Sustainability Indicators for Agricultural Cooperatives in Cuba: A Strategic Approach for the UBPC MICONS in Trinidad.

Indicadores de sostenibilidad para cooperativas agrícolas en Cuba: un enfoque estratégico para la UBPC MICONS en Trinidad.

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Abstract

This study designed a management strategy integrating sustainability indicators for the UBPC MICONS, an agricultural cooperative in Trinidad, Cuba, to enhance productivity and resilience under economic blockade conditions. A mixed-methods approach combined SWOT analysis, Porter's Five Forces, Ishikawa diagrams, and multivariate regression (SPSS 28) with data from 15 interviews and production records (2018-2023). Twelve sustainability indicators were developed aligned with SDGs and GRI standards. Key findings include a 12% cost reduction, 15% productivity increase, and 22% ROI. The U.S. blockade explains 72% of elevated costs (r^2=0.72, $p<0.01$). Ishikawa analysis identified internal factors (lack of machinery, training gaps) as 60% of root causes. The proposed indicators are replicable across Cuban cooperatives, prioritizing climate adaptation (e.g., 50% irrigation efficiency target) and social equity (70% technical training rate). Blockade mitigation requires NGO partnerships and local innovation (e.g., animal traction).

Keywords: Agricultural sustainability, SWOT analysis, SDGs, economic blockade, cooperative management.

1. Introduction

1.1. Global Context of Agricultural Sustainability

Global agriculture faces unprecedented challenges in the 21st century. Climate change, characterized by rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events, threatens food production systems worldwide (IPCC, 2021). The Food and Agriculture Organization estimates that global food production must increase by 70% by 2050 to feed a population of 9.7 billion, yet this must be achieved while reducing agriculture's environmental footprint (FAO, 2021).

The concept of sustainable agriculture has evolved significantly over the past three decades. Originally focused primarily on environmental conservation, contemporary frameworks integrate three interdependent dimensions: environmental stewardship, economic viability, and social equity (Pretty, 2018). The United Nations' 2030 Agenda, through its 17 Sustainable Development Goals (SDGs), provides a comprehensive framework for sustainable development, with SDG 2 (Zero Hunger) and SDG 12 (Responsible Production and Consumption) being particularly relevant to agricultural systems (ONU, 2015).

Agricultural cooperatives play a crucial role in advancing sustainability. According to the International Cooperative Alliance, cooperatives worldwide employ over 280 million people and contribute significantly to food security, particularly in developing countries (ICA, 2020). Research by Birchall (2019) demonstrates that cooperatives with strong governance structures and participatory decision-making processes achieve better sustainability outcomes than traditional farming operations. Similarly, studies in Latin America have shown that cooperative models can enhance smallholder farmers' access to markets, technology, and financial services (Chiriboga et al., 2022).

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1.2. The Cuban Agricultural Context

Cuba presents a unique case study in agricultural development. Following the collapse of the Soviet Union and the subsequent economic crisis of the 1990s, Cuba underwent a profound agricultural restructuring, transitioning from large state farms to smaller cooperative models (Piñeiro Harnecker, 2018). The creation of Unidades Básicas de Producción Cooperativa (UBPC) in 1993 through Decreto Ley 142 represented a significant shift toward decentralized agricultural management, granting workers usufruct rights over state-owned lands (Decreto Ley 142, 1993).

However, Cuban agriculture continues to face structural challenges. The U.S. economic blockade, intensified in recent years, severely limits access to international markets, agricultural inputs, and technology (Nova González, 2023). According to official statistics, the blockade costs Cuba approximately $5 billion annually, with the agricultural sector being particularly affected (ONEI, 2023). Imported inputs such as fertilizers, pesticides, and machinery parts cost 30-40% more due to shipping restrictions and intermediary costs (Nova González, 2020).

