

# BIODESIGN IN COLOMBIA

## TURNING FASHION ADVERSITY INTO INNOVATION AMIDST SOCIOECONOMIC CHALLENGES

### **CAROLINA OBREGÓN**

School of Fashion, Parsons School of Design,  
The New School

*obrec164@newschool.edu*

*Orcid 0000-0002-6665-060X*

### **GIOVANNA DANIES TURANO**

School of Architecture and Design,  
Department of Design, Universidad de los Andes

*g-danies@uniandes.edu.co*

*Orcid 0000-0001-9689-1140*

**Copyright:** © Author(s). This is an open access, peer-reviewed article published by Firenze University Press and distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Data Availability Statement:** All relevant data are within the paper and its Supporting Information files.

**Competing Interests:** The Author(s) declare(s) no conflict of interest

DOI: <https://doi.org/10.36253/fh-3221>

## Abstract

Under the British dictionary and ChatGPT, **Prosperity** is defined in the context of today and the future in multiple dimensions, reflecting economic well-being and broader aspects of human development and societal health (OpenAI, 2024). As defined in contemporary and future contexts, prosperity encompasses sustainable growth, social equity, environmental stewardship, and adaptability to evolving global dynamics. This paper investigates how Colombia can navigate a prosperous fashion future amidst economic stagnation and the historical dominance of the Global North. By leveraging Colombia's rich biodiversity, this research illustrates how biodesign can transform challenges into opportunities, reshaping the fashion industry through innovative practices and ethical considerations. Through qualitative analyses of perspectives from Colombian biodesigners and fashion designers, the study examines the potential of local resources, ancestral knowledge, and emerging technologies to redefine sustainability. The findings highlight biodesign as a transformative tool that bridges social equity, environmental sustainability, and economic viability, showcasing a roadmap for a regenerative and inclusive fashion ecosystem. This exploration underscores Colombia's role as a model for integrating cultural heritage, biodiversity, and cutting-edge innovation into the global fashion narrative.

**Keywords:** *Biodesign, Colombian fashion, Sustainability; Prosperity, Biodiversity*

## INTRODUCTION

The Colombian fashion industry plays a crucial role in the nation's economy. In 2025, the apparel market is projected to reach approximately US\$10.82 billion, with an annual growth rate of 2.92% through 2029 (Apparel - Colombia | Statista Market Forecast, 2024). In the first quarter of 2024, the fashion market expanded by 6.3% compared to 2023, generating 10.52 trillion pesos in revenue, driven by global price increases (Viana, 2024). The industry is composed mainly of small and medium-sized enterprises (SMEs), with labor costs remaining among the lowest in Latin America, which enhances its competitiveness (FASHION INDUSTRY| Invest in Colombia, 2024). However, the industry's environmental footprint is concern-

ing, with fast fashion contributing significantly to waste. For instance, 92 million tonnes of textiles are discarded globally every year, and fashion waste continues to pollute Colombia's beaches, especially along the central Caribbean coast, where discarded items like shoes and sandals have been found in large quantities (Rangel-Buitrago & Gracia C., 2024). These challenges highlight the urgent need for sustainable practices in Colombia's growing fashion sector.

Colombia, known for its rich culture and biodiversity, faces profound socioeconomic challenges. Historically seen as a resource-rich nation supplying low-cost labor and materials to the Global North (Otero-Cleves, 2010), Colombia can potentially redefine its role in the global fashion

system. A shift from traditional paradigms could foster a fashion system prioritizing social and environmental dimensions alongside economic metrics. Biodesign, which merges biology and design for sustainability and innovation, exemplifies this shift by utilizing DNA, enzymes, bacteria, and raw fibers to reshape the industry.

Colombia is undergoing a renaissance, leveraging its biodiversity to redefine prosperity in fashion. This approach moves beyond imitating the Global North, focusing on regeneration rather than extraction. Through a biological design lens, new possibilities emerge, reconfiguring human and non-human relationships and emphasizing each component's potential to contribute to prosperity while minimizing environmental and human impacts. Biodesign enables innovation, fostering ethical reflection and creating opportunities (Myers, 2015). In Colombia, this approach aligns with a growing innovation sector, bridging traditional fashion design with biodesign.

Despite its progress, Colombia grapples with significant inequalities. Prosperity remains elusive for much of the population, with access to quality of life heavily influenced by social and economic status (Meisel, 2014). Income inequality is among the highest in Latin America, with the wealthiest 20% controlling 60% of the nation's wealth (El País, 2024). Poverty affects 39.3% of Colombians, and 44.2% live on less than \$6.85 daily (The World Bank, 2021; The World Bank, 2021). Structural barriers, such as geographic fragmentation and unequal education systems, perpetuate disparities, with 44% of income inequality tied to circumstances at birth (El País, 2024). Violence remains a systemic issue, with a homicide rate of 23.7 per 100,000 in 2023, disproportionately affecting Afro-Colombian and Indigenous populations, who face poverty rates of 50% and 63%, respectively (DANE, 2023; Insight Crime, 2024).

