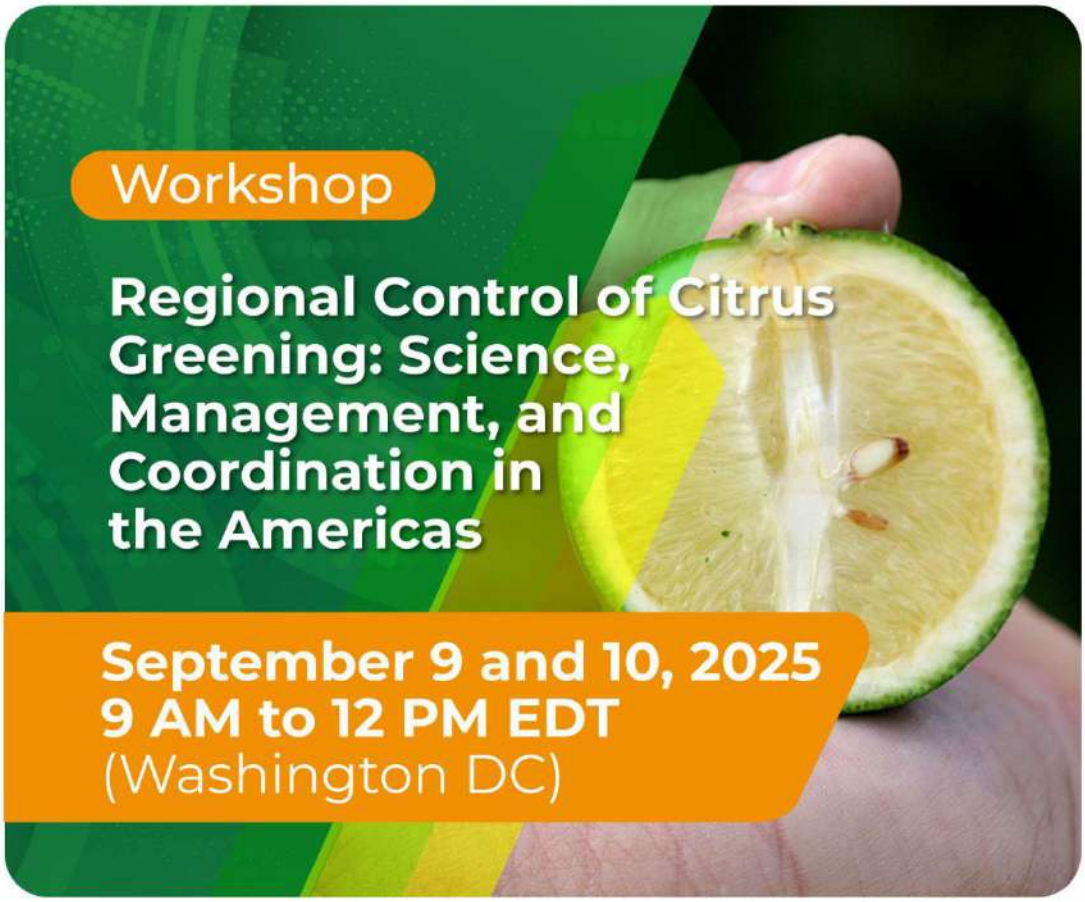

PROCEEDINGS OF THE WORKSHOP REGIONAL CONTROL OF CITRUS GREENING: SCIENCE, MANAGEMENT AND COORDINATION IN THE AMERICAS

Technical Administrative Secretariat

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Participant Institutions

Introduction

This document presents the main points discussed during the Virtual Workshop "Regional Control of Citrus Greening: Science, Management, and Coordination in the Americas," organized by FONTAGRO in collaboration with the University of Florida and partner institutions. The workshop was held on September 9-10, 2025, via the Zoom platform, with simultaneous interpretation in English and Spanish.

The objective of the workshop was to review the current status of Huanglongbing (HLB, also known as Citrus Greening) in the region, share technological advances and management strategies, and promote regional collaboration to strengthen surveillance, develop and validate integrated control measures, and lay the foundations for coordinated, long-term responses. The meeting brought together experts from FONTAGRO, the University of Florida (UF), the USDA Agricultural Research Service, the Citrus Research and Development Foundation (CRDF), the Bioscience Think Tank, Venganza 2.0 and IICA–SAIA (the Agricultural and Agroindustrial Service of the Inter-American Institute for Cooperation on Agriculture, Chile).

The workshop opened with welcoming remarks by Martín Oesterheld (FONTAGRO) and Charlie Messina (CTC/University of Florida), who underlined the urgency of addressing HLB and FONTAGRO's role in convening hemispheric collaboration.

Day 1 featured two thematic panels. In Panel 1, Romina Gazis (UF) highlighted diagnostic challenges and capacity-building needs; Rodrigo Astete (IICA-SAIA) presented innovations in surveillance, including drones and remote sensing; and Rick Dantzler (CRDF) discussed ongoing management efforts and the potential of new treatments, while stressing the need for coordination. In Panel 2, Chuck Niblett (Venganza 2.0) and Ana Bailey (Venganza 2.0) presented advances in RNAi and molecular strategies for psyllid control, while Lucas Stelinski (UF) emphasized integrated vector management and insecticide resistance. The day closed with a broad discussion in which participants, including Carrie Harmon (UF), Fred Gmitter (UF/IFAS), Maria Mercedes Roca (Bioscience Think Tank), and others, reflected on detection, resistance management, regulatory challenges, and the urgent need for a coherent "master plan" for HLB control.

Day 2 opened with Panel 3, which showcased advances in genetic improvement and biotechnology. Karen Koch (UF) discussed physiological strategies such as strigolactone modulation and phloem regeneration, Eric Triplett (UF) presented progress on NPR1 transgenic lines and their regulatory pathway, Rosemary Loria (UF) introduced AI-based prediction of host–pathogen protein interactions, Kim Bowman (USDA ARS) highlighted new tolerant rootstocks, Fred Gmitter (UF) reported on scion breeding and genomics, and Michelle Heck (USDA ARS) described "Symbion" technology as an innovative therapeutic delivery system. Panel 4 turned to extension and coordination, where Michael Rogers (UF/IFAS) presented the Florida experience with Citrus Health Management Areas (CHMAs), emphasizing the importance of extension in reducing grower "strategic uncertainty" and facilitating collective action.

