant increase in the frequency of months with water deficits during the dry season and extreme precipitation events, negatively affecting aquifer recharge and increasing risks to local hydraulic infrastructure. Considerable vulnerability variability among micro-watersheds was also identified, with many exhibiting high susceptibilities to diffuse pollution, sediment transport, and landslide risk. Integrating projected increases in extreme dry and wet events with hazard zoning, local infrastructure, and recharge areas allowed identification of critical zones requiring

nature-based adaptation strategies. Findings highlight the necessity of managing sediment transport, land cover, and recharge areas to preserve not only water quantity and quality but also long-term soil functionality. The study presents a replicable model linking watershed diagnostics with community-led climate adaptation and sustainable landscape governance.

Keywords: climate adaptation, watershed resilience, ASADA, soil-water interface

Wetlands as One Health pillars: climate adaptation pathways and inclusive governance for resilient socio-ecological systems

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Abstract

Wetlands are undergoing accelerated degradation under intensifying climate change, which increases hydrological variability, drives ecosystem fragmentation, and weakens essential services supporting human, animal, and environmental health. These changes undermine water regulation, heighten exposure to extreme events, elevate pathogen transport, and reduce biodiversity, thereby eroding the One Health foundations of socio-ecological systems. This study aims to identify effective climate adaptation pathways demonstrating how wetland restoration and conservation, implemented as nature-based solutions, can strengthen resilience and generate measurable One Health co-benefits. Our study focuses on temperate wetlands in Poland (Central Europe), where intensive agriculture, drainage systems, and hydromorphological alterations have disrupted water cycles and ecological integrity. We applied an integrated, multi-scale methodology combining GIS-based hydrological modelling, ecological functional assessments, and field-validated water balance analyses to quantify the effects of wetland restoration. A complementary socio-economic and governance evaluation, including stakeholder interviews and policy gap analysis, was conducted to identify barriers and enabling conditions for large-scale implementation. Results indicate that re-wetting degraded peatlands, restoring river-floodplain connectivity, and protecting small lentic water bodies attenuate outflow, increase water retention by 0.1–2% of the total annual river runoff (corresponding to 60–350 m³·ha⁻¹ of additionally retained water), and improve water quality through natural filtration. These interventions also enhance key ecological functions, including nutrient cycling, habitat provisioning, and the recovery of water-dependent species, reinforcing One Health outcomes. Long-term effectiveness relies on governance models that involve local communities and incorporate ecological knowledge into decision-making. When combined with adaptive policy measures,

these approaches support fair and sustainable transitions toward more resilient socio-ecological systems. This study highlights wetlands as critical components of the One Health framework and provides evidence-based climate adaptation pathways to inform integrated landscape management and regional policy development. The study was funded by the Minister of Science under the Regional Initiative of Excellence Program.

Keywords: wetland restoration, nature-based solutions, hydrological connectivity, socio-ecological resilience

Transforming community water governance in Ecuador: Partnerships, gender and livelihoods

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Abstract

Indigenous territories in the Andean and Amazon regions of Ecuador face a persistent paradox: significant investment in rural water infrastructure coexists with unsafe household water, chronic child malnutrition, and a high prevalence of waterborne disease. This study examines how strengthening community water governance, with an emphasis on women's leadership, converts infrastructure investments into sustained health and livelihood benefits. Specifically, we analyze a multi-sector partnership model led by Fundación Ingenieros en Acción – Ecuador (FIEA–Ecuador) that links Community Water Boards, municipal governments, health services, and international NGOs to improve decision-making mechanisms. Using a community water governance lens, we integrate baseline and ex-ante evidence collected with a Sustainable Livelihoods Assessment Tool in six Indigenous communities, complemented by household WASH surveys, focus groups, and participatory governance mapping of actors, decision points, and coordination flows. Results show increased women's representation in Water Boards (approaching a 50% target) and documented governance changes, including the creation of new leadership roles for women, formalized tariff-setting procedures, strengthened operation and maintenance routines, and clearer coordination protocols with local health services. These institutional adjustments were associated with improved tariff collection, better hygiene behaviors, reductions in self-reported diarrheal disease, household time savings, and strengthened productive activities. The findings indicate that infrastructure alone is insufficient; social capital, particularly women's leadership combined with structured intersectoral partnerships is essential to sustain services. By reinforcing links between water security, community health, and ecosystem wellbeing, the model offers a

replicable One Health aligned pathway for Indigenous rural contexts, contingent on legal recognition of community bylaws and platforms bridging community priorities with public policy.

Keywords: indigenous water governance, women's leadership, WASH, rural partnerships, water systems, One Health

Academic contribution to public policy: Opportunities to integrate One Health in watersheds of Paraguay

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Abstract

Water resources in Paraguay face multiple challenges due to the ongoing degradation of both rural and urban watersheds, highlighting the need to strengthen water governance through the active involvement of stakeholders and the use of standardized procedures for watershed management. In this context, and considering the growing relevance of integrated approaches such as One Health, this research was conducted as part of the Master's Program in Watershed Management and Governance at CATIE during 2024. Its purpose was to develop a methodological guide to support the formulation of watershed management plans in Paraguay and to analyze the institutional opportunities for progressively incorporating a One Health perspective into watershed planning. The study employed a qualitative approach and included the review and analysis of national laws, resolutions, and technical guidelines; a comparative analysis of regional methodologies; 12 in-depth interviews with officials from the Ministries of Environment of Colombia, Panama, and Paraguay, as well as other key actors; 2 focus groups; 1 expert panel; and 6 technical meetings with academic experts, Water Council representatives, and public institutions. This process made it possible to assess the national institutional context, the feasibility of adoption, and key methodological elements for the guide. The resulting guide is structured into three main components and four stages, and proposes toolboxes designed to support social actors throughout the planning process. The analysis also identified favorable conditions for integrating One Health-related considerations into watershed governance through participatory processes, inter-institutional dialogue, and the articulation of local knowledge with technical criteria. Following the defense of the final research work, the guide was formally presented to the authorities of the Ministry of Environment, who issued a favorable opinion and confirmed its applicability to the national context. As an academic achievement, it was

