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ORIGINAL SCIENTIFIC PAPER

Female Leadership in Mexican Agricultural Firms and Its Impact on Sustainability



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A B S T R A C T

Women-led agricultural enterprises are critical to environmental sustainability and rural development. However, national generalizations obscure how regional disparities, land tenure constraints, and business maturity shape women's strategic environmental choices. Integrating the Natural Resource-Based View (NRBV) with literature on female leadership and regional economic resilience, this study examines subnational typologies of women-led agricultural enterprises in Mexico to address three core questions: (1) how regional structural conditions constrain environmental practice adoption; (2) what leadership

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strategies women deploy across regions; and (3) how NRBV strategies are operationalized subnationally. Utilizing state-level data from the 2022 Mexican National Agricultural Census (INEGI across 32 federal entities), we performed Principal Component Analysis, Ward's hierarchical clustering, and K-means clustering. The empirical results reveal significant subnational heterogeneity and identify three distinct territorial typologies: I. Diversified Environmental Practice Territories, characterized by Product Stewardship via adaptive diversification; II. Transitioning Territories, focused on operational Pollution Prevention under capital constraints; and III. Strategic Leadership Territories, aligned with Sustainable Development through long-term risk management. This research extends Hart's NRBV to subnational rural contexts in emerging economies, demonstrating that female leadership acts as an adaptive mechanism that transforms structural constraints into place-based capabilities. Policy-wise, these typologies provide an empirical framework for designing targeted, regionally differentiated rural development interventions.

KEYWORDS: *agricultural businesses, female leadership, women, sustainability, Mexico*

Introduction

Navigating economic uncertainty in the agricultural sector requires strategically managing internal resources and dynamic capabilities to maintain long-term competitiveness (Ramírez Molina et al., 2024). Internal control and administrative management must align with sustainable development demands, specifically mitigating lifecycle impacts, optimizing inputs, and reducing waste (Carrasquero Ferrer, 2024; Mesco-Valeriano, 2024). Within this operational context, female leadership has emerged as a key driver of agricultural sustainability through innovation and resource optimization (Arintyas, 2024; Pierli et al., 2022).

In Mexico, agriculture constitutes a vital economic and sociocultural pillar, yet it faces severe threats from climate change, ecosystem degradation, aquifer overexploitation, and soil depletion (SEMARNAT, 2015; Vargas Aguilar, 2025). However, these pressures manifest unevenly across a deeply heterogeneous territory: a capital-intensive, export-oriented northern region contrasts sharply with the southern and central zones, which are dominated by small-scale producers, *ejido* structures, and subsistence farming (Medina, 2025). Gender gaps in asset ownership exacerbate this territorial disparity; historically marginalized from land tenure frameworks, women hold official titles to only 26% of *ejido* and communal plots

(Sobrino-García, 2023), severely restricting their access to formal credit, technical assistance, and advanced technologies (Hernandez, 2024; Medina, 2025). Paradoxically, data from the 2022 Agricultural Census reveal that women actively manage thousands of production units, make strategic decisions, and implement conservation practices despite facing acute capital shortages (INEGI, 2023). Thus, Mexico offers an ideal empirical setting to analyze how female leadership counters structural constraints through subnational environmental strategies. While previous research has examined rural women's leadership, empowerment, and sustainability in emerging economies (Díaz-García et al., 2016; Kabir et al., 2022; Vujadinović & Marjanović, 2025; Stevandić et al., 2026), gaps remain. Qualitative or localized studies often treat women producers as a homogeneous group, overlooking how spatial structures, land tenure systems, and regional business maturity shape environmental decisions. Furthermore, a disconnect persists between Hart's (1995) Natural-Resource-Based View (NRBV) and studies on gender-focused leadership; this leaves unexamined how women entrepreneurs operationalize NRBV dimensions, pollution prevention, responsible product stewardship, and sustainable development in contexts of severe resource scarcity. Additionally, subnational quantitative typologies that can inform spatially differentiated public policy interventions tailored to each state's or region's specific capacities are lacking. To address these gaps, this study resolves three core research questions:

Q1: How do regional structural conditions and business maturity across Mexican states limit or condition the adoption of environmental practices among women-led agricultural enterprises?

Q2: What types of leadership strategies do women adopt regarding agricultural practices across the various regions of Mexico?

Q3: How are the strategies of NRBV operationalized within the different subnational typologies of female agricultural leadership?

