Innovative Strategies to Improve the Productivity and Sustainability of Shrimp Farming in Ecuador

Ecuador's shrimp farming industry has become a cornerstone of the national economy, cultivating shrimp across roughly 220,000 hectares of coastal ponds.

This presentation explores the innovations driving Ecuador's shrimp aquaculture toward a more productive and sustainable future.

Roberto A. Santacruz-Reyes, Ph.D.
Faculty of Agricultural Sciences
Technical University of Machala
ECUADOR

Ecuador: Leading Shrimp Producer in the Western Hemisphere

22x

Production Growth

Farmed production grew 22-fold from 2000 to 2020s

220K

Hectares

Coastal ponds dedicated to shrimp cultivation

#1

Top Exporter

Leading shrimp producer in the Western Hemisphere

Ecuador's shrimp exports are now the nation's top non-oil foreign-income source. This expansion reflects favorable natural conditions including warm temperatures and extensive mangrove areas, combined with technological and managerial advances.

However, this growth has imposed environmental pressures, including significant mangrove loss and effluent impacts, while remaining vulnerable to high-impact diseases.

Historical Evolution: From Crisis to Recovery

1

1970s-1990s

Rapid expansion begins with *Penaeus vannamei* cultivation. By 1998, annual output exceeded 115,000 metric tons, making Ecuador a top global exporter.

2

1994-2000

Disease devastation: Taura Syndrome (1994) and White Spot Syndrome Virus (2000) caused exports to plummet 70% to just 37,700 MT.

3

2002-2006

Recovery through innovation: Ban on wild larvae, selective breeding for disease resistance, and improved biosecurity restored production to pre-WSSV levels.

4

2007-2017

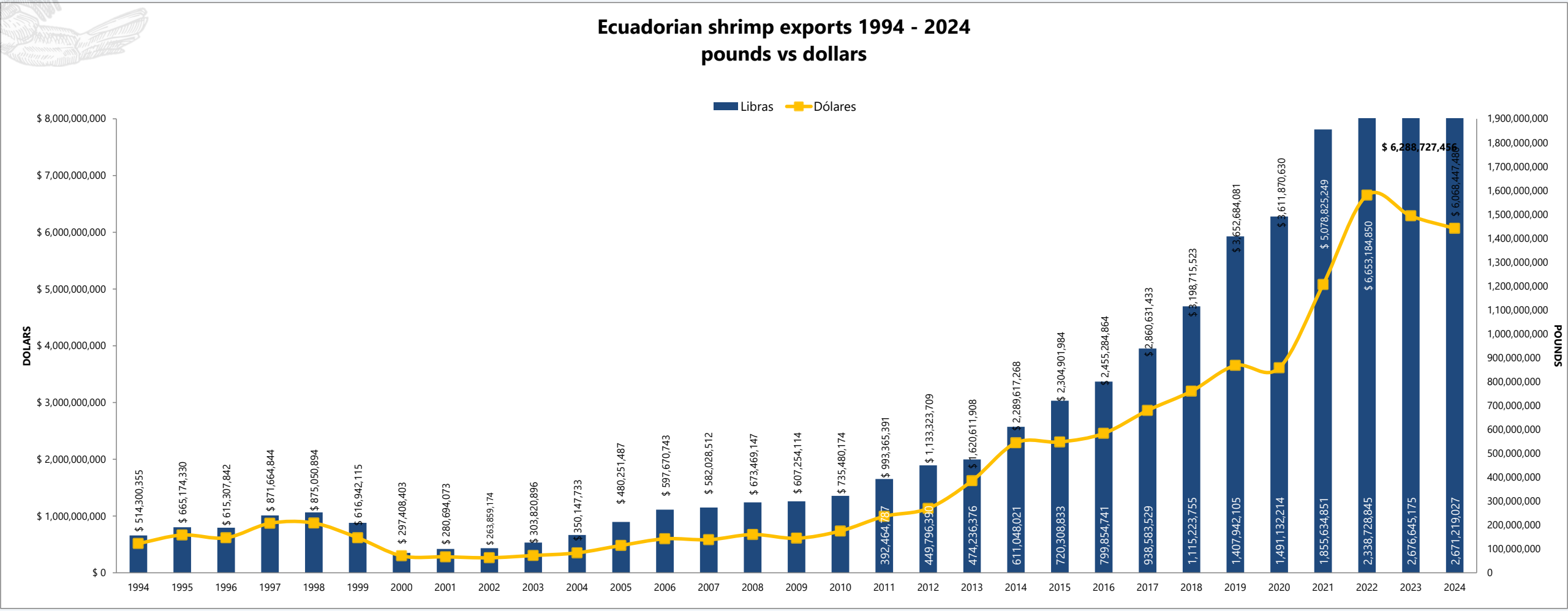
Renewed expansion at ~12% annual growth. Record exports of 432,913 MT in 2017. Ecuador overtakes India as top global shrimp exporter.