Climate change compounds these challenges. Cuba is highly vulnerable to extreme weather events, including hurricanes, droughts, and rising sea levels (IPCC, 2021). The Institute of Meteorology projects temperature increases of 1.5-2.0°C by 2050, with significant implications for water availability and crop yields (Planos Gutiérrez et al., 2020). Studies by Funes-Monzote (2020) demonstrate that Cuban agriculture must urgently adopt climate-resilient practices, including agroecological approaches and water-efficient technologies.

Recent policy initiatives aim to address these challenges. The Ley de Soberanía Alimentaria y Seguridad Nutricional (2022) establishes a legal framework for local food systems, prioritizing smallholder production and sustainable practices (Gaceta Oficial de Cuba, 2022). The Decreto Ley 358 (2021) grants cooperatives greater financial autonomy, allowing them to retain profits and reinvest in production (Decreto Ley 358, 2021). Nevertheless, implementation gaps persist, particularly in rural areas where institutional capacity is limited (Valdés & Suárez, 2018).

1.3. The UBPC MICONS: Case Study Rationale

The UBPC MICONS, located in the municipality of Trinidad, Sancti Spíritus province, exemplifies both the potential and the challenges of Cuban agricultural cooperatives. Established in 1993, the unit comprises 120 hectares dedicated primarily to sugarcane (60%), with the remainder devoted to mixed crops (30%) and pastures (10%). Its workforce of 35 members benefits from proximity to the Palmarito settlement and access to water sources, including two active wells and a seasonal stream (UBPC MICONS, 2023).

Despite these advantages, the UBPC MICONS faces significant operational challenges. Production costs exceed the national average by 25%, reflecting inefficiencies in input management and equipment maintenance (Valdés & Suárez, 2018). Machinery obsolescence is critical, with 80% of equipment exceeding its useful lifespan (D2). The cooperative also struggles with workforce instability, operating with only 70% of its authorized staff (D1), and limited technical capacity, with only 40% of workers having received formal agricultural training (D3) (UBPC MICONS, 2023).

External factors further constrain performance. The blockade limits access to spare parts, irrigation equipment, and improved seeds (A1). Climate variability, particularly recurrent droughts, has reduced sugarcane yields by 15% over the past five years (A3) (ONEI, 2023). Additionally, the absence of local suppliers for high-quality seeds and livestock (A2) perpetuates dependence on external sources (Pérez Rojas, 2021).

1.4. Research Problem and Justification

The central research problem emerges from the contradiction between the UBPC MICONS' productive potential and its actual performance. Despite favorable natural conditions and a committed workforce, organizational and structural weaknesses prevent the cooperative from fulfilling its mission: contributing to local food security while ensuring member welfare.

Previous research has addressed strategic management in Cuban cooperatives. Valdés and Suárez (2018) developed a simplified SWOT methodology adapted to the UBPC context, demonstrating its utility in identifying priority areas for intervention. Pérez Rojas (2021) analyzed economic efficiency across 45 UBPCs in central Cuba, identifying common constraints including equipment shortages and limited access to credit. Nova González (2020, 2023) documented the blockade's differential impact

across agricultural subsectors, providing quantitative estimates of associated costs.

However, significant knowledge gaps persist. No existing study integrates sustainability indicators explicitly into UBPC management strategies, despite international frameworks (GRI, 2020; FAO, 2021) offering relevant methodologies. The specific interactions between internal organizational factors and external constraints (blockade, climate) remain underexplored. Furthermore, limited research addresses how Cuban cooperatives can leverage local opportunities, such as the municipal food security strategy or tourism demand, to mitigate external pressures.

Research Question: How can a management strategy integrating sustainability indicators enhance the productive, economic, and social resilience of the UBPC MICONS under conditions of external constraint?

1.5. Research Objectives

General Objective:

To design a management strategy for the UBPC MICONS that integrates sustainability indicators to improve productive efficiency, economic viability, and social equity, contributing to territorial food security in Trinidad, Cuba.

Specific Objectives:

1. To diagnose internal strengths and weaknesses and external opportunities and threats affecting the UBPC MICONS using SWOT analysis and Porter's Five Forces framework.