The closing discussion, moderated by Oesterheld and Messina, drew together the insights of participants. Eric Triplett (University of Florida), Rosemary Loria, Maria Mercedes Roca, Michelle Heck, Lucas Stelinski, and others stressed the importance of regional integration, stronger diagnostic networks, rapid field validation of tolerant varieties and biotech solutions, and private sector engagement. Rick Dantzler reiterated the need for a comprehensive master plan to integrate research outputs into actionable strategies, while participants agreed on the value of establishing regular follow-up meetings and exploring the creation of a dedicated program integrator role.

To access the recordings of the event, please click here for Day 1 and here for Day 2.

Challenge Addressed

Huanglongbing (HLB, Citrus Greening), caused by *Candidatus* Liberibacter spp. and transmitted by the Asian citrus psyllid (*Diaphorina citri*), is the most severe threat to citrus worldwide. Once established, it leads to chronic tree decline, reduced yields, poor fruit quality, and ultimately tree death. For small and medium-scale growers in Latin America and the Caribbean, HLB poses a direct threat to income and livelihoods, as well as to the long-term sustainability of the citrus industry.

The disease is particularly challenging because it has no cure, spreads quickly through insect vectors and movement of infected plant material, and is difficult to detect in its early stages due to non-specific symptoms. Management strategies, such as vector control, removal of infected trees, antibiotics, and nutritional programs, offer only partial or temporary relief and are often costly. In Florida, nearly all commercial citrus trees are now infected, highlighting the scale of the challenge.

Research advances presented in the workshop, including resistant or tolerant scions and rootstocks, RNAi-based tools, microbial symbiont strategies, and trunk injection technologies, show promise but require validation, regulatory approval, and pathways for adoption. Meanwhile, integrated approaches - combining cultural practices, vector management, and nutrition - need to be tested under diverse regional conditions.

Countries in the region face a dual challenge: sustaining citrus production in the short term while investing in medium- and long-term solutions. Surveillance and diagnostics remain uneven, communication of detections is often limited by trade and regulatory concerns, and growers face uncertainty in adopting new technologies without coordinated frameworks. Climate change and the movement of nursery material further increase the risk of spread across borders.

Without strengthened regional collaboration and pilot projects that validate integrated approaches across countries, national efforts will remain fragmented and insufficient to contain or mitigate HLB’s impact.

Agenda

	Day 1: Early detection, vector management, and certified plant material **Tuesday, September 9 - Zoom virtual meeting *(all times in EDT)***
9:00 - 9:20	**Opening Session** Welcome remarks from FONTAGRO and the University of Florida. Overview of the workshop objectives, expected outcomes, and relevance for regional coordination. *Speakers:* **Martín Oesterheld**, FONTAGRO **Carlos Messina**, CTC/UF
9:20 - 10:20	**Panel 1: Early Detection, Diagnostics and Surveillance** Field-deployable tools, laboratory readiness, and surveillance strategies *Panelists:* **Romina Gazis**, UF IFAS **Rick Dantzler**, Citrus Research and Development Foundation **Rodrigo Astete**, SAIA-IICA
10:20 - 10:25	**Break**
10:25 - 11:25	**Panel 2: Integrated Vector Management: innovations and challenges** Chemical, biological and cultural control strategies for the Asian citrus psyllid *Panelists:* **Chuck Niblett** and **Ana Bailey**, Venganza 2.0 **Lukasz Stelinski**, UF IFAS CREC Entomology
11:25 - 11:55	**Closing discussion Day 1** Synthesis and Q&A focused on short-term to long-term actions, practical tools for growers, and knowledge gaps. *Moderators:* **Eugenia Saini**, **Carlos Messina** and **Martín Oesterheld**
	Day 2: Genetic Resistance, regional collaboration, and resource mobilization **Wednesday, September 10 - Zoom virtual meeting *(all times in EDT)***
9:00 - 10:40	**Panel 3: Genetic Resistance & Biotechnological Approaches** Advances in tolerant and resistant varieties, CRISPR applications, and transgenic lines under development. *Panelists:* **Frederick Gmitter**, UF/IFAS CREC **Eric Triplett**, UF/IFAS Gainesville **Karen Koch**, UF IFAS **Rosemary Loria**, UF IFAS **Kim Bowman**, USDA REE-ARS **Michelle Heck**, USDA REE-ARS
10:40 - 10:45	**Break**
10:45 - 11:25	**Panel 4: Regional Coordination and Extension** National and cross-country initiatives, role of public-private networks, and innovation hubs. *Panelists:* **Maria Mercedes Roca**, Bioscience Think Tank **Michael Rogers**, UF IFAS CREC
11:25 - 11:55	**Closing Discussion and Next Steps** Summary of outcomes, agreement on follow-up actions, and next steps toward regional implementation. *Moderators:* **Eugenia Saini**, **Carlos Messina** and **Martín Oesterheld**

Opening Session. Welcome remarks from FONTAGRO and the University of Florida. Dr. Martín Oesterheld, FONTAGRO; Dr. Charlie Messina, University of Florida

The meeting was opened by Martín Oesterheld (Chief Scientist, FONTAGRO) and Charlie Messina (Professor, University of Florida/CTC).

Oesterheld highlighted FONTAGRO's long-standing role in supporting regional science and innovation, and underscored the urgency of coordinated action to address Citrus Greening. He drew on his research experience in plant–herbivore interactions and ecological monitoring to stress the value of integrating scientific tools with producer-level management.

Messina emphasized the role of predictive breeding and artificial intelligence in building resilient food systems, and the importance of harmonizing efforts across the Americas. He called for a shared regional strategy that connects basic science with practical solutions for growers, framing the challenge of HLB as both a scientific and socio-economic imperative.

Panel 1: Early Detection, Diagnostics and Surveillance. Dr. Romina Gazis, University of Florida; Rick Dantzler, Citrus Research and Development Foundation; Rodrigo Astete, SAIA-IICA

Romina Gazis (UF/IFAS Tropical Research and Education Center).

Dr. Gazis framed diagnostics as central to any IPM pathway, drawing on extension and clinic experience. She reviewed the three unculturable causal agents (Candidatus Liberibacter spp.), noting "asiaticus" predominates in Latin America but labs must detect all species. She contrasted field diagnosis with laboratory confirmation, stressing risks of confusion with abiotic disorders and the value of pattern recognition. Using a Homestead lime trial (2017 planting), she showed rapid epidemic development: by 2018–2020 all 239 trees tested positive, with impacts on juice quality and tree decline. She noted sampling constraints from low, uneven bacterial titers, recommending mature symptomatic leaf midribs, appropriate controls, and tissue management to improve qPCR reliability. She identified qPCR as the current gold standard, conventional PCR as a lower-resource option, LAMP as field-deployable, and noted the absence of a commercial ELISA. Complementary monitoring (volatile profiling, remote imaging, AI) was highlighted for surveillance, not diagnosis. She pointed to preparedness resources such as PRE-HLB and UF materials.