In response to these challenges, Colombian designers are increasingly moving away from the aspirational norms of the Global North's fashion systems and, instead, are forging a unique path by leveraging local resources and ancestral knowledge. This shift is evident in integrating scientific advancements, such as biodesign and sustainable materials, reshaping the industry's trajectory in the Global South. For instance, designers use the country's rich biodiversity to develop bio-based materials, including bacterial dyes, mycelium

textiles, and plant-based fibers. Initiatives like Universidad de los Andes' Biodesign Challenge and collaborations with artisans highlight how Colombia combines ancestral knowledge with cutting-edge innovation to create sustainable, inclusive, and culturally significant fashion. Examples include efforts to incorporate waste into production, such as *Woocoa*, which transformed local agricultural byproducts into viable textiles. This contributes to fashion's environmental sustainability and supports economic empowerment by involving artisanal communities in the production chain. Regional brands like Baobab and Laura Laurens emphasize circular economy principles and ethical production, redefining prosperity through inclusivity and ecological stewardship.

This paper explores Colombia's transformation, highlighting the interplay between scientific research, localized knowledge, and sustainable design. By embracing local resources and innovative practices, Colombian fashion is carving a distinct path that addresses global and regional challenges. This redefinition of prosperity demonstrates how an industry shaped by inequality can evolve into a model of innovation and regeneration.

## METHODOLOGY

This study adopted a qualitative research approach to explore the evolving role of biodesign within the Colombian fashion industry and its potential to redefine prosperity. By examining the practices of biodesigners and fashion designers, the research aimed to uncover how biodesign is reshaping the industry. Qualitative methods were selected to better understand the contextual, cultural, and socio-economic factors influencing these practices. The methodology combined two key components: case studies of biodesign projects and semi-structured interviews with Colombian biodesigners and fashion designers collaborating with local communities to promote sustainability.

The interviews involved Cristina Cruz (*Micelva*), Diego Arango (*Sauria*), Diego Hernandez (*E.biodye*), Matilde Orduz (*Filling Green*), Nicole Hakim (*LOOP*), Julieta Gaitan (*Wasi*), Moises Hernandez (*Woocoa*), Juanita Salgado (*Biodesign*), Sofia Moncayo (*Brideology*), Danielle Lafourrie (*Olga Piedrahita*), Isabella Espinosa (*Baobab*), and Laura Laurens (*Laura Laurens*). Thematic analysis was employed to identify recurring patterns and key insights related

to sustainability, community engagement, and innovation in the industry.

## CASE STUDIES

The first component of the methodology involved analyzing biodesign projects from Universidad de los Andes in Bogotá, a leading institution in fostering innovation and sustainability in the design and fashion sectors. Projects selected for case studies included those that had received significant recognition, such as being finalists in the Biodesign Challenge competition held once a year at Parsons School of Design and MoMA in New York City, and those that excelled in the classroom, demonstrating innovative thinking and impactful design solutions. These case studies detailed how biodesign principles were applied, including the materials and methods used and collaborations with artisans or communities. A systems thinking perspective was used to develop the projects by ensuring and visualizing the environmental and social impacts of the projects. Specific questions guided the exploration, such as: How do these initiatives integrate biodesign principles into fashion? What are the measurable environmental and social impacts of these projects? What barriers exist to scalability, and how are they addressed within the Colombian context?

## SEMI-STRUCTURED INTERVIEWS

The second component comprised semi-structured interviews with team members from the selected biodesign projects and other local fashion designers. This method was chosen for its flexibility, enabling participants to provide in-depth responses while allowing the interviewer to explore unanticipated topics that emerged during the written questionnaire. The interviews focused on the designers' backgrounds, motivations, and definitions of sustainability and their experiences integrating biodesign principles into their work from their perspective as Colombian designers.

The semi-structured interviews also aimed to uncover the challenges faced in implementing biodesign practices, such as limited access to advanced biotechnologies, financial constraints, and consumer education gaps. Participants were asked to provide insights into their engagement with local communities and resources, emphasizing how these collaborations influenced their designs and contributed to social and environmental sustainability. Additionally, they shared their perspectives on emerging trends in Colombian

fashion, recommendations for fostering sustainable practices within the industry, and the comparison with the Global North.

## ETHICAL CONSIDERATIONS

The study adhered to ethical research standards by obtaining informed consent from all interview participants and ensuring the confidentiality of sensitive information. Participants were informed about the purpose of the study and their right to withdraw at any stage without any repercussions. By combining case studies and semi-structured interviews with rigorous analysis and ethical practices, this methodology provided a holistic understanding of the transformative potential of biodesign and fashion in Colombia. The approach allowed for exploring both practical and theoretical dimensions of biodesign, situating it within the broader discourse of sustainability and innovation in fashion. This multifaceted methodology underscores the importance of contextual and localized approaches in fostering sustainable development and redefining prosperity in creative industries.