Accordingly, this research aims to construct and analyze a subnational typology of women-led agricultural enterprises in Mexico based on their environmental practices. This study provides empirical evidence on the strategic heterogeneity of female agricultural leadership. Theoretically, this research extends Hart's (1995) NRBV framework to subnational rural contexts in emerging markets, demonstrating that female leadership serves as an adaptive mechanism that transforms institutional constraints into place-based capabilities. In practice, it provides an empirical framework for policymakers to design targeted, regionally differentiated interventions that

foster both sustainable agricultural development and female economic empowerment.

Theoretical Framework

Female leadership is widely associated with participatory, collaborative, and creative management, as well as a strong orientation toward social and environmental performance (Eagly et al., 2007; Álvarez Hernández et al., 2025). In small and medium-sized enterprises (SMEs), female leaders foster organizational ambidexterity, balancing operational efficiency with eco-innovation practices to achieve sustainability goals (Veiga et al., 2025).

In agri-food value chains, these leadership attributes matter because business operations are directly linked to natural resource governance (World Farmers' Organization, 2025). Female leaders act as catalysts for the transition to a circular economy and for sustainable supply chain management (García-Sánchez & Enciso-Alfaro, 2025). However, female agency remains conditioned by broader socioeconomic ecosystems, such as institutional infrastructure and regulatory frameworks (Stevandić et al., 2026). In emerging economies, women-led agricultural enterprises foster economic diversification, reduce poverty, and empower communities (Kabir et al., 2022; Vujadinović & Marjanović, 2025).

Rural women entrepreneurs face deeply rooted structural barriers that limit the scale and scope of their operations, including restricted access to credit markets, financial services, advanced technologies, and specialized technical assistance (Díaz-García et al., 2016; Medina, 2025). Disproportionate domestic responsibilities reduce the time and energy women can devote to business management (Hernandez, 2024). They are underrepresented in rural producer organizations, irrigation boards, and cooperatives (Sánchez Gómez et al., 2022). Cultural norms often assign management authority to male family members, limiting women's operational autonomy (Vega-García et al., 2024). Customary inheritance practices widen this gap by favoring male heirs, restricting access to land titles. In Mexico, women hold legal title to only 26% of *ejido* and communal land plots (Sobrino-García, 2023).

The Natural Resource-Based View (NRBV) and Regional Resilience

To assess the development of environmental capabilities in women-led agricultural enterprises, this study draws on Hart's (1995) NRBV framework, which grounds competitive advantage in an organization's relationship with the natural environment through three strategic pillars: I. pollution prevention, II. product stewardship, and III. sustainable development. In agri-food SMEs, operationalizing NRBV capabilities strengthens market reputation, operational resilience, and competitive differentiation (Johnson-Hall & Hall, 2022; Royer & Simon, 2024).

However, environmental capabilities do not develop uniformly across space. Evolutionary economic geography highlights that business practices and regional resilience-defined as a territory's capacity to adapt and forge new growth trajectories-are path-dependent and conditioned by local structural and institutional legacies (Boschma, 2015). The NRBV framework has recently been extended to rural SMEs, circular economy adoption, and emerging markets (Hart & Dowell, 2011; Darmandieu et al., 2022). In resource-constrained rural settings, deploying the strategic capabilities proposed by Hart relies heavily on intangible organizational assets, such as dynamic adaptability, community leadership, and local ecological knowledge, to offset deficits in formal capital (Debasmita et al., 2026; Manono, 2025).

By integrating female leadership, the NRBV, and regional economic resilience, this study posits that female leadership acts as an adaptive moderating mechanism. Faced with various territorial constraints, women-led agricultural enterprises implement specific NRBV strategies, giving rise to sub-national business typologies.

Characterization of the Agricultural Sector in Mexico and Female Entrepreneurship

Mexico's primary sector exemplifies a heterogeneous landscape in which capital-intensive commercial operations coexist with subsistence smallholders. While primary activities contribute 3.2% to national GDP (INEGI, 2026), the sector underpins rural livelihoods for approximately 27 million people (INEGI, 2023). Decadal structural shifts, driven by trade liberalization (Schwentesius et al., 2012), climate variability, migration, and land reform, have altered production unit dynamics (Semerena & Catalán, 2008), elevating the strategic importance of women's leadership (WFO,

2025) and its characteristically participatory, resource-sensitive management style (Eagly et al., 2007; Álvarez Hernández et al., 2025).