5

2020s-Present

Modernization era: Advanced genetics, automation, and sustainability initiatives position Ecuador as industry leader.

Export Growth: A Remarkable Trajectory



Ecuador's shrimp export volume rose from 146,000 MT in 2010 to 432,913 MT by 2017, demonstrating consistent growth driven by technological advances and institutional development. Industry leaders project this pattern will continue.

Current Challenges Facing the Industry

Disease Threats

White Spot Syndrome (WSSV) and Early Mortality Syndrome (EMS/AHPND) remain perennial threats requiring constant vigilance through SPF broodstock and strict biosecurity.

Environmental Impact

Ecuador lost 83% of coastal mangroves in some areas between 1991-2001. Over 50,000 hectares disappeared since 1969, nearly half due to shrimp aquaculture.

Water Quality

Farm effluents pose water-quality risks. Balancing higher stocking densities against dissolved-oxygen demands and effluent loads is critical.

Market Volatility

Fluctuating shrimp prices and Asian competition pressure margins. Industry consolidation expected as smaller farms face challenges.

Innovations to Improve Productivity

Ecuadorian farmers have embraced cutting-edge technologies and methods in breeding, nutrition, and farm management to push yields higher while controlling costs.

Genetic Improvement: The Foundation of Success

From Wild to Domesticated

Since the 2002 ban on wild larvae capture, all shrimp postlarvae now come from hatcheries using domesticated broodstock selected for performance and disease resistance.

Strategic Partnership: Macrobio & Hendrix Genetics

In 2020, Ecuador launched its first commercial closed-cycle breeding operation for specific-pathogen-resistant (SPR) Pacific white shrimp. This program applies salmon breeding expertise to shrimp, using genetic techniques to stack traits.

- Stronger survival and faster growth
- Reduced need for antibiotics or chemicals
- Optimized land use - produce more with less
- Bred specifically for local conditions

Automatic Feeding Systems: A Game Changer

Traditional Method

Hand-broadcast feed 1-3 times daily in large ponds (>5 hectares) with low stocking densities

Automated Innovation

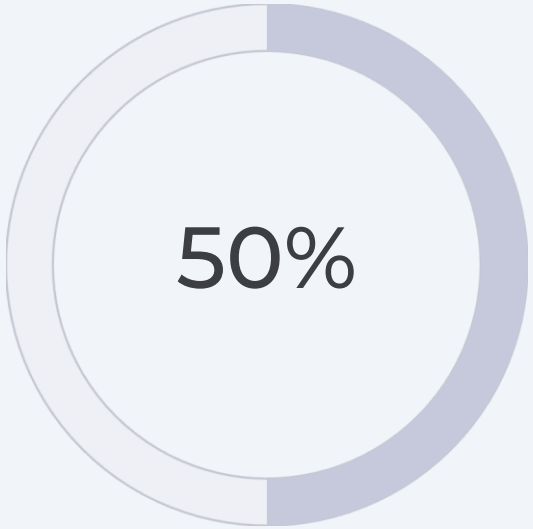
Mechanical auto-feeders (often solar-powered) use acoustic sensors to dispense pellets 50-100+ times per day

Dramatic Results

Feed input increased by over 50% for same stocking density, supporting faster growth and higher yields

> Automatic feeders have become the “main driver” on productivity growth in Ecuador’s ponds, enabling farms to achieve uniform growth and shorter production cycles.