## RESULTS

### CASE STUDIES ANALYZED

Case studies were analyzed to provide insight into the application of biodesign principles, the environmental and social impacts of these projects, and the challenges they face in scaling within the Colombian context. The projects examined include *Sauria*, *E.biodye*, *Bridelogy*, *Filling Green*, *Woocoa*, and *LOOP*, each offering innovative solutions to various environmental and ethical challenges in the fashion industry.

#### *Sauria*: Ethical Alternatives in the Reptile Skin Industry

*Sauria* represents a pioneering approach to addressing ethical and environmental issues within Colombia's reptile skin trade, a sector linked to illegal hunting and habitat destruction. The project's innovative use of in vitro reptile skin production significantly reduces the need for animal exploitation by replacing traditional skin sourcing with lab-grown materials. This biodesign process involves biopsy collection, tissue culture, and harvesting, minimizing reptile harm and mitigating the environmental damage caused by the conventional reptile skin industry. The project aligns with Colombia's conservation goals by

supporting endangered species protection, fostering ethical luxury markets, and offering an alternative to practices that harm biodiversity. Despite its promise, *Sauria* faces scalability challenges due to high production costs and the need for regulatory frameworks that support lab-grown alternatives. However, it represents a key step in redefining the luxury goods market with sustainability at its core (Fig. 01).

### ***E.biodye*: Revolutionizing Dyeing Practices**

*E.biodye* introduces a groundbreaking solution to dyeing, one of the fashion industry's most polluting processes. Traditional dyeing methods consume vast quantities of water and produce toxic runoff, contributing significantly to environmental degradation. *E.biodye* employs engineered microorganisms to produce eco-friendly dyes, significantly reducing water usage and pollution. This innovation provides a sustainable alternative to conventional dyeing methods and aligns with Colombia's broader environmental conservation efforts. Using local microbial resources, *E.biodye* creates economic opportunities within the biotechnology sector, supporting green technologies and fostering a culture of innovation. Despite these benefits, the scalability of the technology depends on the further development of local infrastructure and market acceptance of biotechnological solutions in fashion.

While the *E.biodye* team has yet to fully quantify the reduction in greenhouse gas (GHG) emissions, their process has shown substantial potential for mitigating environmental impacts. The fixation process operates at lower temperatures (50-70°C), reducing GHG emissions by approximately 45-55%, while dye production occurs at 37°C, cutting emissions by about 41-47% compared to conventional methods. Additionally, *E.biodye* uses simple sugars instead of fossil fuel-based intermediates, eliminating the carbon emissions typically associated with chemical dye production.

*E.biodye*'s process is also highly efficient in water use, allowing for water reuse throughout the dye production cycle, thus minimizing waste. They also eliminate the generation of toxic waste by ensuring that no effluents containing heavy metals or harmful byproducts are produced. Furthermore, the dyes are fully biodegradable, preventing water bodies and soil contamination. Last, a key feature of the *E.biodye* production process is the transformation of bacterial cells without using antibiotics to

select successfully transformed cells. This approach minimizes the environmental and health concerns often associated with antibiotic use in industrial processes. *E.biodye* exemplifies how biodesign can address key ecological issues while fostering economic growth (Fig. 02).

### ***Brideology*: Redefining Traditional Fashion Concepts**

The *Brideology* project challenges traditional notions of wedding attire by creating a biodegradable wedding dress made from corn starch, gelatin, and dandelion fibers. This project embodies the principles of circularity and biodegradability, aiming to reduce the fashion industry's environmental footprint by rethinking the garments' life cycle. While the biodress offers an innovative solution to waste generated by the fashion industry, it requires specific preservation conditions, such as avoiding high temperatures. The project's challenges lie in scaling its production while ensuring its performance and durability under different environmental conditions. Despite these obstacles, *Brideology* offers an inspiring example of how fashion can achieve greater sustainability by embracing alternative, biodegradable materials (Fig. 03).

### ***Filling Green*: Sustainable Alternatives to Down and Polyester**

The *Filling Green* project addresses the ethical and environmental concerns surrounding down feathers and polyester by proposing plant-based alternatives. Utilizing corn silk, pineapple leaves, and tururi sacs from the Amazon's Jagua tree, *Filling Green* offers materials that are renewable, biodegradable, and free from the cruelty often associated with traditional down. These materials reduce waste—corn silk is frequently discarded as a byproduct of corn farming—and offer functional benefits comparable to animal-derived and synthetic alternatives. This biodesign solution promotes environmental sustainability and supports ethical practices in the fashion industry. However, scalability is limited by the availability and harvesting of these materials, particularly the tururi fiber, which is native to specific regions in Colombia. Addressing logistical and supply chain challenges will be critical for the widespread adoption of these materials in fashion.