In Mexico, 13.6 million women inhabit rural areas, 21.1% of the national female population (INMujeres, 2020), and head 876,456 production units, or 19.0% of the national total (INEGI, 2023). However, an acute paradox persists between female operational presence and institutional authority. Female heads face severe asset gaps: only 84.4% hold legal land titles, 5.2% access productive credit, 6.5% own machinery, and 19.8% lack formal education (INEGI, 2023), severely constraining business formalization and scaling (FAO, NRI & AWARD, 2026).

Methodology

This study employed a cross-sectional, exploratory quantitative design based on secondary data from the 2022 Agricultural Census conducted by the National Institute of Statistics and Geography (INEGI, 2023). The unit of analysis comprised the 32 Mexican federal entities and included women-managed agricultural production units that reported environmental actions. INEGI (2023, p. 5) defined a production unit as one or more plots in the same municipality, managed by the same female producer, and using common production resources. The analysis considered only agricultural and livestock production units; it excluded large-scale producers and forestry operations.

Variables and Operationalization

The analysis included 11 variables: eight environmental-practice variables and three structural variables. The environmental variables were derived from the Environment section of the Basic Questionnaire for Agricultural Production Units and captured resource conservation, environmental management, preventive actions, ecosystem management, and waste management. The structural variables were total agricultural units, women-managed units, and units reporting environmental actions. Table 1 presents the variables included in the analysis.

Table 1: Variables included in the analysis

Variable	Type	Environmental dimension/measure
General environmental action	Environmental practice	Overall environmental engagement
Energy conservation	Environmental practice	Resource efficiency
Water conservation	Environmental practice	Resource efficiency
Living fences	Environmental practice	Ecosystem and land management
Fire prevention	Environmental practice	Environmental risk prevention
Pest control	Environmental practice	Environmental management
Packaging separation	Environmental practice	Waste management
Other environmental actions	Environmental practice	Other environmental practices
Total agricultural units	Structural	Business structure
Women-managed units	Structural	Women's participation in agricultural activity
Units reporting environmental actions	Structural	Environmental business structure

Source: Authors' elaboration based on INEGI (2023)

Data Transformation and Standardization

INEGI reported the environmental-practice variables as percentages at the federal-entity level. To facilitate comparison among states, these variables were categorized into five ranges: 0–20% (very low), > 20–40% (low), > 40– 60% (medium), > 60–80% (high), and > 80–100% (very high adoption). We applied this categorization only to the eight environmental variables; it does not represent a conventional Likert scale because we derived the categories from aggregated census percentages. We retained the three structural variables as quantitative counts. We then standardized all 11 variables using Z-scores before PCA and cluster analysis.

Table 2: Categorization of environmental-practice variables based on census percentages

Percentage range	Code	Interpretation
0–20%	1	Very low adoption
> 20–40%	2	Low adoption
> 40–60%	3	Medium adoption
> 60–80%	4	High adoption
> 80–100%	5	Very high adoption

Source: Authors' elaboration based on the 2022 Agricultural Census (INEGI, 2023)

Statistical Analysis

We conducted the analyses using SPSS Statistics version 26. We applied a multivariate strategy combining Principal Component Analysis (PCA) and cluster analysis to identify territorial profiles based on business structure and environmental practices. First, we conducted PCA using the 11 standardized variables to identify underlying dimensions of the environmental-practice structure. We assessed sampling adequacy using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. We retained components with eigenvalues >1 and examined factor loadings, communalities, and explained variance.

Second, hierarchical cluster analysis using Ward's method and squared Euclidean distance explored the grouping structure of the 32 federal entities. We then applied K-means clustering to the same standardized variables. We compared solutions with K=2, K=3, and K=4. We retained the three-cluster solution because it produced more differentiated and substantively interpretable territorial profiles, despite the lower silhouette coefficient than K=2. We used cluster centers and descriptive F-statistics to characterize the resulting groups. We interpreted the F-statistics descriptively because the clustering procedure maximizes between-group differences.

Results

Principal Component Analysis (PCA)

The principal component analysis (PCA) identified four components with eigenvalues greater than 1, explaining 76.38% of the total variance.