subsequently institutionalized through Resolution No. 339/2025 of MADES. The One Health approach is incorporated into the guide as an operational framework, enabling the identification of health determinants through integrated diagnostics that include environmental and sanitary variables, the prioritization of issues related to water contamination, food safety, and vector exposure, and the formulation of coordinated preventive actions. Watershed management is thus consolidated as a territorial platform for surveillance, prevention, and the reduction of health risks, strengthening the ecosystem services that sustain human well-being and promoting healthy watersheds as the foundation for healthier lives.

Keywords: governance, territory, participation, resilience, social actors

Impacto del Distrito de Riego Arenal-Tempisque en el Corredor Seco Centroamericano

Resumen

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El Corredor Seco Centroamericano enfrenta un desafío estructural vinculado con la escasez y alta variabilidad climática. Es una zona que sufre sequías recurrentes y también lluvias extremas, situación que incrementa la vulnerabilidad económica y social de comunidades cuya subsistencia depende principalmente de la actividad agropecuaria. Paralelamente, las limitaciones en infraestructura y gestión del recurso hídrico dificultan el acceso seguro y continuo al agua potable, lo que restringe las oportunidades de desarrollo en otros ámbitos sociales y productivos. En la provincia de Guanacaste, esta problemática se manifiesta en dos dimensiones críticas: por un lado, la alta exposición del sector agropecuario a sequías prolongadas que afectan la productividad y la seguridad alimentaria y, por otro, la insuficiente cobertura y calidad del servicio de agua potable para una población en crecimiento, especialmente en zonas rurales y costeras. El objetivo del presente estudio es analizar el impacto del Distrito de Riego Arenal-Tempisque (DRAT), en sus componentes de riego agropecuario y abastecimiento de agua potable, como instrumentos estratégicos de gestión hídrica y desarrollo sostenible en la región. La metodología empleada comprendió una revisión documental de datos operativos del DRAT, proyecciones técnicas de su ampliación mediante el Proyecto Agua para la Bajura y los avances del Convenio de Cooperación Interinstitucional suscrito entre el Instituto Costarricense de Acueductos y Alcantarillados (AyA) y el Servicio Nacional de Aguas Subterráneas, Riego y Avenamiento (SENARA) para el diseño del Componente de Agua Potable (CAP). Actualmente, el DRAT brinda servicio de riego a aproximadamente 32 000 ha, lo que beneficia de forma directa a alrededor de 1000 productores dedicados a cultivos de caña de azúcar, arroz, pastos, piscicultura y producción diversificada. Con el Proyecto Agua para la Bajura, proyecta incorporar 17 000 ha adicionales bajo riego y ayudaría a cerca de 600 productores en los cantones de Carrillo, Santa Cruz y Nicoya, lo cual representa una ampliación sustancial de la frontera agrícola con disponibilidad hídrica regulada. En materia de agua potable, el CAP

impactará un área aproximada de 99 430 ha y beneficiará a 80 sistemas de abastecimiento: 22 administrados por el AyA y 58 por ASADAS, mediante la potabilización del agua en la comunidad de Palmira, recurso hídrico que será aportado desde el Canal Oeste de SENARA, con una proyección de cobertura poblacional al año 2050 de 304 144 personas. El estudio registra un avance de 92% en la factibilidad del CAP, con inicio de construcción proyectado para octubre de 2028 y finalización en octubre de 2031. En conjunto, el DRAT y su ampliación con el proyecto Agua para la Bajura constituyen una estrategia integral de adaptación y resiliencia hídrica en el Corredor Seco Centroamericano al fortalecer la seguridad alimentaria, reducir la vulnerabilidad socioeconómica ante la variabilidad climática y mejorar la calidad de vida de la población guanacasteca.

Palabras clave: Riego, agua potable, seguridad hídrica, desarrollo agropecuario, Guanacaste

Agua Tica: A water fund based in scientific data measurement

Abstract

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Water scarcity—in terms of both quantity and quality—has become a major issue for water users in the Mesoamerican Dry Corridor, increasing their dependence on groundwater sources. Since 2018, the Agua Tica (AT) Initiative, the first public–private–civil society water fund in Costa Rica, has been responsible for conducting baseline surveys to assess the current conditions of the Virilla and Grande river sub-basins, using science as the foundation for achieving water security objectives. Agua Tica employs different technologies, such as GIS and drones, to run models including the Universal Soil Loss Equation (USLE). Drones are used to assess forest cover conditions and to calculate the Normalized Difference Vegetation Index (NDVI). Water quality is evaluated using physicochemical and bacteriological parameters (fecal coliforms and *E. coli*), through multiparameter field equipment and laboratory analyses based on Decree No. 33903-MINAE-S. Results indicate that in a pilot area of 1 200 ha located in Costa Rica's Central Valley, total infiltration yielded approximately 1 254 000 m³ ha⁻¹ of water replenished per year between 2014 and 2025. Water quality measurements across farms and sampling sites showed extreme values of total fecal coliforms ranging from 11 to 2 400 NMP 100 mL⁻¹, and *E. coli* values ranging from 2 to 2 400 NMP 100 mL⁻¹, depending on whether samples were taken during the dry or rainy season. These results allowed the mapping of the forest cover–water cycle–water quality nexus. Additionally, AT has established a hydrometeorological station network throughout the area of influence (AOI), collecting real-time data on evapotranspiration, temperature, rainfall, wind direction, among other variables. In conclusion, Agua Tica has enabled the development of a science-based methodology in which each dollar invested can be translated into a robust investment portfolio, prioritizing intervention areas. These results can be easily incorporated into corporate sustainability KPIs related to water use, thereby securing future funding.