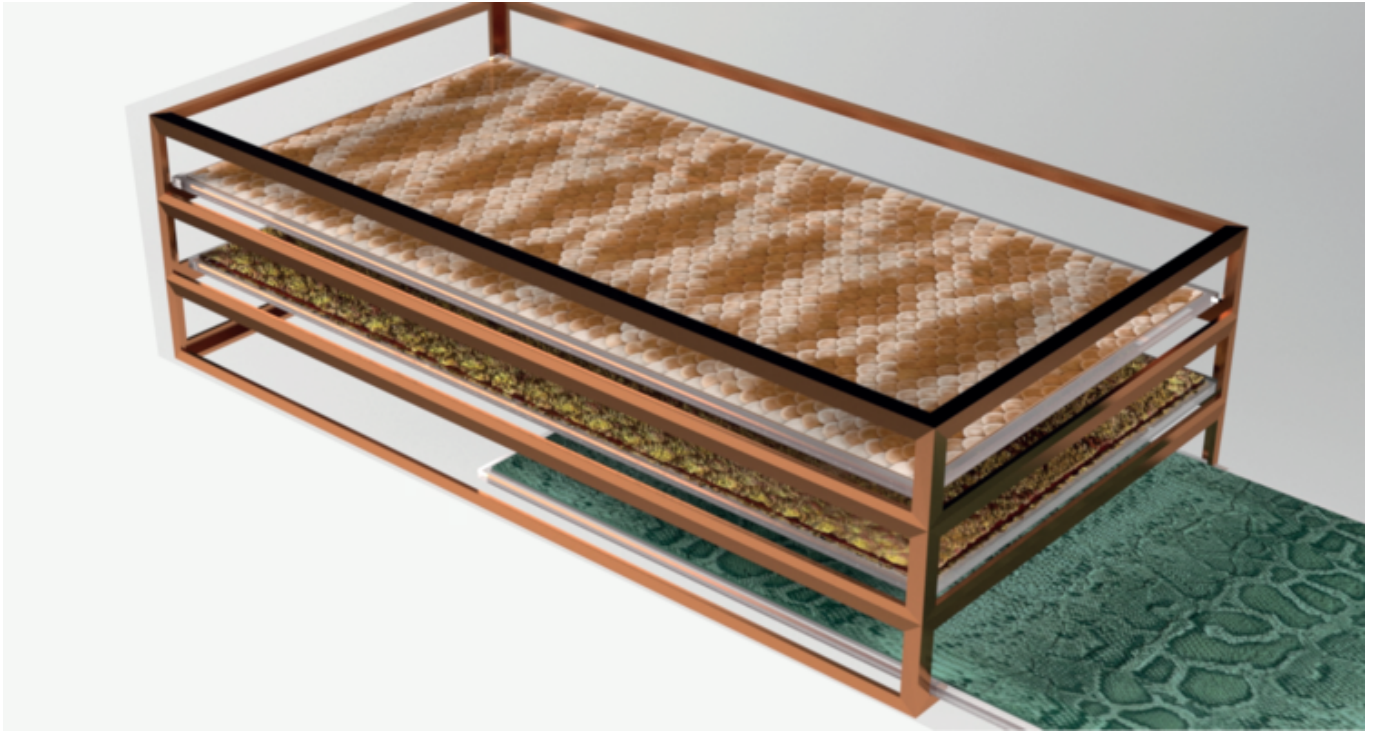


Fig. 01



Fig. 02



Fig. 03

## Woocoa: Harnessing Colombia's Biodiversity for Sustainable Fashion

*Woocoa*, an innovative vegan wool alternative made from a blend of *Cannabis sativa* and coconut fibers, exemplifies the potential of biodesign to transform waste into sustainable, eco-friendly materials. By addressing fiber roughness with a Lacasse enzyme derived from oyster mushrooms, *Woocoa* mimics the softness and qualities of traditional wool, providing a cruelty-free, environmentally conscious option.

The project also highlights Colombia's rich biodiversity, repurposing cannabis industry waste and creating economic opportunities in rural areas that have historically relied on illicit marijuana cultivation. However, *Woocoa*'s scalability faces challenges, including the need to expand local cannabis fiber processing infrastructure and overcoming market resistance to new, non-traditional fibers. Despite these hurdles, *Woocoa* offers a promising solution to reduce the environmental impact of wool production while fostering local economies.

When compared to conventional cotton, *Woocoa* significantly outperforms in sustainability. The current garment industry's demand for hemp, a variety of *Cannabis*, can be met by using only one-third of the land required for cotton to produce the same amount of fiber. Regarding water consumption, cotton demands 2.5 times more water per hectare than hemp. Additionally, cotton is among the highest consumers of pesticides and insecticides in the world, whereas hemp, thanks to its resilience and rapid growth, requires no pesticides or insecticides (Duque Schumacher et al., 2020) (Fig. 04).

### LOOP: Circular Fashion with Biomaterials

*LOOP*, a sustainable fashion brand, exemplifies the power of circular design in fashion, promoting a manifesto of sustainability through biomaterials and circular processes. By embracing sustainable materials and production methods, *Loop* aims to redefine the fashion industry's approach to resource consumption. The brand's focus on craftsmanship, innovation, and the use of renewable resources resonates with the principles of biodesign and circularity. *LOOP*'s commitment to creating a closed-loop system ensures that products are designed with end-of-life considerations, allowing them to be returned to the cycle responsibly. While *LOOP*'s approach to circular fashion is innovative, its scalability is hindered by the complexities of



Fig. 04

consumer behavior and the widespread adoption of circular fashion models. Despite these challenges, *Loop*'s success in merging craftsmanship with sustainability offers a pathway for the fashion industry to transition toward more conscious consumption.