Productivity Gains from Automation



Feed Input Increase

Auto-feeders boost total feed by over 50% for same stocking density

Tonnes per Hectare

Top farms achieve 24 ton/ha/year through intensive cropping with auto-feeders

Daily Feedings

Continuous feeding systems dispense feed 50-100+ times per day

> “The technification of Ecuador’s ponds with automatic feeders and paddlewheel aerators has raised average stocking densities from 10/m^2 to 20-25/m^2 and higher, further amplifying production”.

Nutritional Innovation: Alternative Ingredients

Black Soldier Fly Larvae Meal

BioMar and Innovafeed announced large-scale trials integrating insect protein into Ecuadorian shrimp feeds, partnering with retailer Auchan.

Benefits:

- Replaces fishmeal partially
- Delivers antimicrobial peptides that boost shrimp health
- Reduces reliance on wild-caught fish
- Meets consumer demands for responsible sourcing

> "This commitment marks a step toward circular feed ingredients while supporting responsible shrimp farming."

SustainED Workshop: Nutritional Excellence

In May 2025, the Sustainable Shrimp Partnership (SSP) and National Chamber of Aquaculture (CNA) held a workshop focused on "Nutritional Innovation: How to Maximize Feed Efficiency at Every Stage of Shrimp Farming."

01

Knowledge Sharing

Over 150 industry experts attended, covering topics from larval feeding to grow-out nutrition regimes.

02

Practical Strategies

Multiple pellet sizes, dynamic feeding schedules, and better feed storage to reduce spoilage.

03

Impact Focus

Even 5% improvement in feed conversion yields large cost savings and reduces effluent load.

SSP Director Pamela Nath: “Feed is one of the main factors determining the environmental impact of shrimp farming. Real solutions already exist that can make a significant difference.

AI and Automation: Precision Farming

AI-Powered Counting

Automated shrimp counters use cameras and machine vision to count hundreds of thousands of shrimp per hour with ~95% accuracy, eliminating guesswork about stock numbers.

Water Quality Sensors

Automated systems log temperature, salinity, pH and oxygen continuously, alerting farmers to anomalies in real-time.

Aerial Monitoring

Drones and satellite imagery map pond conditions across large areas, detecting algal blooms or aeration effectiveness.

Cloud Analytics

Farm management software aggregates all data, enabling predictive analytics and quick identification of underperforming ponds.

Case Study: AI Counting Technology

SincereAqua Innovation

Danish firm SincereAqua developed shrimp-counting devices that revolutionize inventory management.

Time Savings

From 3 workers taking 3 hours down to 1 person taking 1 hour

Accuracy

95% precision vs. manual counting errors

Perfect Rationing

Real-time population data enables precise feed calculations

AI-driven tools in shrimp aquaculture "boost accuracy, cut labor, optimize stocking and improve productivity by reducing feeding errors."

Strategies for Sustainability

As productivity has risen, the industry has simultaneously turned its attention to reducing environmental impacts and ensuring long-term viability through habitat conservation, resource management, and market-driven standards.

Mangrove Conservation: Reversing Past Losses

83%

Mangrove Loss

Coastal mangroves lost in some areas between 1991-2001

50K

Hectares Disappeared

Over 50,000 hectares lost since 1969, nearly half due to aquaculture

4,850

Restoration Target

Hectares to be restored through Mangroves for Climate project

150K

Protection Goal

Hectares to be protected in Ecuador's main estuaries

Major producers now implement on-site mangrove planting and preserve riparian buffers.

Granjas Marinas Group reports protecting mangrove forests and implementing forestation programs along canals.

Mangroves for Climate: US$45.9M Initiative

Green Climate Fund Project

Conservation International and partners launched this six-year initiative to restore degraded mangroves and protect existing ecosystems.