Keywords: water quality, infiltration, USLE, *E. coli*, land use, forest, replenishment, investment portfolio.

Coffee processing by-products: production and economic valorization in the Trifinio Region

Abstract

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Coffee processing generates 40.68 million tons of waste per year globally, and its inadequate management pollutes water sources and ecosystems. Circular economy approaches offer alternatives for their valorization, yet there remain significant information gaps regarding mass flows and the potential economic value of these residues under different transformation pathways. This study analyzes the operations and mass flow of wet coffee processing, from harvest to consumption, based on interviews with operators from 42 coffee mills in the Trifinio Region, which represent approximately 70% of all commercial coffee mills in the region. These data, along with official figures on green coffee production, enabled estimates of total waste generation. Additionally, the benefit transfer valuation method was used to estimate the potential economic value of waste under various valorization pathways. Results show that, for every 100 kg of fresh coffee cherries, 73.2 kg become waste, 24.08 kg are lost as vapor during drying and roasting, and only 2.71 kg are ultimately consumed as beverage. Annual production is estimated at 224 501 Mg of pulp, 64 703 Mg of fresh mucilage, and 20 130 Mg of parchment, although only 50% is recovered at the mills. The pathways with the highest gross revenues include the extraction of functional compounds such as pectin, caffeine, and cellulose (USD 173–202·Mg⁻¹), charcoal for energy purposes (USD 117·Mg⁻¹), and cultivation of edible mushrooms (USD 98·Mg⁻¹). However, valorizing these residues requires overcoming technical, financial, knowledge, and market barriers, which calls for supportive policies, economic investment, and feasibility studies. This study provides a scientific foundation for assessing the economic viability of circular economy initiatives in the coffee sector.

Keywords: mass flows, circular economy, coffee waste, valorization pathways, coffee mills.

Reduction of environmental impacts through the valorization of coffee by-products in Gaitania (Planadas, Tolima, Colombia)

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Abstract

Coffee farming in Gaitania generates a large amount of organic waste with low levels of reuse, which significantly contributes to soil and water source contamination in the area. This study aimed to analyze the potential for the valorization of coffee by-products to reduce these environmental impacts while generating sustainable business models based on the principles of the bioeconomy. A mixed-methods approach using both inductive and deductive methods was applied across 69 farms located in five rural districts (veredas), through surveys, semi-structured interviews, participatory tools, and univariate analysis by district. The sampling design was non-probabilistic by quotas and considered both quantitative and qualitative variables. The value chain mapping revealed critical points in waste management and allowed for the characterization of current practices among coffee growers. Although 46% of producers acknowledge that coffee by-products can be used to create alternative products, a considerable gap remains between this recognition and effective action. Coffee pulp is the most reused by-product (30%), though 65% of its potential use remains untapped. It is followed by coffee stems and husks, both with 20% utilization. In contrast, mucilage and coffee grounds are the least reused, with only 5% effective circular use each. Furthermore, 89% of coffee growers do not reuse the honey water resulting from coffee processing. Based on the results, a participatory portfolio of 25 scalable bio-business models was designed, suitable for small, medium, and large-scale implementation across different market segments. It is concluded that the valorization of coffee by-products offers a strategic pathway to mitigate the environmental burden of coffee production, foster local innovation, and strengthen rural livelihoods.

Keywords: sustainable agriculture, bioeconomy, circular economy, agricultural by-products.

Scientific research on nature-based solutions for water management in banana, plantain, and pineapple

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Abstract

In Central America, banana, plantain, and pineapple supply chains face several water management (WM) challenges. Nature-Based Solutions (NbS) are environmentally sound alternatives to conventional (gray) infrastructure. Advances in NbS scientific research remain poorly documented. This study systematizes recent scientific research on NbS related to WM in the production, post-harvest and processing of these three fruit chains. Drawing from a systematic review using the PRISMA 2020 protocol, 42 scientific articles published between 2020 and 2024 were screened, selected, and analyzed to identify recurring NbS for WM (input, content, ingredient, solvent, or pollutant adsorbent). A thematic inductive method was complemented by a deductive analysis of the topics researched and the investigation methods. The scientific articles on NbS related to WM were focused on the processing stage. For bananas and plantains, the most frequent topics were the bioadsorption-based removal of water contaminants, the use of by-products and residues, and innovation in fruit applications as a product. And, for pineapples, the use of by-products and residues was the most frequent topic. We conclude that recent scientific research identifies various potential NbS for these agri-food chains in Central America, especially the agroindustry. These NbS approaches contribute to the One Water for One Health paradigm by linking water quality improvements to ecosystem, agricultural livelihoods and human health benefits. Abundant basic research is available on the use of banana/plantain (leaf/peel powder, solutes, starch) as a natural water decontaminant. Despite the availability of laboratory-based studies, applied research for implementing NbS at the farm and landscape level remains limited. Field-scale experimentation and validation are key to bridging gaps in the operation of water systems. The resulting investigations' typology is an input for development and innovation in these value chains on

WM, including combinations with grey infrastructure, and on value addition and circularity in banana/plantain. Further research on applied WM NbS is needed, especially for waterlogging (e.g., ecosystem management as part of drainage maintenance), and, in pineapple farms, soil erosion/land degradation (e.g., green mulch, biocontrol).