Rick Dantzler (Citrus Research and Development Foundation).

Dantzler outlined CRDF's applied approach: assume all Florida trees are infected and prioritize grower viability over 3–7 years until "trees of the future" are available. He noted clearer separation of effective vs. ineffective tools across trials, with visible canopy recovery despite setbacks. CRDF's focus is to reduce CLas until durable tolerant/resistant material is validated. As a key near-term tool, he highlighted oxytetracycline trunk injection, noting variable responses but improved health by year 3–4. To manage resistance and regulatory risk, CRDF's "Grow First" effort is testing alternative antimicrobials (e.g., doxycycline, tetracycline) with differing feasibility. He also referenced plant growth regulators, protective covers, and brassinosteroids. Long-term, he stressed validation of tolerant rootstocks, scions, and engineered trees. Partnerships include Coca-Cola trials of 68 orange-like scions, UF/USDA breeding and bioinformatics, and NPR1 transgenics moving through regulation. Priorities are extending oxytetracycline approval, securing an additional antibiotic, and accelerating validation of tolerant and engineered materials.

Rodrigo Astete (IICA–SAIA).

Astete presented a regional early-detection and surveillance model using scalable remote sensing to complement conventional field surveillance. He outlined IICA and COSAVE mandates and SAIA's role in strengthening phytosanitary systems. Pilots in Corrientes (Argentina) and Uruguay (2022–2023) applied high-resolution satellite, hyperspectral and thermal sensors, drones, and algorithms to distinguish HLB-positive/negative plants and generate heat maps for targeted sampling and PCR confirmation. Results showed feasibility for broader application. He described capacity-building (internships, joint fieldwork, fluorescence sensors, prototype scaling) and expected outcomes: stronger Southern Cone surveillance, innovation, and regional synergy under IICA–COSAVE. He contrasted reactive symptom-driven surveillance with proactive, technology-based approaches offering earlier detection and faster coverage across ~1 million hectares. Strategic benefits include reduced losses, informed decisions, and improved coordination. He called for alliances among governments, academia, UF, FONTAGRO, and others to expand adoption of early-detection technologies and develop larger regional projects for resilient citriculture.

Panel 2: Integrated Vector Management: innovations and challenges. Chuck Niblett and Ana Bailey, Venganza 2.0; Lukasz Stelinski, UF/IFAS CREC

Chuck Niblett and Ana Bailey (Venganza).

Niblett and Bailey presented two decades of work applying RNA interference (RNAi) or gene silencing to control diverse plant pests, positioning RNAi as a complementary alternative to chemical control and a source of simply inherited, breeder-friendly resistance. Their approach identifies an essential gene in the target pest or pathogen, inserts a corresponding sequence into a plant transformation vector that produces double-stranded RNA (dsRNA), and relies on host processing into small interfering RNAs that, when ingested by the pest or pathogen, silence the target gene and suppress growth, reproduction, or pathogenicity. They demonstrated proof-of-concept across systems: transgenic tobacco resistant to Phytophthora (with molecular evidence of silencing in both plant and pathogen), cross-species effects where closely related pathogens share target sequences, and strong growth suppression in Fusarium assays. They reported insect applications via injection and feeding, including altered pigmentation and high mortality in sweet potato weevil after lacase silencing; reduced larval growth in banana weevil using selected dsRNAs; and mortality in Asian citrus psyllid when feeding on dsRNA-bearing leaves, despite canonical dicer genes not being annotated in the psyllid genome. Collaborations cited included greenhouse feeding systems for psyllid dsRNA delivery, rotation and stacking of multiple dsRNAs within a single construct to deter resistance, and ongoing work on whiteflies with external partners. They argued that RNAi can reduce pesticide use, lower environmental contamination, and provide durable control because resistance would require substantial mutational change to essential target genes; stacking multiple targets should further delay resistance. They acknowledged societal and regulatory hurdles for transgenic crops but judged the risk–benefit calculus favorable given HLB's impact and the flexibility of RNAi to target vectors and pathogens.

Lukasz Stelinski (UF/IFAS CREC).

Stelinski reviewed Florida's chronology and lessons for psyllid control. Asian citrus psyllid was detected in 1998 and HLB confirmation came years later; protracted debates over diagnostics and restrictive select-agent rules delayed decisive action. Statewide acceptance of vector control did not arrive until around 2010, by which time the pathogen was likely widespread and tree removal ("inoculum reduction") faced sociological resistance after earlier eradication campaigns. Early vector control depended on frequent calendar sprays (often monthly), which were costly, disrupted biological control, and rapidly selected for insecticide resistance, notably to neonicotinoids. He presented field evidence that effective mode-of-action rotation can restore susceptibility within months, and that three consecutive non-rotated neonic applications can drive resistance ratios to very high levels, coincident with control failure. Addressing a common grower question in endemic settings - why control vectors if all trees are infected - he showed experiments where trees exposed to infected psyllids fared far worse than trees exposed to noninfective psyllids, and that unmanaged trees collapsed; conversely, maintaining psyllids below defined thresholds preserved canopy and yield. He proposed a threshold-guided strategy: retain a winter "dormant" spray to exploit a life-cycle weak point, then trigger additional sprays only when monitored psyllid counts exceed action thresholds. In trials, this reduced sprays (e.g., four vs. twelve per year) with equivalent profits, while no-spray regimes led to collapse. He positioned thresholds within a broader toolbox: repellents and mulches to reduce landing and oviposition; individual protective covers and covered production systems to exclude vectors; trap crops, repellents, natural enemies, and continued chemical tools used judiciously. As a near-term stopgap, he highlighted trunk-injected oxytetracycline, which, unlike foliar applications, delivered consistent reductions in bacterial titers and visible canopy recovery in multi-lab trials. Looking forward, he emphasized integrating next-generation technologies, such as transgenics (e.g., Bt-expressing citrus relatives or scions), antimicrobial peptides, NPR1-based immune enhancement, and RNAi modalities delivered via plants or plant viruses, to raise treatment thresholds and further reduce spray frequency. He noted multiple RNAi proof-points in ACP (e.g., silencing gut surface proteins to reduce acquisition/transmission; constructs lowering fecundity and fertility), and pointed to the first commercial RNAi insecticide (for a different crop pest) as evidence of translational momentum. His short-term outlook prioritised antibiotics as a bridge, threshold-based vector management to contain costs, hormonal treatments to minimise fruit drop, and rapid movement of next-generation tools from discovery to field use.