2. To develop a comprehensive set of sustainability indicators aligned with SDG targets and GRI standards, tailored to the Cuban cooperative context.

3. To quantify the impact of the U.S. blockade and climate factors on production costs and profitability using multivariate regression analysis.

4. To identify root causes of critical performance gaps using Ishikawa diagrams and prioritize interventions accordingly.

5. To formulate an actionable strategic plan with measurable targets, implementation timelines, and resource requirements.

1.6. Hypotheses

H_1: The integration of sustainability indicators into UBPC management strategies significantly improves productive efficiency, reducing production costs by at least 15% within 24 months.

H_2: The U.S. blockade explains more than 60% of the variance in input costs, constituting the primary external constraint on UBPC profitability.

H_3: Internal organizational factors (machinery availability, training levels) account for the majority of performance gaps and are more amenable to intervention than external factors.

H_4: Locally available opportunities, including municipal development strategies and tourism demand, can offset some external constraints when effectively leveraged.

1.7. Contributions of the Research

Theoretical Contributions:

1. **Adaptation of sustainability frameworks:** This research adapts international sustainability indicator systems (SDGs, GRI) to the specific context of Cuban agricultural cooperatives, incorporating variables unique to the Cuban situation (blockade impact, animal traction alternatives, local innovation capacity).

2. **Integration of analytical methods:** The study combines strategic management tools (SWOT, Porter's Five Forces) with causal analysis (Ishikawa) and quantitative methods (regression, Monte Carlo simulation) in a novel integrated framework.

3. **Contextualized understanding of blockade effects:** By quantifying blockade impacts through regression analysis, the research contributes empirical evidence to the literature on economic sanctions and agricultural development.

Practical Contributions:

1. **Operational sustainability indicators:** The 12 proposed indicators provide the UBPC MICONS with concrete, measurable targets for monitoring sustainability progress across environmental, economic, and social dimensions.

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2. Prioritized action plan: The detailed action plan (33 specific actions with assigned responsibilities, timelines, and resources) offers a practical roadmap for implementation.

3. Replicable methodology: The research design and analytical tools can be applied to other UBPCs and agricultural cooperatives in Cuba and similar contexts, facilitating comparative studies and knowledge transfer.

Methodological Contributions:

1. Simplified SWOT adaptation: The study validates Valdés and Suárez's (2018) simplified SWOT approach, demonstrating its utility in resource-constrained research settings.

2. Combined causal-quantitative analysis: The integration of Ishikawa diagrams with regression analysis offers a robust method for distinguishing between internal and external constraints.

3. Participatory indicator development: The indicator development process, involving workers and managers in target setting, provides a model for participatory strategic planning in cooperative settings. Policy Contributions:

4. Evidence for policy adjustment: Quantified blockade impacts provide empirical support for policies aimed at mitigating external constraints, including expanded NGO partnerships and local input production.

5. Alignment with national strategies: The research demonstrates how UBPC-level strategies can align with national policies, including the Ley de Soberanía Alimentaria and municipal development plans.

6. Lessons for cooperative reform: Findings on the relationship between internal organizational factors and performance outcomes inform ongoing discussions about cooperative governance and support systems.

2. Materials and Methods

2.1. Study Area

The research was conducted at the UBPC MICONS, located in the municipality of Trinidad, Sancti Spíritus province, Cuba (21.8045° N, 79.9847° W). The unit comprises 120 hectares distributed as follows:

- Sugarcane: 72 ha (60%).
- Mixed crops (maize, beans, vegetables): 36 ha (30%).
- Pastures and fallow: 12 ha (10%).

Water resources include two active wells (capacity: 50 m^3/hour each) and a seasonal stream (dry season flow: 10 m^3/hour). Soils are predominantly fertile brown soils with good drainage (UBPC MICONS, 2023).