Keywords: Musa, Ananas, water treatment, PRISMA, systematic review, circular economy.

Volver a la fuente: Gobernanza y restauración socioecológica para la seguridad hídrica y agrícola

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Resumen

En un adecuado manejo del suelo agropecuario radica buena parte de la solución para la seguridad hídrica, alimentaria, climática y de resiliencia territorial. A pesar de las numerosas evidencias positivas, escalar la agricultura regenerativa a todo un territorio sigue siendo un gran desafío, ya que el conocimiento técnico por sí solo no garantiza su adopción. La complejidad de los factores limitantes demanda mecanismos de gobernanza robustos, con enfoque de paisaje, que articulen actores, fortalezcan liderazgos y generen condiciones habilitantes para el cambio. Este estudio indaga sobre limitantes y catalizadores en la adopción de la agricultura regenerativa y la gestión hídrica efectiva, a partir del fomento de procesos de gobernanza local en el cerro Cacahuatique, El Salvador. Mediante el uso de la teoría de los sistemas socioecológicos, la metodología de Investigación-Acción-Participativa (IAP) y una serie de proyectos de la ONG CRS como instrumento de acción, se impulsó durante 6 a 10 años un proceso de fortalecimiento de la gobernanza hídrica, basado en el enfoque de protección de áreas de recarga hídrica. La estrategia se centró en tres líneas: fortalecer capacidades de operadores comunitarios y municipales de agua, promover la articulación entre operadores y otros actores e impulsar prácticas de agricultura regenerativa en zonas de recarga. Como parte de este proceso, se crearon tres Fondos de Agua y Agricultura como plataformas multiactor, con participación de alcaldías, operadores de agua, ONG, productores e instituciones públicas. Además, se levantó información mediante una encuesta de 53 preguntas aplicada a más de 1000 habitantes del territorio. Entre los principales hallazgos, cabe destacar que más de 50 juntas comunitarias rurales de agua invirtieron tiempo y recursos en acciones de protección de fuentes, más de 800 productores fortalecieron capacidades en prácticas agrícolas climáticamente inteligentes en zonas de recarga, con incidencia en más de 1200 ha y 40 comunidades mejoraron su abastecimiento de agua en términos

administrativos y operativos. También se observó que algunos espacios de articulación no alcanzaron los resultados esperados e, incluso, solo uno de los Fondos de Agua se mantuvo activo, lo que evidenció que la falta de liderazgo y cohesión social limita la sostenibilidad de estas plataformas. La investigación concluye que la restauración ambiental efectiva requiere también restaurar el capital y tejido social mediante intervenciones integrales y de largo plazo. Volver a la fuente es un llamado a proteger las tierras de donde proviene el agua y a forjar personas y sociedades capaces de impulsar un cambio positivo.

Palabras clave: Agricultura regenerativa, sistemas socioecológicos, fondos de agua, cohesión social, El Salvador

THEMATIC SESSION 6: AGRI-FOOD SYSTEMS AND HUMAN HEALTH



One Health and smart agriculture for a resilient planet Agroecological Crop Protection offers a “One Health-smart” solution to agriculture-bound human infectious disease risks

Abstract

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The One Health (OH) concept, which emerged in 2004 as a unifying approach recognizing the interdependence among the health of humans, plants, and ecosystems, has facilitated the response to global health threats, such as recent zoonotic pandemics. Although supposedly included in this concept, the health of cultivated plants in agroecosystems has been largely ignored as compared to human, animal, or even natural ecosystem health. This questions the relevance of further extending the OH concept to crop plant health. Among the many ways in which crop protection (CP) practices may affect human and farm animal health, their interactions with human infectious disease risks (viral, bacterial, parasitic, or fungal) are most relevant to the OH concept. We therefore conducted a series of literature reviews on these interactions. However, since agricultural practices not aimed at CP per se may indirectly affect pests or pathogens, plant health via effects on plant physiology, and human health by increasing infectious hazards, we also conducted a comprehensive review of those latter interactions. Our analyses were conducted by type of agricultural practice, using the Efficiency-Substitution-Redesign conceptual framework. The review on practices other than CP highlighted that conventional and Efficiency-based strategies resulted in mixed impacts, while Substitution- and Redesign-based strategies resulted in negative impacts, mainly due to bacterial contamination via irrigation with wastewater and fertilization with livestock manure and human excreta/sewage sludge. However, technical solutions exist to mitigate these negative impacts. Conversely, the first series of reviews generally stressed the irrelevance of conventional and Efficiency-based (mostly agrochemical) practices, the relevance of some Substitution-based practices (mainly by genetic, physical/mechanical or bioprotection methods), and of most

Redesign-based CP practices, with Agroecological Crop Protection (ACP) as the preferred strategy to integrate crop plant health via agroecosystem health, within an extended OH framework.