Closing Remarks - Day 1

Moderation opened the floor to synthesize lessons and frame next steps at a hemispheric scale. Several cross-cutting themes emerged: the need to think beyond the orchard and design region-wide systems for early detection; the imperative to manage resistance across pesticides and biotechnology; and the importance of integrating tools at different technology-readiness levels into coherent field programs.

Charlie Messina emphasized scaling from grove-level solutions to a continental surveillance and management architecture. He highlighted three priority pillars: building an asymptomatic detection system that can leverage satellites and, where feasible, drones; managing resistance proactively across insecticides, Bt, and RNAi; and understanding regulatory implications of multi-trait "stacks" so deployment pathways are realistic.

Martín Oesterheld noted the breadth of promising approaches presented and proposed mapping ongoing solutions against technology-readiness levels to identify gaps, integration opportunities, and a path from research to deployment. He underscored the potential of regional collaboration across Latin America, the Caribbean, and North America to function as a "real-world lab."

From an integrated management perspective, Łukasz Stelinski supported developing matrixed "toolbox" demonstrations that combine vector suppression, antibiotics where permitted, nutrition, tree protection, and cultural practices, but stressed the need to prioritize spend under economic constraints. He advocated threshold-guided vector control to reduce costs while preserving canopy and yield.

Michelle Heck called for designated, reimbursed field test sites where unapproved or experimental technologies can be integrated under research protocols, with appropriate isolation zones and compliance, to generate evidence on which combinations work synergistically. She pointed to new funding that will support a 20-acre integrated trial in Florida.

Maria Mercedes Roca urged accelerating genetic solutions (transgenic and gene-edited) despite regulatory complexity, citing past successes in other crops. From a One Health perspective, she cautioned about reliance on antibiotics and its ecological implications, arguing this should be a bridge rather than a destination.

Fred Gmitter recommended that any integrated field trials include the newest tolerant rootstocks and scions from conventional breeding, noting advanced materials that maintain performance under HLB without antibiotics or protective covers.

Carrie Harmon stressed that management and treatment must be matched by robust, reliable detection. Because field-friendly lateral flow assays are lacking and PCR capacity is essential, she recommended a distributed network of accessible diagnostic centers, rapid data turnaround, and real-time data release to identify hotspots for both trials and targeted management.

Rick Dantzler called explicitly for a master plan. He described his core frustration: results from many funded projects are not being systematically synthesized into a coordinated solution path, and promising findings can languish in final reports. He urged creation of a mechanism that continuously scans outputs across programs, down-selects the most promising interventions, and presents funders with integrated, prioritized deployment packages. He acknowledged antibiotics were pursued as a time-critical bridge to preserve industry viability, not as an end point, and reiterated the need for actions that can "reset" the industry, not just provide marginal gains.

Additional remarks pointed to learning from California's experience in slowing HLB spread via stronger inoculum removal and regulatory tools, which could inform other jurisdictions. The session closed with agreement to use Day 2 to deepen work on genetic solutions and regional coordination, and with a commitment to begin assembling the elements of a master plan that integrates detection infrastructure, resistance management, genetic improvement, regulated field validation, and scalable extension frameworks across the hemisphere.

Panel 3: Genetic Resistance & Biotechnological Approaches. Karen Koch, UF IFAS; Eric Triplett, UF/IFAS Gainesville; Rosemary Loria, UF IFAS; Kim Bowman, USDA REE-ARS; Frederick Gmitter, UF/IFAS CREC; Michelle Heck, USDA REE-ARS.

Karen Koch (University of Florida)

Koch introduced her group's work on previously unexplored strategies to help citrus trees survive HLB. She focused on two areas: amplifying strigolactone (SL) formation and aiding phloem regeneration. Strigolactones, root-derived growth regulators, can move to shoots and have shown promise in countering HLB symptoms in greenhouse trials, including preserving vascular cambium integrity, improving root structure, and enhancing fruit set. However, commercial application is limited by the high cost of SLs. Her team is engineering rootstocks to upregulate the CCD8 gene, a key step in SL biosynthesis, and developing constructs to mimic SL abundance through signal amplification. Koch also presented efforts to stimulate phloem regeneration, building on evidence that tolerant cultivars such as Sugar Belle and Bearss lemon regenerate phloem more effectively than Valencia. Early gene network analyses suggest promising targets, and constructs are in transformation pipelines. She emphasized that the near-, mid-, and long-term goal is consistent: to test these engineered trees in the field through CTC's pipeline and collaborations with experts in grafting and field validation, recognizing that these alterations could reshape rootstock architecture, symbiosis with mycorrhizae, and nutrient uptake.

Eric Triplett (University of Florida)

Triplett reviewed progress on citrus lines transformed with the Arabidopsis NPR1 gene, a broad-spectrum defense regulator first reported in 2010. His presentation focused less on the technology itself and more on regulatory pathways toward EPA approval. Five high-performing transgenic lines have been developed, showing normal growth, consistent fruit quality, and strong tolerance to HLB in both greenhouse (nine years) and field trials (since 2019). These trees become infected but remain largely asymptomatic and productive under heavy disease pressure. Triplett highlighted extensive safety data: the protein is expressed at very low levels in fruit, digested rapidly, shows no allergenicity or toxicity, and is homologous to proteins commonly consumed in plants. USDA approval has already been secured, and EPA has defined a path forward if UF can demonstrate "state agency" status to waive high regulatory fees. FDA submission is also planned. Triplett underscored the importance of yield trials and scale-up, while offering the regulatory template to collaborators as a model for future biotech approvals.

Rosemary Loria (University of Florida)

Loria presented a novel AI-based approach to predict protein–protein interactions between citrus phloem proteins and Liberibacter effector proteins, the molecular drivers of HLB pathogenesis. Using AlphaFold3 on a supercomputing platform, her team screened more than 52,000 predicted interactions derived from 18 complete Liberibacter genomes and 733 known citrus phloem proteins. She explained that this in silico pipeline enables rapid identification of candidate interactions for experimental validation, with preliminary results already recovering several interactions previously confirmed in the literature, lending proof of concept to the approach. Examples included proteases and proteins implicated in resistance pathways. Loria highlighted this as the first application of such computational methods to citrus HLB, providing a new route to identify molecular targets for breeding, gene editing, or transgenic strategies. She credited an interdisciplinary team combining bioinformatics, AI, plant biology, and transformation expertise, with the first paper expected soon.