The workforce consists of 35 members (70% male, 30% female), with an average age of 48 years. Educational levels vary: 20% completed primary education, 60% secondary education, and 20% technical or university education (UBPC MICONS, 2023).

2.2. Research Design

A mixed-methods design was employed, combining qualitative and quantitative approaches to ensure triangulation of findings (Creswell, 2018). The research proceeded in four phases:

Phase 1 (Diagnostic): Collection and analysis of secondary data (production records, financial statements, meeting minutes) and primary data (interviews, observations).

Phase 2 (Indicator Development): Formulation of sustainability indicators based on international frameworks (SDGs, GRI) and stakeholder input.

Phase 3 (Quantitative Analysis): Statistical analysis of production and cost data, including regression modeling of blockade impacts.

Phase 4 (Strategic Formulation): Development of action plans based on diagnostic findings and indicator targets.

2.3. Data Collection Techniques

Documentary Analysis: Production records (2018-2023), financial statements, delivery contracts, and meeting minutes were reviewed to establish historical trends in productivity, costs, and contract compliance.

Semi-Structured Interviews: Fifteen participants were purposively selected for in-depth interviews:

- 8 production workers (representing all work areas).
- 4 cooperative managers (president, vice-president, economic officer, production chief).
- 3 external experts (municipal agriculture delegate, university researcher, NGO project coordinator).

Interview protocols included both open-ended questions ("What are the main challenges facing the cooperative?") and Likert-scale items ("Rate the adequacy of current machinery on a scale of 1-5"). Interviews averaged 45 minutes and were audio-recorded with participant consent.

Direct Observation: Researchers conducted field observations of production activities, equipment conditions, and work processes over 10 site visits.

3.4. Analytical Methods

SWOT Analysis: Following Valdés and Suárez (2018), SWOT was simplified to 7 strengths, 7 weaknesses, 5 opportunities, and 5 threats to avoid redundancy. Cross-impact analysis used binary scoring (1=impact, 0=no impact).

Porter's Five Forces: Each force was scored 1-5 based on interview data and documentary evidence.

Ishikawa Diagrams: For three priority indicators (irrigation efficiency, production costs, training rates), root causes were categorized (manpower, methods, machinery, materials, environment, policies) and validated through expert review.

Statistical Analysis: Data were analyzed using SPSS 28. Descriptive statistics summarized production trends. ANOVA compared productivity across crop types. Pearson correlation examined relationships between variables. Multiple regression modeled cost determinants:

Cost= beta 0 + beta 1(Blockade) + beta 2(Drought) + beta_3(Management) + epsilon

Where:

- Blockade: Index of input price increases (1-5).
- Drought: Months of precipitation deficit.
- Management: Composite index of organizational factors (equipment availability, training levels).

Monte Carlo Simulation: Sensitivity analysis for ROI projections used 10,000 iterations with @RISK software.

3.5. Sustainability Indicator Development

Indicators were developed through:

1. Literature review: Identification of relevant indicators from SDGs, GRI, and academic sources.
2. Stakeholder consultation: Workshops with workers and managers to validate relevance and feasibility.
3. Expert validation: Review by three agricultural economists and two sustainability specialists.

Each indicator meets SMART criteria:

- Specific: Clearly defined and focused.
- Measurable: Quantifiable with available data.
- Achievable: Realistic given resource constraints.
- Relevant: Aligned with cooperative mission and external requirements.
- Time-bound: Specific target dates.

3.6. Ethical Considerations

The research received ethical approval from the University of Sancti Spíritus Ethics Committee (Acta No. 45/2023). All participants provided written informed consent. Data were anonymized during analysis and storage. Findings were shared with the cooperative for validation prior to publication.

4. Results and Discussions

4.1. Diagnostic Findings

SWOT Analysis Results:

The simplified SWOT matrix identified 7 strengths, 7 weaknesses, 5 opportunities, and 5 threats *(Table 1)*. Cross-impact analysis revealed 54 total impacts, with

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64% concentrated in the Weaknesses-Opportunities quadrant.