The KMO value was 0.601, indicating marginal but acceptable sampling adequacy for an exploratory analysis, while Bartlett's test of sphericity was significant ($\chi^2 = 277.879$, df = 55, $p < .001$). These results supported the exploratory PCA, although the KMO value suggests interpreting the component structure with caution.

Table 3: Principal component analysis: rotated component loadings and explained variance

Variable	PC1	PC2	PC3	PC4
Total enterprises	**.970**	.109	.086	.009
Women-managed enterprises	**.979**	.122	.075	.043
Environmental enterprises	**.973**	.147	.070	.040
Environmental action	.180	**.777**	.198	.328
Energy saving	.032	-.244	**-.742**	-.225
Water saving	-.268	-.175	**-.777**	.231
Living fences	.283	-.063	**.525**	.022
Fire prevention	.253	**.736**	.193	-.439
Pest control	.027	**.795**	-.137	-.022
Packaging separation	.097	.024	.079	**.965**
Other actions	-.290	-.251	**.582**	.066
Eigenvalue	**3.780**	**1.764**	**1.568**	**1.289**
Variance explained (%)	**34.366**	**16.036**	**14.259**	**11.716**
Cumulative variance (%)	**34.366**	**50.402**	**64.661**	**76.377**

Note: Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization. Rotation converged in five iterations.

Source: Authors' elaboration

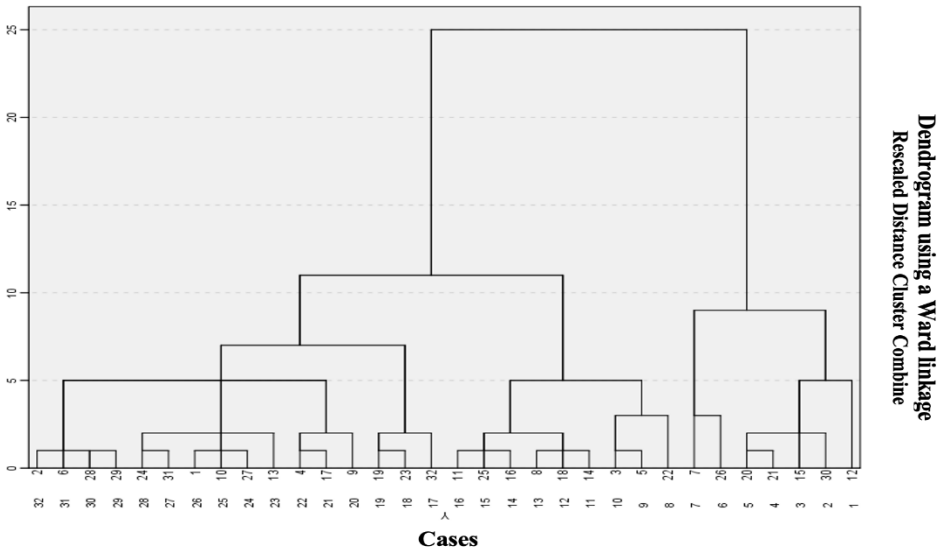
The first component explained 34.37% of the variance and was strongly associated with total enterprises, women-managed enterprises, and environmental enterprises. The second component explained 16.04% of the variance and was primarily associated with pest control, environmental actions, and fire prevention. The third component explained 14.26% and was characterized mainly by water and energy saving, together with living fences and other environmental actions. The fourth component explained 11.72% and was dominated by packaging separation. Overall, the components indicate that environmental engagement is multidimensional,

encompassing business structure, preventive practices, resource management, and waste handling.

Cluster Analysis

Hierarchical clustering using Ward's method revealed a differentiated grouping structure among the 32 federal entities and supported a three-cluster solution (Figure 1). K-means clustering was subsequently applied to obtain the final territorial classification.

Figure 1: Dendrogram of the hierarchical cluster analysis (Ward's method)



Source: Authors' elaboration based on the 2022 Agricultural Census (INEGI, 2023)

The final K-means solution identified three territorial clusters with 14, 6, and 12 federal entities, respectively. Table 4 presents the standardized cluster centers. Positive values indicate scores above the overall mean, whereas negative values indicate scores below it.