Kim Bowman (USDA ARS, Florida)

Bowman discussed the role of rootstocks in improving tree survival, yield, and fruit quality under HLB conditions. He reviewed the performance of first-generation tolerant rootstocks such as US-942, which increased yields 26–44% over standards but still showed 30–50% yield reductions compared to pre-HLB conditions. To advance further, Bowman developed the "SuperSour" breeding strategy, expanding genetic diversity and selecting rootstocks directly in field conditions. He presented trial data from Florida showing SuperSour 3, 4, and 5 delivering superior yields and reduced premature fruit drop compared to standard rootstocks. Thirty ongoing USDA field trials now evaluate 350

new rootstocks, including lemons and mandarins as scions, and genomic sequencing of these materials is enabling trait mapping. He emphasized short- to medium-term incorporation of commercially available tolerant rootstocks into new plantings, and longer-term establishment of regional evaluation plots across the Americas to identify the best performers in diverse environments.

Fred Gmitter (University of Florida)

Gmitter highlighted advances in scion breeding and genomics. He reviewed the release of six new cultivars from UF, including processing sweet oranges, tolerant Hamlin selections, and mandarin hybrids suitable for blending. Field trials show these cultivars maintain vigor and productivity under HLB without antibiotics or protective covers, offering immediate near-term options for growers. Gmitter also described complementary work in rootstocks (e.g., Fast Eddy, OL-10, Orange 14) showing tolerance under HLB and other stresses. From a genomics perspective, he presented findings from radiation-induced mutants, QTL mapping, and GWAS identifying candidate genes linked to HLB tolerance, canopy health, and fruit quality. He argued that HLB tolerance in scions is likely polygenic, requiring genomic selection and pyramiding strategies. He also noted insights from transcriptomics and single-cell RNA-seq showing how Liberibacter suppresses host defenses early in infection. Gmitter concluded that conventional breeding and genomics must advance hand-in-hand, and that genetic solutions will be a critical part of integrated HLB management.

Michelle Heck (USDA ARS, New York)

Heck introduced “Symbion” technology, an innovative delivery system using engineered plant cells derived from Agrobacterium that integrate into citrus tissues and continuously express therapeutic molecules (e.g., antimicrobial peptides, RNAi constructs). Unlike transgenic trees, Symbions can be deployed on existing trees, potentially avoiding replanting and GMO market barriers. Field trials in Florida, conducted under strict regulatory oversight, show Symbions are safe, with no detectable spread of modified microbes. Early data suggest benefits to tree growth and fruit set, possibly from both therapeutic cargos and the plant growth regulator genes used to sustain the Symbions. She described parallel tests in potato (“zebra chip”) as a rapid assay system, and emphasized scalability, regulatory feasibility as a biopesticide, and international collaboration. Heck outlined short-term deliverables (injectables), medium-term uses for juvenile tree protection, and long-term visions of integrating Symbions, tolerant genetics, and other technologies into a “tree of the future.” She closed with a call for coordinated evaluation of solutions in infected trees under real-world conditions.

Panel 4: Regional Coordination and Extension. Maria Mercedes Roca, Bioscience Think Tank; Michael Rogers, University of Florida.

Maria Mercedes Roca (Bioscience Think Tank)

Roca focused her presentation on the regulatory frameworks that condition the deployment of biotechnological solutions for HLB. She highlighted the urgency of the citrus greening crisis in the Americas and argued that conventional methods provide only partial relief, making rapid adoption of transgenic and gene-edited citrus varieties essential. Roca contrasted the relatively streamlined U.S. regulatory pathway for CRISPR-edited crops with the more complex and fragmented situation in Latin America, where the Cartagena and Nagoya Protocols, activist pressure, and unclear national rules slow progress. She underlined the need for science-based, harmonized approaches to ensure safety and build public trust, stressing that trait-based rather than process-based evaluations should guide regulatory decisions. Priority actions include short-term transparency in field trials and alliance-building with growers and civil society, medium-term harmonization of data and training of trusted local spokespeople, and long-term creation of regional biosafety networks and integration of biotech education. She closed by emphasizing that accelerated, science-driven regulation is vital for commercial deployment, sustainable control of HLB, and the resilience of the citrus industry across the Americas .

Michael Rogers (University of Florida)

Rogers shifted the focus from research to extension, stressing the importance of translating science into practical adoption by growers through not only educational materials but also hands-on demonstrations in research stations and growers' fields. He illustrated this with Florida's Citrus Health Management Areas (CHMAs), grower-led programs coordinating insecticide sprays against the Asian citrus psyllid. Supported by UF/IFAS, USDA, FDACS, and CRDF, CHMAs expanded from three pilots to 52 areas covering nearly 500,000 acres, reducing psyllid populations by about 70%, slowing yield decline, and minimizing pesticide resistance. However, the program collapsed in 2016–17 when foliar-applied antibiotics diverted grower budgets and reintroduced "strategic uncertainty," showing how human behavior can determine the success or failure of regional coordination. Rogers concluded with recommendations for future hemispheric coordination efforts: in the short term, hold in-person workshops with growers and decision makers, adapt practices to local environments, identify resource gaps, and design practical, area-specific plans; in the medium term, communicate program successes to expand participation, systematically assess the effectiveness of implemented measures, and evaluate constraints to the adoption of emerging technologies to guide new investments; and in the long term, continually integrate new technologies as they become available, while empowering non-participating growers with resources and incentives to join coordinated programs. He emphasized that addressing behavioral barriers and building trust are as critical as the science itself for ensuring lasting regional impact.

Closing Discussion and Reflections - Day 2

The final discussion brought together reflections from moderators, researchers, extension leaders, and institutional representatives to synthesize lessons from the two-day workshop and chart a way forward.

Charlie Messina (CTC/UF) opened by noting that the breadth of presentations, from technological innovations to regulatory frameworks, provided the essential ingredients for the kind of "master plan" called for by Rick Dantzler. He emphasized that no single silver bullet exists; solutions must be multi-pronged, adaptive to resistance and evolving disease dynamics, and organized at a hemispheric scale. Referring to maps shown earlier, he stressed that HLB spread is a regional problem, amplified by hurricanes and plant movement, and can only be solved through coordinated continental action. He suggested initiating regular virtual meetings to begin structuring a hemispheric plan, potentially culminating in an in-person session to develop an integrated roadmap comparable to (but more actionable than) the earlier National Academies report. He invited participants to join CTC, FONTAGRO, and other partners in this organizing effort.