The Weaknesses-Opportunities quadrant accumulated 23 impacts, indicating that the cooperative's primary strategic challenge lies in addressing internal weaknesses to capitalize on external opportunities.

Porter's Five Forces Analysis:

- Threat of new entrants: High (4/5) due to the Decreto Ley 300 usufruct allocations.
- Rivalry among competitors: Moderate (3/5) given product differentiation potential.
- Bargaining power of suppliers: High (4/5) due to input monopolies.
- Bargaining power of buyers: Moderate (3/5) given tourism demand.
- Threat of substitutes: Low (2/5) given essential nature of food products.

4.2. Sustainability Indicators

Twelve indicators were developed across five dimensions *(Table 2)*. Baseline values were established from 2023 data, with 2025 targets reflecting achievable improvements.

4.3. Economic Analysis

Production Costs: Average production cost decreased from 150 USD/ton (2022) to 132 USD/ton (2023), a 12% reduction attributable to:

- Biofertilizer substitution (saved 15 USD/ton).
- Improved irrigation efficiency (saved 8 USD/ton).
- Reduced post-harvest losses (saved 5 USD/ton).

Return on Investment: ROI improved from 8% (2022) to 22% (2023), calculated as:

ROI = Net Benefits (USD 25,000\Total Costs (USD 113,000) x100 = 22%

Regression Analysis: The multiple regression model explained 78% of cost variance (r^2=0.78, p<0.001):

Cost = 85 + 0.72(Blockade) + 0.18(Drought) + 0.25(Management)

The blockade coefficient (β=0.72, p<0.01) indicates that each 1-point increase in the blockade index (1-5 scale) raises costs by 0.72 USD/ton.

Productivity Analysis: Sugarcane yields increased from 45 to 52 ton/ha (15% improvement). Maize yields rose from 2.8 to 3.4 ton/ha (21% improvement).

Table 1. Prioritized SWOT Factors

Category	Factor	Description
Strengths	F1	Stable leadership commitment
	F2	Workforce proximity to fields
	F3	Proximity to water sources
Weaknesses	D1	Incomplete workforce (70% staffing)
	D2	Obsolete machinery (80% beyond lifespan)
	D3	Limited technical training (40% trained)
	D4	Economic inefficiency (costs 25% above average)
Opportunities	O1	Tourism demand for agricultural products
	O3	Municipal food security strategy
	O4	NGO partnership opportunities
Threats	A1	U.S. economic blockade
	A3	Climate change (droughts)
	A4	Input scarcity and high prices

Table 2. Sustainability Indicators

Dimension	Indicator	Baseline (2023)	Target (2025)	SDG
Environmental	Irrigation efficiency (%)	20%	50%	6.4
	Water consumption (m^3/ha)	5,000	3,500	6.4
Economic	Production cost (USD/ton)	150	120	12.2
	ROI (%)	8%	22%	8.4
Uncultivated	land (%)	15%	0%	2.4
Social	Technical training rate (%)	40%	70%	4.4
Average	wage (USD/month)	30	45	8.5
	Job satisfaction (1-5)	2.8	4.0	8.8
Organizational	Action implementation (%)	84.8%	100%	16.6
	NGO partnerships (number)	1	3	17.16
Climate	Drought-adapted crops (%)	10%	40%	13.1
	Climate loss reduction (%)	25%	10%	13.1

4.4. Ishikawa Analysis

For irrigation efficiency (20% baseline), root causes included:

- Manpower: 70% of workers lack irrigation training (D3).
- Methods: No standardized irrigation protocols.
- Machinery: 90% of irrigation equipment outdated (D2).
- Materials: Limited access to spare parts (A1).
- Environment: Recurrent droughts (A3).
- Policies: Bureaucratic delays in project approval (O4).

For production costs (150 USD/ton baseline), root causes included:

- Manpower: Low productivity (D4).
- Methods: Inefficient input use.
- Machinery: High fuel consumption (D2).
- Materials: Expensive imported inputs (A1).
- Environment: Drought reducing yields (A3).
- Policies: Price controls limiting revenue.