Key Components:

- Restore 4,850 hectares of degraded mangroves
- Protect 150,000 hectares in main estuaries
- Promote sustainable shrimp farming across 20,000 hectares
- Integrate shrimp farming with ecosystem health

> "With this project, we will show that mangroves can thrive in harmony with sustainable shrimp farming“.

Certifications: Meeting Global Standards

National Control Plan

Instituted mid-2000s, requires all export shrimp to meet rigorous sanitary, safety and traceability criteria aligned with EU standards

ASC Certification

Aquaculture Stewardship Council standards adopted by major producers. WWF and IDH partnered with SONGA/Granjas Marinas in 2016

BAP & Others

Best Aquaculture Practices, GLOBALG.A.P., and organic schemes provide multiple certification pathways

These regulations help secure market access to the U.S. and EU while requiring investment by producers in traceability systems and compliance infrastructure.

ASC Feed Certification Milestone

First in Ecuador

In October 2024, BioMar's Guayaquil feed mill became the first in Ecuador to achieve ASC Feed certification.

Significance:

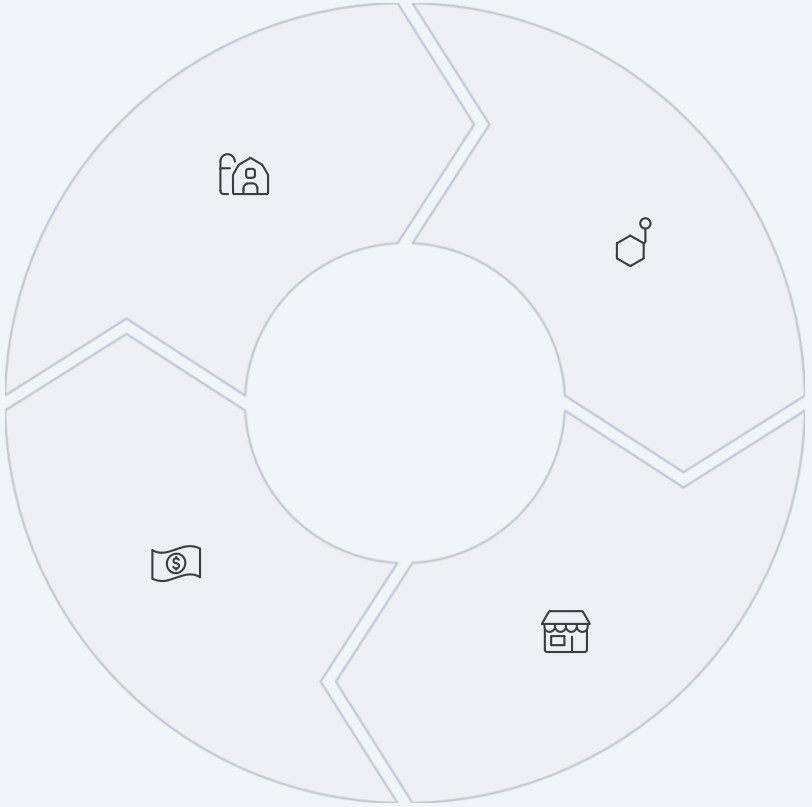
- Farmers can purchase feed meeting highest global sustainability standards
- ASC-certified farms must use certified feed by late 2025
- Milestone toward transforming global feed industry
- Ensures strict sourcing and sustainability compliance

Henrik Aarestrup, BioMar VP: "Farmers can be confident they are using feed that meets the highest global standards for sustainability."

Climate Smart Shrimp: Innovative Traceability

Farm Participation

Shrimp from participating farms are tagged and tracked through the supply chain



Carbon Measurement

Program measures scope-3 carbon emissions for each batch of shrimp

Financing Unlocked

Purchases fund on-farm improvements and local mangrove restoration projects

Buyer Commitment

Seafood buyers see real-time data on carbon footprint and mangrove restoration

This XpertSea and Conservation International partnership creates a market channel for lower-emission shrimp, enabling buyers to play an active role in mangrove restoration and carbon reduction.