Eric Triplett (University of Florida) supported the call for coordination, underscoring that substantial progress has been made across breeding, biotechnology, and field validation. He noted that while disorganization has sometimes slowed progress, "the cream is rising to the top," and expressed optimism that consolidation around the most promising approaches is already under way. He also acknowledged regulatory hurdles as a major challenge that must be addressed collaboratively.

Michael Rogers (UF/IFAS Extension) highlighted the importance of accounting for non-participating countries and industries, recalling cases where infected nursery material was shipped across the Caribbean, likely accelerating HLB spread. He stressed the need for robust diagnostics and capacity-building in countries with weaker surveillance systems, while also calling attention to the importance of safe, non-punitive communication channels for reporting detections. Without incentives for transparency, he warned, detections may remain hidden for years, worsening regional risks.

Carrie Harmon (University of Florida) reinforced the communication challenge, arguing for "safe spaces" or amnesty-like mechanisms that encourage countries and growers to report detections without fear of trade sanctions or reputational harm. She stressed that real-time diagnostic information is essential for deploying management resources effectively and for designing rigorous field trials of new technologies.

Karen Koch (University of Florida) reflected on the inspiration generated by collaborative events like this, crediting the urgency conveyed by leaders such as Rick Dantzler and Charlie Messina with motivating researchers outside traditional citrus fields to engage. She echoed the urgency of moving promising transgenic and biotech solutions into the ground within a year, as emphasized by CRDF.

Maria Mercedes Roca (Bioscience Think Tank) broadened the discussion, insisting on the need for equity and global collaboration. She compared the challenge to vaccine distribution during COVID-19: solutions cannot remain limited to wealthy countries. With the ease of dispersal via hurricanes, ships, and informal trade, she argued for a planetary perspective. She highlighted the role of diagnostics in regions reluctant to report outbreaks and urged continued advances in biotechnology, citing both citrus initiatives and lessons from other pathosystems like lethal yellowing in coconut. She reminded participants not to neglect "orphan crops" and emerging diseases that may require similar approaches.

Michelle Heck (USDA ARS) reiterated that HLB is a global problem that demands regional and hemispheric solutions. She called for broader engagement beyond scientists, particularly growers, regulatory agencies, and agrochemical companies, as core collaborators in designing, validating, and scaling technologies. She emphasized that solutions must be practical, affordable, and aligned with regulatory frameworks, otherwise promising innovations will fail to reach farms.

Lukasz Stelinski (UF/IFAS) emphasized the need for a dedicated "program integrator," independent of academic tenure pressures, to synthesize knowledge across disciplines and design integrated management programs. He cited examples from other agricultural sectors where non-tenure-track coordinators successfully bridged silos and translated research into practice.

Rosemary Loria (University of Florida) stressed the importance of industrial partnerships and commercial investment to complement limited public funding. She suggested that new mechanisms are needed to draw in private-sector commitment alongside international funding agencies.

Eric Triplett responded that he would actively pursue the idea of a program integrator, engaging CRDF and other partners to secure support for a full-time position dedicated to consolidating research outputs and guiding funders toward coherent investment strategies.

Finally, **Martín Oesterheld and Eugenia Saini (FONTAGRO)** closed by thanking all participants and affirming FONTAGRO's role as a platform for regional cooperation. They reiterated their commitment to convening the group beyond the workshop and to expanding collaboration with Latin American, Caribbean, and North American countries, as well as partners outside the current FONTAGRO membership. Saini emphasized that FONTAGRO will remain open to strengthening cooperation across borders to support the coordinated development of durable solutions for citrus greening.

In conclusion, the workshop converged on a clear, shared path: HLB will be met not by a silver bullet but by a coordinated, hemispheric program that blends proven IPM and extension with next-gen solutions, from tolerant scions/rootstocks and genomic selection to symbiont delivery and other biotech. Success hinges on early, accurate diagnostics; safe, non-punitive reporting; and growers engaged as co-developers, not just end users. Participants called for an independent program integrator to stitch research, regulation, and on-farm practice into an actionable roadmap, backed by industry partnerships and pragmatic regulatory strategies. The group emphasized rapid field validation ("trees in the ground"), rigorous data sharing, and resistance-aware stewardship to ensure durability. Finally, equity and regional inclusion were deemed essential: solutions must scale across borders, budgets, and supply chains so that progress anywhere strengthens citrus everywhere.

Annex. I Participant Bios

Day 1: Early detection, vector management, and certified plant material

Opening Session

Eugenia Saini

Executive Secretary of FONTAGRO. Agronomist and Doctor in Agricultural Sciences, born in Argentina, with a deep-rooted passion for advancing agriculture, improving food security, and enhancing the lives of farmers. I am committed to fostering impactful public and private alliances that drive international collaboration in food and agricultural science, innovation, and sustainable agribusiness. My career spans both public and private sectors, with experience at national and global levels. Honored to have been a Fulbright Scholar at Cornell University and, more recently, an Abshire-Inamori Leadership Academy (AILA) Scholar at the Center for Strategic & International Studies (CSIS) in Washington, D.C., I continue to dedicate my work to building resilient food systems and promoting innovation in agriculture globally.

Carlos Messina

Professor, Department of Horticultural Sciences, University of Florida. Dr. Carlos Messina is a professor of predictive breeding in the Department of Horticultural Sciences. Dr. Messina works with breeders to improve the nutritional value of Florida produce and to reimagine agriculture as a solution to climate change. He also specializes in developing AI for plant breeding, which he believes will enable society to harmonize crop improvement efforts for regenerative agricultural systems that improve human health, nutrient security and adaptation to climate change.

Panel 1: Early Detection, Diagnostics and Surveillance

Carrie Harmon

Extension Specialist, Plant Diagnostic Center

I joined the faculty of the UF Department of Plant Pathology in 2003, with responsibilities in extension focused on plant disease detection and diagnosis. My research program focuses on diagnostic method improvement and validation, and my extension program is built around plant disease diagnosis and training in the Plant Diagnostic Center. I serve a wide variety of extension clientele in Florida, the US, and abroad, directing plant problem diagnosis and training diagnosticians and plant professionals.

Romina Gazis

UF/IFAS Tropical Research And Education Center (TREC). Associate Professor - Plant Pathology - Director, Plant Diagnostic Clinic.