For training rates (40% baseline), root causes included:

- Manpower: Limited time for training.
- Methods: No systematic training needs assessment.
- Machinery: Limited training materials.
- Materials: Insufficient budget (D4).
- Environment: Geographic dispersion of workers.
- Policies: Limited institutional support.

5. Discussion

5.1. Comparison with Cuban Studies

The 12% cost reduction achieved exceeds the 9% reported for UBPCs in Cienfuegos (Pérez Rojas, 2022),

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likely due to MICONS' greater emphasis on biofertilizer adoption. However, the 22% ROI remains below the 30% achieved by better-equipped UBPCs in Matanzas, highlighting the machinery gap's importance (Pérez Rojas, 2021).

The finding that 64% of SWOT impacts concentrate in Weaknesses-Opportunities aligns with Valdés and Suárez's (2018) research on CPAs in Trinidad, suggesting that cooperative management in this region faces similar strategic challenges despite organizational differences.

5.2. Comparison with International Cases

Vietnam: Vietnamese cooperatives achieve 30% ROI through:

- Government subsidies for machinery (Dao, 2019).
- Access to international markets.
- Technical training programs reaching 80% of workers.

MICONS' 22% ROI, while respectable under blockade conditions, demonstrates the competitive disadvantage imposed by external constraints.

Colombia: Colombian coffee cooperatives achieve 70% training rates through:

- Federación Nacional de Cafeteros programs (FNC, 2022).
- Premium pricing for certified sustainable coffee.
- Strong institutional support networks.

MICONS' 40% training rate reflects the absence of comparable institutional support, though NGO partnerships (O4) offer potential pathways.

Spain: Spanish cooperatives achieve 85 USD/ton production costs through:

- EU Common Agricultural Policy subsidies (Gómez-Limón, 2021).
- Advanced irrigation technology (65% efficiency).
- Economies of scale (average 500 ha).

MICONS' 132 USD/ton, while high by European standards, is competitive given the blockade context.

5.3. Theoretical Implications

The research validates integrated sustainability frameworks in constrained contexts. SDG and GRI indicators proved adaptable to Cuban conditions, though blockade-specific indicators (e.g., "import dependence rate") would enhance relevance.

The combination of SWOT, Porter's Five Forces, and Ishikawa analysis demonstrates the value of multi-method approaches for understanding complex organizational challenges. The simplified SWOT approach (Valdés & Suárez, 2018) proved effective in identifying priority areas without overwhelming analytical complexity.

5.4. Practical Implications

For UBPC MICONS: The 12 indicators provide clear, measurable targets for monitoring progress. Priority actions include:

- Securing NGO funding for irrigation systems.
- Expanding biofertilizer production.
- Implementing systematic training programs.

For Cuban policymakers: Results demonstrate that internal organizational factors (machinery, training) are as important as external constraints in determining UBPC performance. Policies addressing these factors could yield significant productivity gains.

For international development partners: The research identifies specific intervention points (irrigation, training, biofertilizers) where NGO support could have maximum impact.

5.5. Limitations

Several limitations should be acknowledged:

- Short timeframe: 12 months insufficient for assessing long-term sustainability.
- Single case study: Findings may not generalize to all UBPCs.

- Self-report bias: Interview data may overstate achievements.
- Blockade measurement: Composite index may not capture all blockade dimensions.
- Data gaps: Some production records incomplete (2018-2020).

Future research should extend the analysis to multiple UBPCs over longer periods, incorporate additional quantitative measures, and develop more refined blockade indicators.

6. Action Plan

6.1. Strategic Objectives

Objective 1 (Environmental): Achieve 50% irrigation efficiency by 2025 through:

- Installation of drip irrigation on 36 ha (50% of irrigable area).
- Training 70% of workers in irrigation management.
- Establishing water monitoring systems.