Keywords: agroecosystem, bacteria, E-S-R framework, pesticide, zoonosis

La FAO y el enfoque Una Salud: visión, estrategias y acciones

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Resumen

La creciente interconexión entre la salud humana, animal, vegetal y ambiental, junto con la intensificación de los riesgos sanitarios, climáticos y ecológicos, plantea importantes desafíos para la sostenibilidad de los sistemas agroalimentarios en Mesoamérica. En este contexto, el enfoque de Una Sola Salud (*One Health*) se consolida como un marco estratégico para abordar de manera integrada amenazas como las enfermedades zoonóticas, las plagas transfronterizas, la resistencia a los antimicrobianos, la degradación ambiental y los riesgos para la inocuidad alimentaria. Esta presentación expone la visión, las estrategias y las acciones de la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO) en la implementación del enfoque Una Sola Salud en la región, lo que destaca su contribución a la transformación sostenible de los sistemas agroalimentarios. Se describen las principales áreas de intervención de la FAO, las cuales incluyen la gestión integrada de enfermedades prioritarias, la bioseguridad en los sistemas productivos, el fortalecimiento de la gobernanza y las capacidades institucionales, así como la preparación y respuesta ante emergencias sanitarias. Asimismo, se analizan ejemplos recientes de amenazas sanitarias en los ámbitos animal, vegetal y acuático, tales como la reaparición de enfermedades transfronterizas, la expansión de plagas y el impacto del cambio climático, que evidencian la necesidad de respuestas intersectoriales, coordinadas y basadas en evidencia científica. La presentación resalta el papel de la FAO como miembro de la asociación cuatripartita, que apoya a los países en la adopción de políticas, marcos normativos y mecanismos de coordinación bajo el enfoque Una Sola Salud. Finalmente, se discuten vías futuras para fortalecer la prevención y gestión de riesgos, e incluye la digitalización, el uso de herramientas de inteligencia artificial, la comunicación del riesgo y la inversión sostenida en los sistemas públicos de sanidad. Estas acciones son clave para mejorar la resiliencia, proteger la biodiversidad y salvaguardar la salud de las personas.

Palabras clave: Sistemas agroalimentarios sostenibles, plagas y enfermedades transfronterizas, resistencia a los antimicrobianos, gobernanza del riesgo sanitario

Question bank on food and nutrition security: a starting point for decision-making

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Abstract

Evidence-based decision-making requires defining the public issue, identifying the needs for data and information, assessing existing information systems that manage, store, and provide data, and considering institutional regulations, as well as national plans, programs, and projects. In Guatemala, chronic malnutrition in children under five years of age is 46.5%, with departmental prevalence reaching as high as 70%. The causes of chronic malnutrition are multifactorial and are classified as immediate, underlying, and structural. The objective of this work is to provide a methodology and an information tool for the collection, classification, and prioritization of questions derived from public policies related to nutrition and food security, which can be answered using available data and information to provide evidence. The methodology enabled the organization of focus groups to identify questions emerging from the National Food and Nutrition Security Policy, aiming to explain the behavior or contribution of multisectoral interventions for malnutrition prevention—specifically, the prevention of chronic malnutrition. The questions were then grouped by similarity and prioritized based on immediate data and information needs. Working teams were organized for data management, processing, and analysis, to present timely information for decision-making, disaggregated by territory, target population, nutritional status, public investment, among other types of data and information. Results: Anthropometric data on the nutritional status of children under five years of age by municipality at the national level; per capita municipal public investment in food and nutrition security for children under five. Conclusion: Administrative data facilitates evidence-based decision-making.

Keywords: stunting, multifactorial, administrative data, anthropometry, public spending, municipal.

Valoración cultural, ecológica y nutricional de plantas nativas para fortalecer la seguridad alimentaria en Mesoamérica

Resumen

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El Proyecto ALINA (Alimentos Nativos: La Clave para una Alimentación Nutritiva y Sustentable) tiene como propósito identificar y valorar la fitodiversidad que forma parte de la dieta mesoamericana en Belice, El Salvador, Guatemala y Honduras. El primer paso fue la construcción de tres bases de datos fundamentales. La primera documenta 11 390 especies de plantas nativas y endémicas de los cuatro países, donde destaca Guatemala con 9159 especies. La segunda integra información de CITES sobre especies protegidas. La tercera registra 583 especies comestibles clasificadas en 12 grupos de comida y ocho de bebida, organizadas en categorías como verdura, fruta, condimento, nixtamal e infusión. El estudio aplicó los métodos de valoración cultural y ecológica que posicionaron el maíz (*Zea mays*) como la especie de mayor importancia, seguido del jocote (*Spondias purpurea*), el chipilín (*Crotalaria longirostrata*), la hierba mora (*Solanum americanum*) y la chaya (*Cnidoscolus aconitifolius*). Luego, se analizó la distribución potencial de cinco especies prioritarias para la alimentación de los países estudiados, como chipilín, amaranto (*Amaranthus* spp.), chaya, hierba mora y nopal (*Opuntia* spp.). La metodología empleó modelos de distribución de especies mediante el algoritmo MaxEnt y utilizó registros de presencia de GBIF y 19 variables bioclimáticas de World Clim junto con datos de elevación. Los registros se filtraron para eliminar duplicados y reducir la autocorrelación espacial. Los resultados indicaron que la estacionalidad de precipitación (BIO15), la estacionalidad de temperatura (BIO4) y el rango diurno medio (BIO2) son las variables más influyentes en la distribución de estas especies. Todos los modelos obtuvieron valores de AUC superiores a 0,86, lo que indica una alta confiabilidad predictiva. Los mapas resultantes muestran las zonas con mayor probabilidad de presencia de cada especie, lo que constituye una herramienta para orientar estrategias de conservación.

y aprovechamiento sostenible de la biodiversidad alimentaria regional. Actualmente, la investigación continúa y se está elaborando un libro para presentar las plantas silvestres comestibles en un formato accesible para todo público, que incluye un recetario centrado en especies nativas.