Dr. Gazis is a plant pathologist with extensive experience in fungal biology and an increasing interest in tropical plant diseases caused by other groups of plant pathogens. During her Ph.D. (University of Maryland) and two postdoctoral fellowships (Clark University and University of Tennessee), her research areas were quite diverse. Her dissertation focus was on fungal endophytes inhabiting wild and planted rubber trees (Hevea brasiliensis), with the aim of finding potential biological control agents that could be used against diseases detrimental to natural rubber production. In this project, she collected, identified and characterized hundreds of fungal cultures isolated as endophytes of trees grown in plantations and natural forests of Africa, South and North America. This research effort resulted in the description of several novel fungal lineages, including Trichoderma spp. with potential biocontrol properties and the unveiling of a novel branch in the fungal tree of life (Class Xylonomycetes). At Clark University, Dr. Gazis was part of the Open Tree of Life project where she conducted research on fungal systematics and evolutionary biology, as well as on the fungal comparative genomics and genes that play a role in determining the lifestyle of a fungus. At the University of Tennessee, Dr. Gazis used population genetics and genomic approaches to investigate the evolutionary dynamics and disease ecology of the pathogen/vector system involved in Thousand Cankers Disease.

Dr. Gazis long-term research goal is to understand the biology behind different plant diseases (Fungi, Bacteria, Oomycetes, Viruses) affecting local industries and natural landscapes and use this knowledge to develop efficient and long-term disease management strategies. At TREC, Dr. Gazis has a 60% extension and 40% research appointment. Most of the extension work is related to TREC's Plant Diagnostic Clinic. Serving a diverse array of businesses within the green industry, but with a focus mainly on commercial growers that cultivate ornamental, tropical fruits, and landscape crops. South Florida offers an ideal climate to grow plants year-around but it also represents a hot spot for plant diseases and an entry point for detrimental invasive species.

	**Rick Dantzler** **Chief Operating Officer, Citrus Research and Development Foundation** In 1982, at the age of 26, he was elected to the Florida House of Representatives where he served for eight years. In 1990, he was elected to the Florida Senate where he served until resigning in 1998 to run for the office of Governor of Florida. Later that year he became the Democratic nominee for Lieutenant Governor. After leaving office, Dantzler worked as a lawyer and mediator. In early 2013, he accepted an appointment from President Obama to serve as the State Executive Director of the Farm Service Agency within the USDA. At the end of President Obama's administration, Dantzler went back to practicing law before becoming the COO of CRDF in August of 2018.
	**Rodrigo Astete** **IICA-SAIA** Rodrigo Astete is an Agricultural Engineer, graduated from the University of Concepción, Chile (1995), with postgraduate studies in Public Management, International Negotiations, and Epidemiology. He has built a solid career in Chilean public administration, mainly at the Agricultural and Livestock Service (SAG), where he held technical and managerial positions for more than 25 years, 17 of them in senior management roles .Between 2014 and 2023, he served as Head of the Agricultural-Forestry Protection and Seeds Division at SAG, leading the implementation of plant health policies, regulatory enforcement, and the certification of exports, seeds, pesticides, and fertilizers. He also served as President of the Southern Cone Plant Health Committee (COSAVE) from 2016 to 2018, a period in which he fostered regional strategic planning in plant health. In 2023, he was appointed Deputy National Director for technical matters at SAG, consolidating his career in public management and institutional leadership. Since April 2024, he has been serving as International Specialist in Agricultural Health and Food Safety at the Inter-American Institute for Cooperation on Agriculture (IICA), with responsibilities in the Southern region (Argentina, Brazil, Chile, Paraguay, and Uruguay), actively participating in the SAIA program and in the Inter-American Coordination Group on Plant Health (GICSV).

Panel 2: Integrated Vector Management: innovations and challenges

	Dr. Charles L. Niblett Chuck was raised on a dairy farm in New Hampshire. He received his B.S. in Botany from the University of New Hampshire and his Ph.D. from the University of California, Riverside. His expertise is in applied and molecular plant pathology, particularly with diseases caused by viruses and viroids. For 11 years he did research on cereal viruses at Kansas State University, where he characterized several new viruses and identified the two different viruses causing maize lethal necrosis (MLN), now a serious disease worldwide. He was Plant Pathology Department chair at the University of Florida for 7 years and continued researching citrus viruses for 22 years. He has served as principal investigator and reviewer on numerous grants and for agencies such as AID, NSF, USDA, Fulbright and Rockefeller Foundations, and AgBio companies In 2004 he co-founded Venganza, Inc., a plant biotechnology company developing RNA interference (RNAi) to control plant diseases and pests without the application of pesticides.
	Ana Bailey Dr. Ana Maria Bailey Ana was born and raised in Monterrey, Mexico. She received her B.S. degree in Biology from the Universidad Autonoma de Nuevo Leon, her M.S. in Plant Pathology from the Colegio Superior de Agricultura Tropical in Tabasco, Mexico, and her Ph.D. from the University of California, Riverside. Her expertise is in applied and molecular plant pathology, especially with diseases caused by fungi and bacteria. For 20 years she was a professor at Centro de Investigaciones y Estudios Avanzados (CINVESTAV) in Irapuato, Mexico. She has served as principal investigator and reviewer on numerous grants and for agencies such as AID, CONACYT, and AgBio companies. In 2004 she co-founded Venganza, Inc., a plant biotechnology company developing RNA interference (RNAi) to control plant diseases and pests without the application of pesticides.

	**Lukasz Stelinski** **Professor - Entomology and Nematology** My research focuses on development of integrated management strategies for insect pest control. Although citrus is the focal commodity for my current research program, I extensively collaborate with colleagues on research projects involving insect pests of temperate tree fruit, small fruit (both temperate and tropical), as well as in other agricultural commodities such as ornamental plants and vegetables. My research interests include both principles-level fundamental questions as well as practical applied questions geared toward providing solutions to major problems facing a diversity of agricultural commodities. My philosophy is to meld basic and applied research as a single pursuit. My approach is to conduct research on the behavior and ecology of insects and subsequently develop biorational management solutions. Current ongoing projects include: 1) development of behavior modifying chemicals, including attractants and repellents, for pest control with a focus on but not exclusive to citrus pests, 2) toxicological investigations of insect growth regulators, 3) quantitative measurement of pest movement patterns and dispersal behavior in relation to management practices, 4) identification of herbivore induced volatile emissions from plant roots that recruit entomopathogenic nematodes, 5) development and optimization of mating disruption technologies for moth pests, 6) enhancement of biological control by identification and development of recruitment pheromones and kairomones for natural enemies, 7) pesticide resistance management, 8) development of antifeedants to prevent plant pathogen transmission by insect vectors, 9) pheromone-mediated multitrophic parasitoid-prey interactions, 10) insect sensory physiology as it relates to pheromone and kairomone perception, and 11) optimization of pesticide spray technologies.

