Sustainable Chemistry Meets Bioeconomy: A Perfect Match

How Sustainable Innovation Can Drive Inclusive Growth in Latin America and the Caribbean

Adrián Rodríguez is Chief of the Bioeconomy Unit at United Nations Economic Commission for Latin America and the Caribbean (UN ECLAC). In September last year, he and Romina Laumann, Director of Strategic Alliances at the International Sustainable Chemistry Collaborative Centre (ISC3), visited Germany for a study trip on bioeconomy for regional development.

A Vision for Sustainable Growth

The compelling question of their trip was: Can sustainable chemistry and bioeconomy work hand in hand to promote long-term, inclusive growth in Latin America and the Caribbean (LAC)? They, along with Latin American representatives, investigated how bio-based industries powered by sustainable chemistry create new economic value. Visits to biorefineries and innovation centers during their study tours led to collaborations, joint publications, and a new key insight: sustainable chemistry and bioeconomy could be a perfect match, opening strong paths to sustainable regional development—for inclusive growth in LAC.

Biomass as a Resource: Chemistry's Transformative Role

Chemistry plays a key role in turning organic matter into valuable products. Technologies like enzymatic catalysis and fermentation allow industries to produce bioethanol, bioplastics, and specialty chemicals from agricultural residues, forestry byproducts, and even algae. What's more, innovations in chemical engineering are enabling more precise control over bioconversion processes, increasing yield and product quality. For instance, synthetic biology allows the design of microorganisms tailored to produce specific molecules. These developments offer huge potential for LAC economies to diversify exports and reduce dependence on fossil-based imports.

Biorefineries play a crucial role in this. They are at the heart of a circular bioeconomy because they integrate biochemical and thermochemical processes to convert biomass into a wide array of products and support industrial symbiosis by ensuring that one process's waste becomes another's input. In countries like Brazil, stakeholders are already developing such systems.

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Adrián Rodríguez, UN ECLAC

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Bio-Based Doesn't Automatically Mean Sustainable

When visiting the model region of bioeconomy at the National Research Center Jülich, Rodríguez pointed to a pilot biorefinery in Ecuador that turns crop waste into clean fuel: "A byproduct once seen as waste can become a key economic driver." In the discussion with experts on site, Laumann emphasized that "bio-based doesn't automatically mean sustainable." If designed inefficiently, these processes can consume excessive energy or involve harmful chemicals. After the visit to the plant and the discussions on site, the group of Latin American officials saw lasting confirmation that sustainable chemistry ensures safer, smarter, and resource-efficient solutions.

Use of Agricultural Residues Offers Great Potential

These on-the-ground insights were further enriched by joint research initiatives that explored region-specific opportunities for bio-based innovation. One such area of growing interest is the use of agricultural residues—a resource with significant untapped value in LAC.

A study implemented in the framework of the German-UN ECLAC Strategic Cooperation explored the economic potential of using agricultural residues in four value chains. These projects revealed promising opportunities for value creation yet also highlighted risks. Some biofuel production can conflict with food security or biodiversity. Here, sustainable chemistry guides

decision-making to avoid such trade-offs. To further advance this field, policy support is vital. Investment in biorefinery infrastructure, streamlined regulatory processes, and financial incentives for startups can help scale innovations. Pilot programs in Argentina and Peru have shown that local communities, when involved early, become champions of bio-based transitions. The key lies in building public trust and ensuring benefits are distributed equitably.

"A byproduct once seen as waste can become a key economic driver."

Adrián Rodríguez,
UN ECLAC

Sustainable Chemistry Innovation in Latin America and the Caribbean: Toward Safer Materials

Back to the study trip: During an exchange round with regional development agencies in Leipzig, Rodríguez reported on a project in Uruguay that is a great example of how sustainable chemistry drives the development of biodegradable, recyclable materials. It explores packaging made from pine pulp and industrial hemp. "This is an eco-friendly alternative to plastics," said Rodríguez- "But making it scalable and competitive remains a challenge. Because on the one hand, chemistry helps optimize material properties and reduce production costs. On the other hand, success depends on thoughtful and benign design."

The principles of sustainable chemistry ensure that environmental benefits are not lost in pursuit of growth. There is also growing interest in integrating Life Cycle Assessment (LCA) into product development. LCA tools help researchers and companies evaluate environmental impacts, ensuring that innovations deliver genuine sustainability gains. This is especially relevant in LAC, where environmental degradation and social inequality often overlap. When paired with holistic evaluation tools, green chemistry becomes a lever for just transitions.

Strategic Capacities: Unlocking Regional Potential

After returning from the study trip to Germany, Rodríguez is even more convinced that bioeconomy is a key strategy for diversifying the LAC economy and creating local value. "Currently, bioeconomic value is concentrated in food and agriculture," he noted. "But with investment in knowledge and innovation, the Latin America and the Caribbean region can go further."

"Bio-based doesn't automatically mean sustainable."

Romina Laumann,
Director of Strategic Alliances, ISC3

LAC's vast biodiversity offers a rich foundation for bio-based industries. Brazil, for instance, used its G20 presidency to launch a global bioeconomy Initiative. The initiative promotes sustainable growth, conservation, and job creation. Meanwhile, national policies in Colombia and Brazil are starting to embed bioeconomy principles into their broader industrial strategies.

Moreover, academic institutions and innovation clusters play a pivotal role in capacity development. Universities in Chile and Costa Rica are already offering interdisciplinary programs in bioeconomy and green chemistry. Supporting these ecosystems through international cooperation can create a new generation of skilled professionals equipped to lead the region's sustainable transformation.

A Collaborative Path Forward

The study trip has impressively demonstrated the need for cross-regional collaboration, particularly Germany, has supported LAC through knowledge transfer, research, and green investment. Programs have played a vital role. But strengthening cooperation within LAC itself is equally important. It enhances supply chain resilience, supports local production, and spreads the benefits of innovation.

The ISC3 White Paper "Advanced Bioeconomy and Bioenergy: Strategies for Sustainable Development in Ecuador & Uruguay" offers guidance:

- Adopt "Safe and Sustainable by Design" principles
- Invest in education and local expertise
- Build inclusive policy frameworks

Sustainable chemistry and bioeconomy, together, hold the potential to lead LAC into a future of innovation-driven, sustainable prosperity.

Looking ahead, the establishment of regional platforms for dialogue and joint action will be essential. Whether through shared research hubs, intergovernmental working groups, or multi-stakeholder initiatives, a united approach will help LAC countries realize the full promise of a sustainable bioeconomy rooted in chemistry. In a world confronting climate crisis, resource scarcity, and inequality, the synergy between sustainable chemistry and bioeconomy stands out as both visionary and necessary.

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As Laumann put it with a wink: "'A Perfect Match.' And perhaps, a blueprint for the future."

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