## SEMI-STRUCTURED INTERVIEWS

Recurring patterns and key insights from the alumni and sustainable fashion designers' responses were extracted using a thematic analysis approach. The process involved coding the qualitative data, identifying significant themes, and drawing conclusions on their relevance to the broader context of fashion. Each response was reviewed to highlight central ideas, unique experiences, and commonalities among the alumni and fashion designers, respectively.

### Qualitative Analysis of Biodesign Alumni Responses

This analysis delves into the experiences, challenges, and perspectives of biodesign alumni, focusing on the intersection of biofashion and sustainability. Using a thematic approach, we identified key



insights, recurring patterns, and alumni contributions to fashion. The analysis is structured around five core dimensions: Background and Motivation, Biodesign Integration, Challenges and Opportunities, Community Engagement, and Future Perspectives.

## **BACKGROUND AND MOTIVATION: BRIDGING DESIGN AND NATURE**

Biodesign alumni exhibited a strong alignment between their academic backgrounds and professional motivations. Many cited diverse influences—from microbiology to local artisan traditions—propelled them toward sustainable design alternatives. A common theme was to bridge scientific knowledge and creative processes to challenge the extractive, profit-driven fashion industry, including i) personal and academic influence, ii) connection to biodiversity and local contexts, and iii) a personal mission to drive systemic change.

Alumni often attributed their inspiration to pursue biodesign to academic courses on biomaterials, sustainability, and microbial experimentation. Professors specializing in biodesign played pivotal roles in guiding students toward biofashion. The influence of Colombia's biodiversity and artisanal heritage was frequently mentioned as a motivating force, with students exploring local resources such as fungi, natural fibers, and cultural techniques to create sustainable materials. Alumni exhibited a clear sense of personal mission to create systemic change in the fashion industry by addressing environmental challenges and rethinking waste as a resource.

A key quote encapsulates this ethos: 'Biofashion is not just a trend but a movement toward a symbiotic relationship between humanity and the environment, where creativity evolves hand in hand with nature's intelligence.' This statement reflects the transformative role of biodesign education, emphasizing a holistic integration of environmental stewardship and creative innovation.

## **BIODESIGN INTEGRATION: FROM CONCEPT TO CO-CREATION**

For alumni, biodesign extends sustainability beyond harm reduction to embrace regeneration, circular economies, and cultural preservation. Merging biology and design, biodesign involves living organisms as co-creators. Key themes include its definition, innovative techniques, and experimental design processes.

Biodesign transcends functionality by embedding ecological thinking and closed-loop systems. Methods such as bacterial and fungi-based dyes, bioplastics, and natural fibers like Iraca, Cumare, and silk exemplify its approach. Experimentation through trial and error—developing microbial dyes, mycelium-based materials, and cornstarch bioplastics—was central, emphasizing iteration and nature collaboration.

An alumnus shared: 'Biodesign shifts focus from human-centered solutions to co-creating with nature, reimagining design to align with ecological principles.' Alumni projects like mycelium textiles and bioplastics showcase this paradigm shift, replacing traditional methodologies with holistic, nature-inclusive approaches.

The emphasis on ecological principles redefines material sourcing, manufacturing, and waste transformation, illustrating the interconnectedness of natural, social, and industrial systems. This regenerative philosophy models prosperity in fashion, demonstrating that biodesign is not merely a set of tools but a holistic approach prioritizing sustainability and the health of all systems.

## **CHALLENGES AND OPPORTUNITIES: SCALING INNOVATION WHILE PRESERVING INTEGRITY**

Biodesign's promise is tempered by challenges like scaling production, cost constraints, market barriers, consumer perception, and infrastructural gaps. Innovations such as microbial dyes and fungi-based textiles face hurdles in replicability, cost, and process optimization when moving to industrial scales. High material costs and slow production processes make products less competitive in fast-fashion markets, and consumer education on the value of handmade, slow fashion remains a challenge. Limited access to biotechnological resources, such as sterile labs, and a lack of localized infrastructure for testing and scaling further hinder progress.

Alumni emphasize the potential of cross-disciplinary collaboration among designers, engineers, and scientists to create circular models and reimagine production systems. Consumer education is vital, as sustainable fashion is often undervalued compared to mass-produced alternatives. One alumnus stated, 'Biodesign introduces inherently sustainable systems, creating decentralized models that empower communities and reduce dependency on global industries.' This reflects biodesign's shift from linear, extractive systems to



regenerative practices rooted in circular economies and ecological balance.

Decentralization is pivotal, as localized production reduces carbon footprints and bolsters regional economies. Projects in Colombia, leveraging native biodiversity like bacterial strains and agricultural by-products, exemplify this approach.

## COMMUNITY ENGAGEMENT: LOCAL KNOWLEDGE AND RESOURCES

Themes of community engagement were prominent, with many alumni recognizing the importance of involving local communities in production. Key themes included: i) local community, ii) role of local resources, and iii) knowledge sharing.