Palabras clave: Dieta mesoamericana, conocimiento ecológico tradicional y servicios ecosistémicos

Nature-based solutions with potential co-benefits for addressing climate change and antimicrobial resistance: a scoping review

Abstract

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Antimicrobial resistance (AMR) and climate change are two intersecting global crises with devastating implications for environmental and public health, particularly in low- and middle-income countries. However, current policy and scientific approaches often address these issues in isolation, missing opportunities for integrated solutions. This study aimed to explore the potential of Nature-based Solutions (NbS), ecosystem-based interventions such as restoration, protection, and sustainable management of natural systems, to deliver dual mitigation benefits for both AMR and climate change. A scoping review of peer-reviewed literature was conducted using PRISMA-ScR guidelines to identify relevant studies linking NbS to AMR- and climate-related outcomes across sectors including agriculture, water management, aquaculture, and urban systems. The findings were further enriched through four multisectoral roundtables held in Europe, Asia, and Africa between 2023 and 2024, engaging 46 experts from public health and clinical care, veterinary medicine, agriculture and aquaculture, environmental sciences, governance, policy, and the social sciences. Several NbS interventions were found to simultaneously reduce greenhouse gas emissions and address environmental drivers of AMR, such as antibiotic pollution and resistant pathogens in water systems. These include constructed wetlands, vegetative buffers, mangrove restoration, improved manure management, biochar systems, and integrated agroecological practices. However, important gaps remain in empirical evidence, especially in assessing co-benefit effectiveness, trade-offs, and the integration of AMR into NbS frameworks. Insights from the roundtables further highlighted that successful implementation depends not only on technical feasibility, but also on enabling systems such as inclusive governance, integrated monitoring, context-specific research, equitable financing, and the recognition of local and traditional knowledge through a Just Transitions

lens. The study concludes that NbS hold promise for addressing AMR and climate change concurrently, but their implementation requires greater policy alignment, cross-sectoral collaboration, and context-sensitive evaluation metrics. These findings offer a stronger foundation for developing community-driven pilot interventions and for advancing more equitable, integrated, and high-impact NbS strategies in vulnerable regions.

Keywords: natural systems, ecosystem-based interventions, ecological health, adaptation, global South.

Integrating surveillance of antimicrobial resistance in the agrifood chain

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Abstract

Antimicrobial resistance (AMR) poses growing risks to public health, animal health, food production, and market access, making integrated surveillance across the agrifood chain an urgent priority. This work presents the experience of the Inter-American Institute for Cooperation on Agriculture (IICA) in supporting AMR surveillance in the Americas through a One Health approach developed over more than ten years in collaboration with academic, public, and private partners. The work is grounded in the premise that surveillance is the basis for generating science-based evidence, justifying public investment, identifying priority intervention points, and designing mitigation measures in agrifood systems. The methodology applied by IICA does not propose a new surveillance model but rather adapts and harmonizes existing international recommendations to national contexts. It draws on Codex Alimentarius, the WOAHP Terrestrial Animal Health Code, World Health Organization guidance, and reference experiences from countries such as Canada and the United States. The approach supports countries in three main pathways: the design of surveillance programs from the outset, the review and expansion of existing programs, and the transition from pilot research initiatives to official national surveillance systems. A central component is governance. Countries are encouraged to establish formal multisectoral subcommissions involving ministries of agriculture, health, environment, and foreign affairs, together with universities, industry actors, and producer associations. Through a structured 16-step process, participating institutions define roles, identify capacities, and develop flexible surveillance plans that can expand over time from primary production to slaughterhouses, points of sale, aquaculture, and environmental monitoring. Country experiences illustrate the value of this model. In Costa Rica, university laboratory capacity supports official diagnostics; in Paraguay, engagement with the beef sector facilitated surveillance in bovine production; and in Colombia, the methodology was used to complete a national

planning process through interinstitutional collaboration. Once surveillance systems are in place, the resulting evidence can be used to develop action plans to reduce AMR in specific production chains. The experience shows that effective AMR surveillance in agrifood systems depends on sustained awareness, institutional integration, and shared ownership among public authorities, academia, and the private sector.

Keywords: multisectoral governance, food safety, animal health, export competitiveness

THEMATIC SESSION 7: TRANSVERSAL TOPICS ON CLIMATE JUSTICE, INCLUSION AND EQUITY



Climate justice, governance, inclusion and equity, these transversal issues are critical to effectively implement the One Health approach

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Abstract

In particular, the structural dimensions of inequality, gender, governance, indigenous knowledge systems, and rural perspectives are essential elements in designing and delivering lasting solutions. By drawing on the principles of climate justice, equity, diversity and human rights, inclusive approaches that empower the most affected communities will enhance the sustainability of outcomes for people and the natural environment around us. Procedural justice is orientated towards a transparent and deliberative process in which even the most vulnerable have decision-making powers. A climate-just policy is one that is 'designed with' rather than 'for those' most affected by climate change (or their representatives), making it potentially more legitimate and effective at the local level. Some voices are relatively absent from the debate on international climate policy (Indigenous communities, women, the young, the elderly, the landless, the poor, the disabled, among others). As such, those most affected by climate change have been consistently underserved by climate and development initiatives in the Global South. Adopting a climate justice framework will help 'Change the Narrative' on One Health. It will allow us to position people and society at the heart of protecting and restoring biodiversity and ecosystems which we all depend on.