Table 4: Final cluster centers obtained from the K-means analysis (K = 3)

Variable	Cluster 1	Cluster 2	Cluster 3
Total enterprises	-0.53706	**1.84451**	-0.29568
Women-managed enterprises	-0.50776	**1.90338**	-0.35931
Environmental enterprises	-0.49461	**1.92814**	-0.38702
Environmental action	0.40018	**0.72624**	-0.82999
Energy saving	-0.39549	-0.18456	**0.55368**
Water saving	-0.09342	-0.59167	**0.40482**
Living fences	0.07987	**0.66074**	-0.42355
Fire prevention	0.25514	**0.85992**	-0.72763
Pest control	0.32277	**0.53271**	-0.64292
Packaging separation	0.09342	0.09342	-0.15570
Other actions	**0.44776**	-0.42355	-0.31061

Note: Values represent standardized Z-score cluster centers. Positive values indicate scores above the overall mean, whereas negative values indicate scores below the overall mean.

Source: Authors' elaboration

Territorial Profiles

Cluster 1: Lower business structure and diversified environmental practices

This cluster comprises 14 federal entities and shows below-average values for total enterprises, women-managed enterprises, and environmental enterprises. Nevertheless, environmental action, living fences, fire prevention, pest control, and other environmental actions are at or above the overall mean. Water and energy saving remain below the mean. The profile therefore reflects relatively diversified environmental engagement despite a smaller business structure.

Cluster 2: Stronger business structure and broader environmental engagement

This cluster includes six federal entities and presents the highest values for total enterprises, women-managed enterprises, and environmental enterprises. It also shows above-average environmental action, living fences, fire prevention, and pest control. However, water saving, energy saving, and other environmental actions remain below the overall mean. The

profile combines stronger business structure with broader engagement in environmental and preventive practices.

Cluster 3: Lower business structure with emphasis on resource efficiency

This cluster comprises 12 federal entities and presents below-average values for the three structural variables. In contrast, energy and water saving are above the overall mean, while environmental action, living fences, fire prevention, pest control, and other actions are below average. The profile is therefore characterized primarily by resource-efficiency practices rather than preventive or land-management actions.

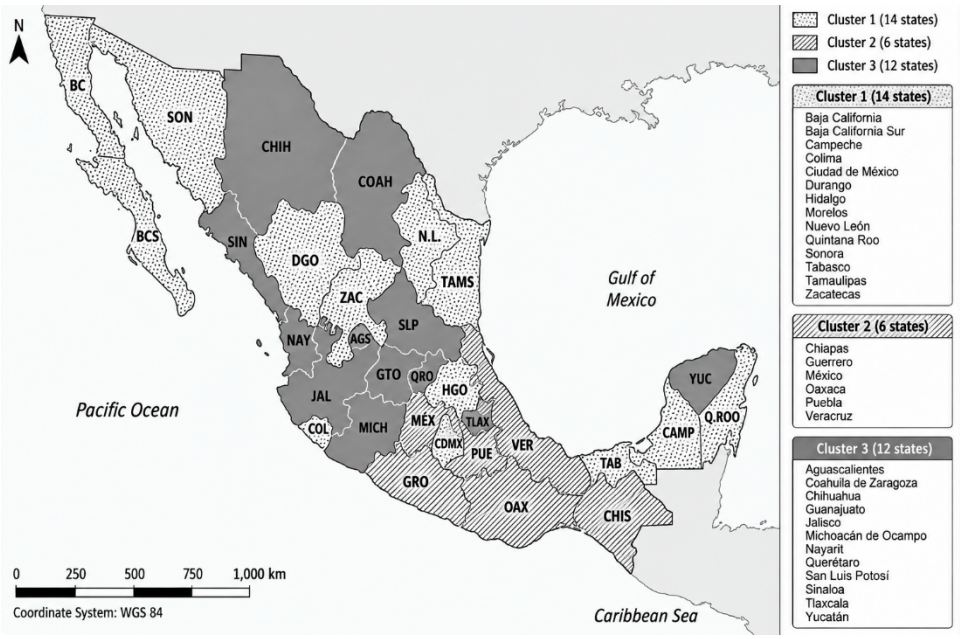
Table 5: Summary of territorial cluster profiles

Cluster	Federal entities	Territorial profile
Cluster 1 (n = 14)	Baja California; Baja California Sur; Campeche; Colima; Durango; Hidalgo; Mexico City; Morelos; Nuevo León; Quintana Roo; Sonora; Tabasco; Tamaulipas; Zacatecas	Lower business structure and moderate preventive environmental practices.
Cluster 2 (n = 6)	Chiapas; Guerrero; State of Mexico; Oaxaca; Puebla; Veracruz	Stronger business structure and broader environmental engagement.
Cluster 3 (n = 12)	Aguascalientes; Coahuila; Chihuahua; Guanajuato; Jalisco; Michoacán; Nayarit; Querétaro; San Luis Potosí; Sinaloa; Tlaxcala; Yucatán	Lower business structure with emphasis on water and energy saving.