The collaborative proposals tend to vary depending on the artisans or designers involved. The designer's role often involves understanding the artisans' local processes, timing, and working methods. In this way, the designer essentially acts as an interpreter, navigating what the artisan can produce while guiding the project along that path. These collaborations can be profoundly enriching for the artisans as they introduce new ways of thinking and perspectives on their craft.

These collaborations offer designers invaluable access to materials and processes deeply rooted in the land, providing a unique and authentic experience. However, as stated by Olga Piedrahita's Creative Director, Danielle Lafourrie, one of the main challenges of these collaborations is the difference in work rhythms. For instance, in regions like Guajira, in the north of Colombia, when there is a death in the community, rituals can take up to a month and a half, during which production completely halts. Additionally, maintaining consistency in materials over time can also be challenging. A simple example is when artisans order materials today, and then the next day, they purchase the same materials but may not always be aware that color consistency or material quality needs to be maintained throughout production, which can lead to variations in the final products.

In terms of the impact on the craft, these collaborations offer new perspectives on traditional techniques, one of the most valuable outcomes for the artisans involved. The exchange of knowledge and ideas can deeply influence both the artisans' work and the designers' approach, resulting in a dynamic and mutually beneficial relationship.

Alumni underscored the importance of

working with local artisans, co-developing new techniques, and incorporating traditional crafts into sustainable design. This collaborative approach ensures the fashion process remains contextually relevant while honoring local heritage. One alumna stated: 'Collaboration with local communities is central to my design process. I work closely with artisans, blending tradition with contemporary design for the global luxury market.'

A key quote from the alumna highlights her approach: 'Collaboration with local communities is central to my design process. From the start, I worked closely with artisans, learning their techniques and co-creating designs that blended tradition with contemporary expressions for the global luxury market.' Projects incorporating Colombian traditional weaving techniques or local plant fibers illustrate this model, where artisans are not just labor providers but active co-creators, ensuring cultural respect and shared ownership.

## FUTURE PERSPECTIVES: BIODESIGN AS A CATALYST FOR SYSTEMIC CHANGE

Alumni envision biodesign as a catalyst for broader systemic change in the fashion industry. They identified emerging trends, such as increased use of bio-based materials, circular economy practices, and integrating traditional crafts with biotechnological innovations. Key themes included: i) emerging trends, ii) policy and regulation, iii) consumer education, and iv) hope for the future of biofashion.

Several alumni expressed optimism about the growing visibility of biodesign, particularly in Colombia, where the rich biodiversity and cultural heritage offer unique opportunities for sustainable fashion. They called for policy changes to incentivize sustainable practices, such as carbon taxes and support for circular production. Recommendations included government support for bio-labs, funding for research, and decentralized production infrastructure. Alumni also emphasized a cultural shift toward valuing quality, slow fashion, and transparency. Many highlighted increased student and community interest and the inclusion of biodesign courses in academic programs.

A key quote highlights Colombia's potential in biofashion: 'By leveraging its biodiversity and cultural heritage, Colombia has the potential to lead in biofashion, showcasing how natural resources can inspire world-class, sustainable design.' As the second-most biodiverse country, Colombia is well-positioned to lead sustainably by creating

bio-based materials that are both innovative and rooted in its unique ecosystems. This recognition positions Colombia as more than just a supplier of raw materials. Instead, it frames the country as a hub for biodesign-driven innovation, where biodiversity is not only preserved but also as a unique inspirational framework fostering creative and sustainable applications.

### Qualitative Analysis of Colombian Sustainable Fashion Designers

Interviews with Colombian designers from diverse backgrounds—from fine arts to industrial design and law—revealed a complex and evolving landscape for sustainability in fashion, emphasizing the importance of localized, innovative approaches that respect cultural and ecological values. The designers highlighted the potential for Colombian fashion to redefine prosperity through sustainability, addressing environmental and social equity concerns.

### SOCIOECONOMIC CONTEXT

Designers acknowledge the socioeconomic challenges that hinder sustainable innovation in Colombia, such as inequality, limited access to education, and the dominance of informal labor markets. Furthermore, there is a lack of local fabric suppliers' reliance on imports, restricted access to artisanal training due to economic constraints, and greenwashing practices by more prominent manufacturers. However, these challenges also foster resilience and creativity. Designers see opportunities to empower local artisans by providing education and fair wages and promoting local supply chains to reduce dependence on imported materials.

### LEVERAGING BIODIVERSITY

Colombia's exceptional biodiversity is a key resource for sustainable fashion innovation, inspiring materials, and techniques rooted in its ecosystems. Designers highlight the potential for integrating local ecosystems into fashion products and point to the social and environmental challenges in regions rich in biodiversity. Collaboration between large companies and small-scale sustainable initiatives is crucial for harnessing this potential.

### INNOVATION AND ETHICAL CONSIDERATIONS

Colombian designers are exploring innovative ways to combine environmental sustainability with social equity, but ethical concerns persist. Transparency in supply chains and the unintended environmental impacts of set practices, like plastic recycling, were noted. However, many designers are developing circular models that transform waste into new opportunities for innovation and community empowerment.