Keywords: human rights, community empowerment, indigenous knowledge systems, rural perspectives, participatory decision-making

From ideal to real: attitudes towards lifestyles changes

Abstract

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Unsustainable production and consumption patterns have resulted in climate change, biodiversity loss, and pollution, highlighting the urgent need for substantial changes to promote human well-being and sustainability. This study examines public preferences for environmental policies in Costa Rica, Ghana, and Vietnam, focusing on the food, transport, fashion, and waste sectors. An online survey experiment (n = 5,000) measured public support for hypothetical policy packages with increasing costs, ranging from no explicit costs to behavioral changes, to direct financial burdens, and to “transition options” that combine temporary costs with more sustainable future alternatives. For example, in the transport sector, respondents were presented with scenarios involving reduced use of private cars and motorbikes in favor of walking, cycling, buses, and carpools; higher gasoline and diesel prices through taxation; or transitions toward cleaner options such as electric or hydrogen-powered vehicles and expanded shared transport. Similar framings were applied across the other sectors. Preliminary findings suggest that public acceptance is not uniform, but depends on the sector, the type of cost imposed, and how the policy is framed. In general, people are more likely to favor policies whose costs are not clearly defined, while support tends to decline when explicit financial costs are introduced. However, when policies are framed around a green and alternative future—such as cleaner technologies, affordable sustainable choices, and attractive low-carbon lifestyles—support increases again across all sectors. These results suggest that public backing for sustainability transitions in the Global South is shaped not only by perceived costs, but also by the extent to which policies offer credible, desirable, and realistic pathways for change.

Keywords: sustainable consumption and production, trust, public policies, carbon pricing.

Bridging cultures in distance education: a confluence of critical pedagogy of place and indigenous education philosophy: case-study reference in Fiji and Vanuatu

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Abstract

This research examines an evolving pedagogical model that integrates Critical Pedagogy of Place with Indigenous education philosophies from Fiji (Itaukei) and Vanuatu (Ni Vanuatu), particularly within digitally mediated distance education environments. It draws from two case studies rooted in community-based learning sessions that utilize Talanoa and Kustom dialogue methodologies as culturally embedded pedagogical tools. These approaches foster intergenerational knowledge transfer and cultural affirmation while addressing the intersecting challenges of geographic isolation, climate vulnerability, and systemic inequities. Within the One Health framework, which recognizes the interconnectedness of human, animal, and environmental health, the findings of this study offer actionable insights for education, research, and technical assistance initiatives in Pacific Island nations and other Indigenous contexts. By embedding Indigenous epistemologies and place-based narratives into remote education, these pedagogical tools become more than instructional methods—they evolve into platforms for building health literacy, promoting ecosystem stewardship, and strengthening cultural resilience. For example, community-led online sessions exploring traditional herbal medicine, sustainable fisheries management, and climate adaptive agricultural cycles reinforce not only environmental sustainability but also preventative health practices and interspecies balance. From an educational perspective, this approach empowers learners to reframe Western curricula through their own cultural lenses, fostering critical engagement with environmental and health sciences that are deeply embedded in place, ancestry, and ecology. In terms of research, it encourages the co-production of knowledge that honors Indigenous methodologies and values, advancing ethical and reciprocal partnerships in health and environmental studies. Regarding technical assistance, this model promotes culturally appropriate interventions—such as using Indigenous

knowledge in water security planning or zoonotic disease monitoring—ensuring that community wisdom is recognized and integrated into health and development programming. Framing my pedagogical and heutagogical approaches—which emphasize self-determined learning, reflection, and praxis—as tools for sustainable practice is especially pertinent in remote, climate exposed regions. In Fiji, for instance, Talanoa-led digital learning activities involving elders and youth in coastal communities have helped document marine biodiversity loss while reviving traditional conservation practices such as tabu areas. In Vanuatu, Kustom-informed discussions on forest and land use have led to increased youth involvement in traditional agroforestry systems, bolstering food security and biodiversity conservation. These culturally grounded education models, therefore, do more than transmit knowledge—they reinvigorate relational ethics, situating the learner within a web of responsibilities to land, water, animals, and community. They promote a One Health vision that is not externally imposed but internally animated through Indigenous values of stewardship, reciprocity, and interconnectedness. Ultimately, this approach affirms that distance education, when designed through the lens of Critical Pedagogy of Place and Indigenous philosophy, can serve as a transformative conduit for culturally embedded, community-led, and ecologically aligned One Health implementation.

Keywords: Itaukei, ni-Vanuatu, constructivist paradigm, digital technologies, Two-Eyed Seeing, culturally responsive education

Reconciling the dual worldviews of ancient wisdom and modernity: collaborative-learning implications for future discourse