Day 2: Genetic Resistance, regional collaboration, and resource mobilization

Panel 3: Genetic Resistance & Biotechonlogical Approaches

	**Frederick Gmitter** **Professor - Horticultural Sciences** Citrus breeding and genetics for variety improvement; genomic research to develop efficient ways to select improved plants and to enable cloning and manipulation of important genes; seedless variety development by mutation breeding and tissue culture methods; citrus germplasm acquisition and characterization; applied genetic transformation research.
	**Eric Triplett** Eric Triplett is Professor and Chair of the Department of Microbiology & Cell Science at the University of Florida. His research explores microbial diversity and interactions in both plant and human systems, with current projects addressing microbial aspects of Huanglongbing and the role of microbiomes in crop health.
	**Karen Koch** Professor, Department of Horticultural Sciences, University of Florida. Dr. Karen Koch is also a member of the UF-Genetics Institute and the Plant Molecular Biology Program. She focuses on the functional biology of crop species with emphasis on mechanisms that enhance quality and/or quantity of yield. Her expertise extends from field biology to molecular genetics and eagerly collaborates at all levels.

	**Rosemary Loria** Dr. Rosemary Loria is a professor of bacteriology in the Department of Plant Pathology at the University of Florida where she served as chair from 2011 to 2023. Prior to moving to UF, Loria served on the faculty at Cornell University where she was active in research, extension and teaching. She also served in several administrative roles at Cornell including chair of the Department of Plant Pathology (1999 – 2004). Loria received the prestigious Ruth Allen Award from the American Phytopathological Society (2010) for outstanding, innovative research on plant pathogenic streptomycetes. Loria is a Fellow of the American Phytopathology Society (2015) and a Fellow of AAAS (2020). She is currently pursuing novel sources of genetic resistance for disease management in crop plants.
	Kim Bowman Kim Bowman is a Research Geneticist and Acting Research Leader with the USDA Agricultural Research Service in Fort Pierce, Florida. He leads the SuperSour rootstock strategy, with a focus on developing new citrus rootstocks that improve tolerance to Huanglongbing (HLB) through long-term field evaluations.
	**Michelle Heck** Michelle Heck is a Research Molecular Biologist with the USDA Agricultural Research Service and a faculty member at Cornell University and the Boyce Thompson Institute. Her research examines insect–pathogen interactions and vector biology, with emphasis on understanding how insects transmit plant pathogens and on developing tools to disrupt transmission.

Panel 4: Regional Coordination and Extension

	Maria Mercedes Roca Dr. Maria Mercedes Roca, is a plant pathologist, virologist, and committed global citizen—born in Colombia, holding both British and Bolivian citizenship, and now based in Bolivia. Trained in the UK (B.Sc. Microbiology, King's College London; Ph.D. Plant Pathology–Virology, University College London), and with advanced risk analysis credentials from USDA and Texas A&M, Dr. Roca has forged an impactful career spanning research, academic leadership, and science policy across Latin America, the US, and Europe. Dr. Roca has directed and taught in biotechnology and integrated pest management programs at leading institutions—including the Tecnológico de Monterrey in Mexico and Zamorano University in Honduras—building capacity and collaboration at the intersection of science, innovation, and regulatory policy. She has played a central role in regional and international biotechnology regulatory frameworks, serving on biosafety committees (including CIBIOGEM, Mexico, Biotechnology & Biosafety Committee, Honduras) and as a national delegate and Youth Biotech representative in UN negotiations concerning the Cartagena Protocol of the Convention on Biological Diversity. She is co-author and editor of the "Environmental Risk Assessment Guide for Genetically Modified Organisms," published in 2024 as a collaborative effort with CTNBio Brazil and experienced US specialists, now used regionally by researchers and regulators alike. Currently, Dr. Roca leads BioScience Think Tank and coordinates Bolivia's Master's in Agricultural Biotechnology at Universidad Gabriel Rene Moreno. She also advises regional innovation funds and remains deeply committed to preparing the next generation of scientists and policy leaders, fostering technical excellence and building networks for regional cooperation under One Health principles and the emerging bioeconomy. With her extensive scientific, regulatory, and cross-cultural experience, Dr. Roca brings to the citrus greening event a unique perspective on integrated disease management, regional regulatory harmonization, and collaborative innovation for agriculture's most urgent challenges.

Michael Rogers

Dr. Michael Rogers is Director and Professor at the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) Citrus Research and Education Center (CREC). He joined the CREC in 2004 as an entomology Extension specialist, where he developed citrus integrated pest management (IPM) programs for Florida growers. Following the arrival of citrus greening, his work focused on management of the Asian citrus psyllid, including field trials and research on feeding behavior, insecticide use, and disease spread. Rogers led the creation of the statewide Citrus Health Management Area (CHMA) program, which grew to 52 CHMAs covering 486,000 acres of commercial citrus, helping growers coordinate psyllid control while reducing sprays and pesticide resistance risks. Since 2014, he has served as CREC Director and UF/IFAS Statewide Citrus Research & Extension Coordinator, guiding research and outreach efforts to support Florida's citrus industry.

Moderator

Martín Oesterheld

Chief Scientist of FONTAGRO. He was born in Argentina and holds degrees in Agricultural Engineering and a Ph.D. in Biology. He developed his academic and research career at the Faculty of Agronomy of the University of Buenos Aires and at CONICET (the National Scientific and Technical Research Council of Argentina), where he currently works on an honorary basis. His two main research areas are plant–herbivore interactions and the spatial and temporal patterns of energy flow in grasslands and savannas. He has developed technology to monitor and forecast forage production and crop yields using remote sensing tools, which have been widely adopted both nationally and regionally. He has taught undergraduate and graduate courses on various aspects of ecology and technical communication. He has served as editor-in-chief and associate editor of scientific journals, Director of the Graduate School at the Faculty of Agronomy of the University of Buenos Aires, and Director of the Institute of Physiological and Ecological Research Related to Agriculture (IFEVA). He is a full member of the National Academy of Agronomy and Veterinary Medicine of Argentina.


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