### INSIGHTS FROM THE GLOBAL SOUTH AND GLOBAL NORTH

The decline of Latin American textile markets, driven by the influx of products from Asian countries, has put significant pressure on local industries to improve product quality and adopt more sustainable practices to offer better value to consumers (Jarpa & Halog, 2021). In response, designers in the region have increasingly moved beyond Global North influences, embracing local materials and techniques to create distinctive, sustainable products. For example, in Colombia, designers have adopted slower production methods that align with the country's natural rhythms while utilizing local biodiversity to shape a unique identity for sustainable luxury fashion. In Brazil, designers and artisans have similarly embraced sustainability by tapping into the country's rich biodiversity for eco-friendly textile production. One example is using plant-based dyes derived from native plants, which exemplifies efforts to create a more sustainable and culturally significant local fashion industry (Marocco, n.d.). One example is Maibe Marocco, founder of Matricaria, who integrates traditional eco-printing techniques and natural inks using Brazil's diverse dye plants (Marocco, n.d.). Although these initiatives are small, they foster awareness under Brazil's biodiversity umbrella and help to reduce the environmental impact of the dyeing processes, which are water-intensive and involve toxic chemicals (Calgaro, 2018). Brazil and Colombia's approaches highlight the relevance of biodesign in fostering sustainability and providing a culturally resonant alternative to conventional fashion practices.

In comparison, the Global North, particularly the Netherlands, has been at the forefront of sustainable fashion innovation. Companies like MUD Jeans have pioneered the use of recycled denim and introduced programs where customers

can lease jeans instead of purchasing them, aiming to reduce overall textile consumption (Lease Jeans Made with Recycled Denim, 2019; MUD Jeans | Circular Denim, n.d.). Dutch Design Week has also featured cutting-edge sustainable fashion innovations such as mycelium leather and bio-fabricated textiles (Dutch Design Week 2024, 19-27 October, n.d.).

Scandinavia, particularly Sweden, has also made strides in circular fashion models. Swedish brand Filippa K has implemented a recycling program encouraging customers to return old garments for reuse or upcycling (Filippa K, 2023). Additionally, Sweden has established national policies promoting the repair and reuse of textiles, contributing to a reduction in textile waste. While Sweden's sustainability efforts are largely policy-driven, contrasting with Colombia's grassroots-driven initiatives, both aim to foster systems prioritizing regeneration over extraction. These examples highlight the diverse approaches to sustainability in fashion, demonstrating the potential for both the Global South and North to learn from each other in the quest for a more sustainable, equitable industry.

## DISCUSSION

Biodesign projects in Colombian fashion showcase innovative responses to environmental and ethical challenges, leveraging local resources, biotechnology, and circular design principles. While scalability remains challenging due to production costs, infrastructure limitations, and market acceptance, these initiatives highlight biodesign's potential to create sustainable materials, support local economies, and address environmental issues.

Through interviews with biodesign alumni and local designers, prosperity in Colombian fashion is redefined as a balance of environmental stewardship, social equity, and cultural preservation. Biodesign emerges as a philosophical and practical tool, fostering collaboration, innovation, and regeneration within an inclusive, circular fashion system.

Alumni emphasize the importance of sustainable practices, local resource utilization, and community engagement in driving innovation. By leveraging Colombia's biodiversity and artisanal traditions, designers promote ethical fashion while advancing social and environmental equity. They call for industry and policy support to scale biodesign, stressing the need to shift from linear,

extractive models toward systemic change.

Integrating local materials like Indigenous fibers, fungi, and agricultural by-products showcases biodesign's capacity for sustainable innovation. Innovative design practices and traditional knowledge contribute to a global movement toward environmentally conscious fashion. Education in biodesign and systems thinking empowers students to see fashion as a tool for ecological and social regeneration.

However, to realize this potential, a concerted effort is required from multiple stakeholders. Biodesign cannot thrive in isolation—it needs systemic support through infrastructure, policy incentives, and consumer education. Colombian designers, positioned at the forefront of the biofashion movement, exemplify how traditional knowledge and cutting-edge biotechnological innovations can create a sustainable fashion model that aligns with global sustainability goals.

In conclusion, biodesign offers a pathway to prosperity that prioritizes shared well-being, inclusivity, and ecological balance, transforming the fashion industry into a sustainable, regenerative, and equitable global model.

## CAPTIONS

[Fig. 01] Diego Arango; Sauria; Bio-leather prototypes; Courtesy: Sauria.

[Fig. 02] Diego Hernández; E.biodye; Bacterial dye; Courtesy: E.biodye.

[Fig. 03] Sofia Moncado; Brideology; Bioplastic wedding dress; Courtesy: Brideology.

[Fig. 04] Moises Hernández; Woocoa; Vegan wool fiber development; Courtesy: Woocoa.