Sustainable Shrimp Partnership (SSP)

Industry Leadership

Founded in 2018, SSP is a group of leading Ecuadorian shrimp companies committed to high social and environmental standards through collaboration and transparency.

Member Companies:

- Almar
- Lanec
- Omarsa
- Promarisco
- Songa
- and others

2023 Achievements:

- Zero antibiotic use in farming
- Natural resources conservation programs
- Systematic traceability adoption
- Enhanced labor standards and fair wages

Future Outlook: Continued Innovation

Advanced Genetics

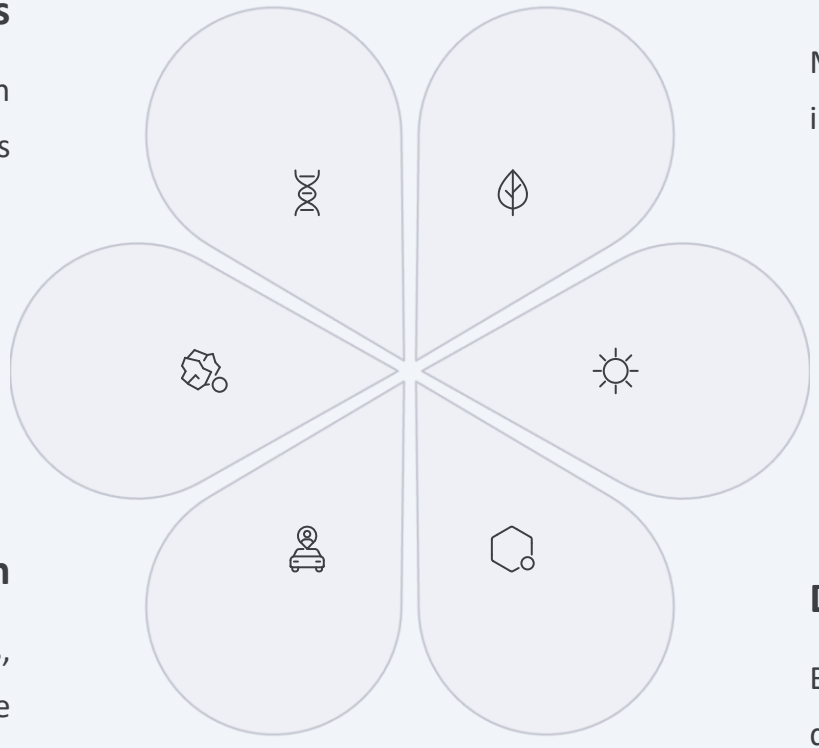
Genome editing and selection schemes for even more robust shrimp lines

Circular Systems

Wetlands treatment, recirculation, stricter effluent standards for environmental protection

Social Inclusion

Living wage certification, fair-trade schemes, community benefits strengthening social license



Novel Feed Proteins

Microbial, plant-based proteins and immunostimulants to reduce costs and footprint