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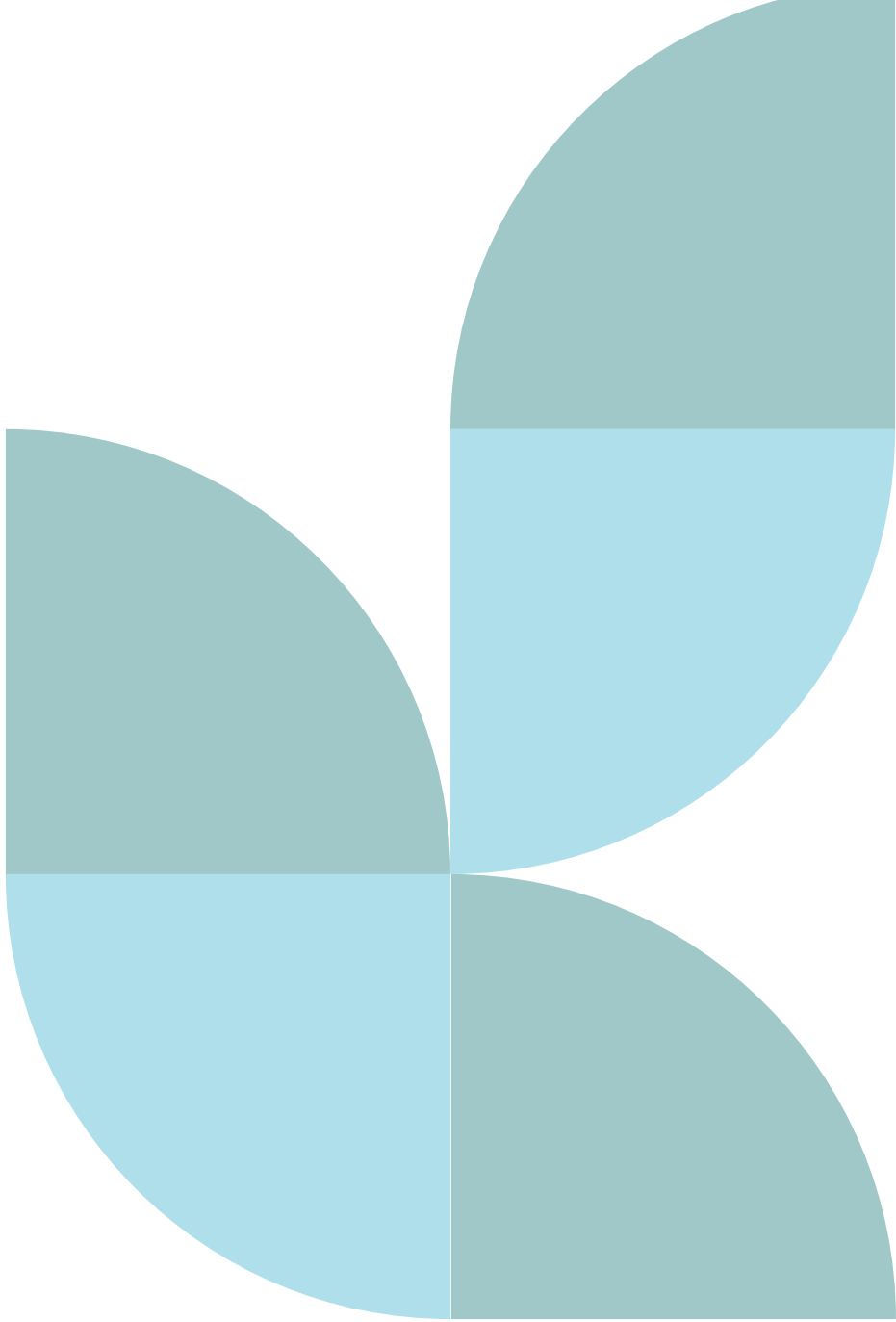
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Abstract

This presentation interrogates the conceptual and practical intersections between indigenous knowledge systems and Western Scientific Paradigms, highlighting their potential synergies in addressing contemporary health and ecological crises. It emphasizes the importance of collaborative learning spaces—both physical and digital—where epistemological pluralism is not only acknowledged but actively engaged to co-produce culturally resonant solutions. Drawing from case studies in Fiji and Vanuatu, the work reflects on how ancient worldviews—rooted in relational ontologies and place-based ethics—can meaningfully inform future-oriented strategies within the One Health framework. A key example is the use of Itaukei lunar calendars and seasonal observations in Fiji to guide agricultural planting and fishing practices. These Indigenous temporal indicators, when integrated with climate modeling tools, have helped communities better anticipate shifting weather patterns, preserve biodiversity, and reduce food insecurity—thereby addressing both human and environmental health vulnerabilities. In the highlands of Vanuatu, kastom-based forest classification systems, which include spiritual taboos and knowledge of wildlife migration, have been instrumental in shaping conservation zones that also function as buffers against zoonotic spillover, offering direct benefits to animal and human health. Case studies in the research demonstrate that traditional knowledge is not static or romanticized, but dynamic and deeply empirical, honed through generations of close ecological observation and place based teachings. By reconciling these systems with modern scientific methods—such as GIS mapping, epidemiological surveillance, or ecosystem services valuation—new hybrid approaches are emerging that are context-specific, ethically grounded, and environmentally sound. This integrative approach also has educational implications: when learners engage in collaborative dialogue pedagogy, where elders, scientists, and youth co-facilitate learning, a richer understanding of environmental interdependence and health risks emerges. For example, in participatory workshops

held in cyclone-affected communities in Fiji, youth have co-documented oral histories of disease outbreaks following ecosystem disruption, alongside biomedical analyses of vector-borne illnesses—leading to community health plans that blend herbal remedies, habitat restoration, and modern diagnostics. By centering Indigenous worldviews in discourse with science, this presentation supports a holistic, inclusive, and justice-oriented vision of One Health. It calls for a transformation in how knowledge is valued and applied—not as a binary between the ancient and the modern, but as a dialogic convergence that can foster deeper understanding and more sustainable responses to the interlinked crises of climate change, ecosystem degradation, and public health in the Anthropocene.

Keywords: traditional knowledge, climate change, indigenous science, worldviews



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