## REFERENCES

- Apparel—Colombia | Statista Market Forecast. (2024). Statista. [http://frontend.xmo.prod.aws.statista.com/outlook/cmo/apparel/colombia?utm\\_source=chatgpt.com](http://frontend.xmo.prod.aws.statista.com/outlook/cmo/apparel/colombia?utm_source=chatgpt.com)
- Calgaro, S. (2018, January 23). Flavia Aranha: Finding old and new avenues to sustainable fashion. Believe Earth. <https://believe.earth/en/flavia-aranha-finding-old-and-new-avenues-to-sustainable-fashion/>
- DANE. (2023). Poverty statistics for ethnic groups in Colombia. Retrieved December 23, 2024, from <https://dane.gov.co>.
- Duque Schumacher, A. G., Pequito, S., & Pazour, J. (2020). Industrial hemp fiber: A sustainable and economical alternative to cotton. *Journal of Cleaner Production*, 268, 122180. <https://doi.org/10.1016/j.jclepro.2020.122180>
- Dutch Design Week 2024, 19-27 October. (n.d.). Retrieved March 21, 2025, from <https://ddw.nl>
- El País. (2024, December 4). La trampa de la desigualdad en Colombia eclipsa la disminución de la pobreza. El País. <https://elpais.com/america-colombia/2024-12-04/la-trampa-de-la-desigualdad-en-colombia-eclipsa-la-disminucion-de-la-pobreza.html>

Fashion Industry | Invest in Colombia. (2024). <https://investincolombia.com.co/en/sectors/fashion-industry>

Filippa K. (2023). Sustainability report 2023. [https://www.filippa-k.com/on/demandware.static/-/Sites-FilippaK-Library/default/Sustainability\\_Report/FilippaK\\_Sustainability\\_Report\\_2023.pdf](https://www.filippa-k.com/on/demandware.static/-/Sites-FilippaK-Library/default/Sustainability_Report/FilippaK_Sustainability_Report_2023.pdf)

Insight Crime. (2024). Homicide rates in Latin America. Retrieved December 23, 2024, from <https://insightcrime.org>

Jarpa, S. G., & Halog, A. (2021). Pursuing a Circular and Sustainable Textile Industry in Latin America. In M. Á. Gardetti & R. P. Larios-Francia (Eds.), *Sustainable Fashion and Textiles in Latin America* (pp. 105–130). Springer. [https://doi.org/10.1007/978-981-16-1850-5\\_6](https://doi.org/10.1007/978-981-16-1850-5_6)

Lease jeans made with recycled denim. (2019, March 25). MaterialDistrict. <https://materialdistrict.com/article/lease-jeans-recycled-denim/>

Maroccolo, M. (n.d.). Maibe Maroccolo dyes & lakes. WILD PIGMENT PROJECT. Retrieved March 21, 2025, from <https://wildpigmentproject.org/maibe-maroccolo-dyes-lakes>

Meisel, A. (2014). No reversal of fortune in the long run: Geography and spatial persistence of economic History, 32(3), 411–428.

MUD Jeans | Circular Denim. (n.d.). MUD Jeans. Retrieved March 21, 2025, from <https://mudjeans.com/>

Mullen, M. (2023, November 20). Sweden's Circular Fashion Industry. CIL. <https://www.circularinnovationlab.com/post/sweden-s-circular-fashion-industry>

Myers, W. (2012). Bio design: Nature, science, creativity. Museum of Modern Art.

OpenAI. (2024). ChatGPT (Mar 14 version) [Large language model]. <https://chat.openai.com>

Otero-Cleves, A. M. (2024). Plebeian consumers: Global connections, local trade, and foreign goods in nineteenth-century Colombia. Cambridge University Press.

Rangel-Buitrago, N., & Gracia C., A. (2024). From the closet to the shore: Fashion waste pollution on Colombian Central Caribbean beaches. *Marine Pollution Bulletin*, 199, 115976. <https://doi.org/10.1016/j.marpolbul.2023.115976>

Statista. (n.d.). Income inequality in Colombia: Share of income held by the richest 20% of the population from 2010 to 2022. Statista. Retrieved December 24, 2024, from <https://www.statista.com/statistics/1075279/colombia-income-inequality/>

The World Bank. (2021). Global poverty monitoring. Retrieved December 23, 2024, from [https://databankfiles.worldbank.org/public/ddpext\\_download/poverty/987B9C90-CB9F-4D93-AE8C-750588BF00QA/current/Global\\_POVEQ\\_COL.pdf](https://databankfiles.worldbank.org/public/ddpext_download/poverty/987B9C90-CB9F-4D93-AE8C-750588BF00QA/current/Global_POVEQ_COL.pdf)

The World Bank. (2021). Poverty and equity brief: Colombia. Retrieved December 23, 2024, from <https://documents1.worldbank.org/curated/en/099243210122287317/pdf/IDU026d76e0706df-d047e40915e043f4231e4ce7.pdf>

Viana, C. (2024, June 29). Economic Impact of the Fashion Industry in Colombia. Colombia One: News from Colombia and the World. <https://colombiaone.com/2024/06/28/colombia-fashion-industry-economic-colombiamoda/>