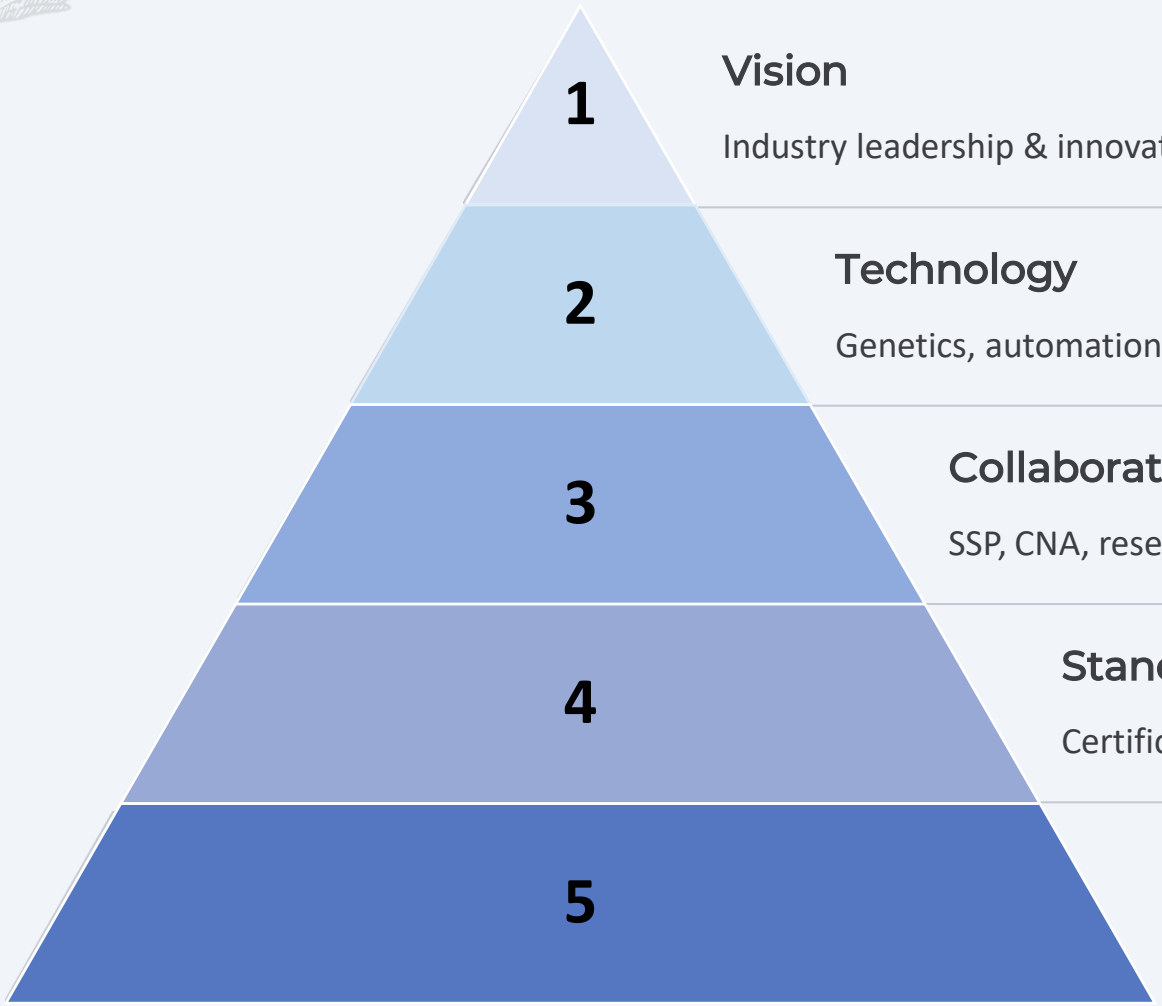
Renewable Energy

Solar aeration, biogas from waste ponds, carbon accounting becoming routine

Digital Traceability

Blockchain for supply chain, AI sensors for disease detection, drone monitoring

Key Success Factors



Vision

Industry leadership & innovation culture

Technology

Genetics, automation, AI & precision farming

Collaboration

SSP, CNA, research institutions & partnerships

Standards

Certifications, traceability & market compliance

Sustainability

Ecosystem restoration, resource conservation & social responsibility

Conclusion: A Model for Global Aquaculture

From Crisis to Leadership

Ecuador's experience shows how an aquaculture industry can evolve from boom-and-bust to balanced growth through innovation. In 25 years, the sector has absorbed lessons from disease outbreaks, harnessed advances in science and engineering, and built institutional frameworks to support modernization.

The Path Forward:

- Continue adopting proven technologies and science based management
- Deepen commitment to environmental stewardship
- Maximize yield per unit while minimizing inputs
- Maintain transparency from pond to plate

> "By staying at the forefront of both productivity and sustainability, Ecuador's shrimp sector is well-positioned to meet future challenges and maintain its status as a model for tropical shrimp aquaculture.

Thank you very much

Muito obrigado

Roberto A. Santacruz-Reyes, Ph.D.
santacruz.reyes@gmail.com