Note: Cluster profiles are based on standardized Z-score centers and each cluster's relative position with respect to the overall sample mean.

Source: Authors' elaboration

Figure 2: Territorial distribution of the three environmental-business clusters in Mexico



Note: Clusters were obtained via K-means clustering (K = 3) using 11 standardized business and environmental variables across the 32 Mexican federal entities.
Source: Own elaboration

The spatial distribution confirms substantial heterogeneity among Mexican federal entities. The results indicate that business structure and environmental practices do not follow a uniform territorial pattern. In particular, Cluster 2 links stronger business structure with broader environmental engagement, whereas Cluster 3 links smaller business structures with specific resource-efficiency practices.

Sensitivity and Descriptive Differentiation

We examined alternative K-means solutions to assess the robustness of the three-cluster solution. K=2 produced highly unbalanced groups (7/25) despite a higher silhouette coefficient (0.316), while K=4 generated excessive fragmentation, including a cluster of only two entities. K=3 produced groups of 14, 6, and 12 entities and, although its silhouette

coefficient was lower (0.165), provided the most differentiated and substantively interpretable territorial profiles. Therefore, we retained K=3 as the principal solution, while treating K=2 and K=4 as sensitivity checks.

Table 6: Sensitivity analysis of alternative cluster solutions

Number of clusters	Cluster sizes	Silhouette coefficient	Interpretation
K = 2	7 / 25	**0.316**	High internal separation, but highly unbalanced.
K = 3	**14 / 6 / 12**	0.165	**More differentiated and interpretable territorial profiles.**
K = 4	14 / 5 / 11 / 2	Not calculated	Excessive fragmentation; one cluster contains only 2 entities.

Note: Cluster sizes refer to the 32 federal entities included in the analysis. The silhouette coefficient was calculated for the available alternative solutions.

Source: Own elaboration

The variables showing the greatest descriptive differentiation among clusters were environmental enterprises (F = 42.660), women-managed enterprises (F = 37.823), fire prevention (F = 22.237), and total enterprises (F = 20.008). Living fences, water saving, energy saving, and environmental action also contributed to the differentiation, whereas pest control, packaging separation, and other actions showed lower F-statistics. These values are reported descriptively and should not be interpreted as conventional inferential tests.

Table 7: Descriptive F-statistics for variables differentiating the clusters

Variable	F
Environmental enterprises	**42.660**
Women-managed enterprises	**37.823**
Fire prevention	**22.237**
Total enterprises	**20.008**
Living fences	**10.834**
Water saving	**9.010**
Energy saving	**6.494**

Variable	F
Environmental action	**4.661**
Pest control	1.185
Other actions	1.818
Packaging separation	2.337

Note: F-statistics are reported for descriptive purposes only because the clusters were formed to maximize between-cluster differences. Therefore, do not interpret the associated significance levels as conventional hypothesis tests.

Source: Own elaboration

Discussion

The findings show that female leadership in Mexican agricultural enterprises is territorially heterogeneous and shaped by interactions among business structure, organizational capacity, and environmental practices. Regarding Q1, the cluster with the strongest business structure also showed the highest concentration of women-managed and environmentally active enterprises, together with broader preventive practices. This pattern is consistent with research associating female leadership with innovation, operational efficiency, sustainability-oriented decision-making, and environmental management (Li & Tong, 2023; Pierli et al., 2022; García-Sánchez & Enciso-Alfaro, 2025), as well as with international evidence emphasizing women's role in advancing sustainable agricultural systems (World Farmers' Organization, 2025; FAO, 2026).

However, these results should not be interpreted as evidence that female leadership alone determines environmental performance. Rural women entrepreneurs continue to face structural constraints related to access to finance, technology, productive assets, institutional support, and decision-making autonomy (Díaz-García et al., 2016; Hernández Herrera, 2024; Karami et al., 2024). At the same time, women may respond to these constraints through diversification, resource efficiency, environmental knowledge, and adaptive practices (Karami et al., 2024; Álvarez Hernández et al., 2025; De Marco Larrauri et al., 2016; Acevedo-Ortiz et al., 2024). Thus, the results support an interpretation in which environmental sustainability emerges from the interaction between organizational capabilities and territorial conditions rather than from business size or female leadership in isolation, consistent with the NRBV and evolutionary

regional resilience perspectives (Hart, 1995; Boschma, 2015; Royer & Simon, 2024).