Objective 2 (Economic): Reduce production costs to 120 USD/ton by 2025 through:

- Expanding biofertilizer production to cover 80% of crop needs.
- Optimizing machinery use through preventive maintenance.
- Reducing post-harvest losses to 5% (from 15%).

Objective 3 (Social): Increase training rates to 70% by 2025 through:

- Conducting training needs assessments.
- Partnering with University of Trinidad for technical courses.
- Establishing peer-to-peer learning networks.

6.2. Detailed Actions

Table 3. Action Plan Summary

Action	Responsible	Timeline	Resources	Indicator
Install drip irrigation	Production Chief	12 months	$15,000 (Oxfam)	50% efficiency
Train workers in irrigation HR	Manager	6 months	$2,000 (university)	70% trained
Expand biofertilizers	Innovation Lead	8 months	$5,000 (internal)	80% coverage
Preventive maintenance program	Machinery Chief	3 months	$1,000 (internal)	90% equipment availability
Post-harvest loss reduction	Production Chief	6 months	$3,000 (internal)	5% losses
Training needs assessment HR	Manager	2 months	$500 (internal)	Assessment completed
University partnership	President	4 months	$0	MOU signed

6.3. Monitoring and Evaluation

A digital dashboard will track progress monthly:

- Environmental indicators: Updated from water meter readings.
- Economic indicators: Calculated from financial records.
- Social indicators: Measured through quarterly surveys.

Quarterly review meetings with the Board of Directors will assess progress and adjust actions as needed. Annual external evaluation by university researchers will validate findings.

7. Conclusions

7.1. Key Findings

1. Strategic diagnosis: SWOT analysis revealed 64% of critical impacts in the Weaknesses-Opportunities quadrant, indicating that addressing

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internal constraints is essential for capitalizing on external opportunities.

2. Indicator development: Twelve SMART indicators were developed across environmental, economic, social, organizational, and climate dimensions, providing a comprehensive sustainability monitoring framework.

3. Economic analysis: The 12% cost reduction and 22% ROI demonstrate the strategy's effectiveness, though blockade impacts remain significant (explaining 72% of cost variance).

4. Causal analysis: Ishikawa diagrams identified internal factors (machinery, training) as 60% of root causes, confirming that organizational improvements can yield substantial benefits even under external constraints.

7.2. Contributions

1. Theoretical: Adaptation of international sustainability frameworks to the Cuban cooperative context, incorporating blockade-specific variables.

2. Methodological: Integration of strategic management tools (SWOT, Porter) with causal analysis (Ishikawa) and quantitative methods (regression, Monte Carlo).

3. Practical: Actionable 12-indicator system and detailed implementation plan for UBPC MICONS.

4. Policy: Evidence-based recommendations for Cuban agricultural policy and international cooperation.

8. Recommendations

8.1. For UBPC MICONS:

- Prioritize irrigation investment and training programs.
- Expand NGO partnerships for technology access.
- Implement digital monitoring systems.

8.2. For Cuban policymakers:

- Streamline approval processes for cooperative projects.
- Strengthen technical training institutions.
- Develop blockade mitigation strategies.

8.3. For international partners:

- Support irrigation and renewable energy projects.
- Facilitate technology transfer and training.
- Document and disseminate successful interventions.

8.4. Future Research

- Multi-case studies across Cuban UBPCs.
- Longitudinal analysis of sustainability indicator trends.
- Refinement of blockade impact measurement.
- Comparative studies with other embargoed economies.

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9. Appendices (1 page)

Appendix A: Interview Questionnaire (English Translation)

1. Demographic information (age, gender, years in cooperative).

2. What are the main challenges facing the cooperative?

3. How adequate is current equipment for production needs? (1-5 scale)

4. What training have you received in the past 2 years?

5. How satisfied are you with working conditions? (1-5 scale)

6. What opportunities do you see for improving production?

7. How does the blockade affect your daily work?

8. What support would be most helpful from government/NGOs?