Regarding Q2 and Q3, the three territorial profiles reveal differentiated environmental strategies. The manuscript interprets *Cluster 1*, characterized by a smaller business structure and diversified environmental practices, through Hart's (1995) product stewardship perspective. Its combination of preventive, adaptive, and land-management practices is consistent with evidence that small-scale producers can use diversification and local environmental knowledge to respond to economic, technological, institutional, and environmental constraints (Shi et al., 2012; Karami et al., 2024; Álvarez-Hernández et al., 2025; Acevedo-Ortiz et al., 2024). These practices can therefore be understood as expressions of strategic flexibility and entrepreneurial adaptation (Boschma, 2015).

Cluster 2, which presents the strongest business structure and broader environmental engagement, is associated in the manuscript with Hart's (1995) pollution prevention strategy. This interpretation emphasizes environmental practices as mechanisms to improve operational efficiency and reduce costs, particularly under constraints related to land ownership, production costs, and access to formal credit. Previous studies indicate that pollution prevention and environmental efficiency can constitute an initial strategic response among resource-constrained SMEs (Darmandieu et al., 2022; Sobrino-García, 2023; Medina, 2025; Royer & Simon, 2024). Evidence from rural contexts also shows that women entrepreneurs can transform resource limitations into operational capabilities through innovation and conservation practices (Vujadinović & Marjanović, 2025; Lashitew & Werker, 2020; Lashitew et al., 2020).

Cluster 3 presents a different configuration: although its business structure is below the overall mean, it records above-average water- and energy-saving practices. This pattern suggests that environmental adaptation does not necessarily depend on organizational scale and that resource efficiency may represent a specific pathway for responding to territorial and resource constraints (Karami et al., 2024; Álvarez Hernández et al., 2025; Royer & Simon, 2024). From an evolutionary regional resilience perspective, territories may develop different environmental trajectories based on their existing structural and institutional conditions (Boschma, 2015). Consequently, the lower levels of preventive and land-management practices observed in this cluster should not automatically be interpreted as lower sustainability.

From a theoretical perspective, the findings support applying the NRBV to subnational agricultural contexts by showing that environmental strategies vary with organizational and territorial configurations. The results also reinforce the relevance of female leadership as an adaptive mechanism, while avoiding the assumption that women-led enterprises constitute a homogeneous category. Nevertheless, this study did not directly measure resilience; therefore, references to resilience should be understood as a theoretical interpretation rather than empirical evidence that one cluster is more resilient than another.

Conclusion

The results demonstrate that female leadership in Mexican agriculture is territorially heterogeneous and that the interaction between business structure, organizational capabilities, and regional conditions shapes environmental practices. The three-cluster typology reveals differentiated pathways of environmental engagement rather than a uniform relationship between business size and sustainability. While Cluster 2 combines stronger business structure with broader environmental and preventive practices, Cluster 1 shows diversified environmental engagement despite a smaller business structure, and Cluster 3 emphasizes water and energy efficiency despite a below-average business structure.

These findings extend the NRBV perspective by suggesting that environmental capabilities may develop through different organizational and territorial pathways. Female leadership should therefore not be considered an isolated determinant of environmental sustainability; its contribution is embedded in access to resources, organizational capabilities, and territorial conditions.

From a policy perspective, the identified typology suggests that environmental interventions for women-led agricultural enterprises should avoid standardized approaches. Territories with stronger business structures may benefit from support for technological innovation and consolidation of environmental practices. In contrast, territories characterized by resource-efficiency strategies may require greater access to water- and energy-saving technologies, financing, technical assistance, and training.

The study is limited by its reliance on secondary cross-sectional data, which restricts analysis of women's experiences, motivations, and leadership dynamics. Future research should incorporate primary and longitudinal data,

as well as variables explicitly constructed from the NRBV framework, to examine causal relationships and multilevel territorial effects. Because the analysis focuses on Mexico, comparative studies across countries would also help identify how institutional, cultural, and territorial contexts shape these dynamics.

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