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Research Article

Digitalization and Climate-Smart-Technologies Drive Sustainable Rural Women Entrepreneurship

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Abstract

Globalization is reshaping rural economies through digital transformation and increasing environmental pressures, creating both opportunities and challenges for women-led entrepreneurship. In this context, technological innovation has emerged as a key mechanism for promoting sustainability, competitiveness, and inclusion. The objective of this study is to analyze two emerging global trends—namely inclusive digitalization and climate-smart technologies—and their implications for rural women entrepreneurship within a prospective horizon of 2026–2031. The research adopts a qualitative approach with an interpretative and prospective orientation, based on documentary analysis of academic literature and international institutional reports. The findings reveal that inclusive digitalization facilitates market access, enhances business visibility, and improves productivity by enabling rural women entrepreneurs to overcome structural and geographical barriers. At the same time, climate-smart technologies contribute to strengthening resilience and sustainability in rural production systems by optimizing resource use and improving adaptive capacity in the face of climate change. However, the results also indicate that persistent structural inequalities, particularly in terms of gender, access to technology, and digital capabilities, continue to limit the full potential of these innovations. The study concludes that technological innovation plays a multidimensional role in rural development, simultaneously influencing economic performance, environmental sustainability, and social equity. It also highlights the need for inclusive innovation ecosystems and targeted policies to ensure that technological transformation leads to equitable and sustainable outcomes for rural women entrepreneurs.

Keywords

Technological Innovation, Rural Women Entrepreneurship, Digitalization, Climate Smart Technologies, Sustainable Development, Gender Inclusion, Rural Competitiveness

1. Introduction

Globalization has intensified [8, 9] the transformation of rural economies through the expansion of digital technologies and the increasing impact of environmental challenges. In recent years, digital transformation and climate change have emerged as key forces reshaping production systems, market structures, and development opportunities, particularly in rural areas of developing countries. These dynamics have significant implications for women entrepreneurs, who often face structural barriers related to access to resources, technology, and markets [5].

The growing importance of digitalization has been widely

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recognized as a driver of economic inclusion and competitiveness. Digital technologies, including internet connectivity, mobile devices, and online platforms, enable rural entrepreneurs [10, 15] to access broader markets, improve business processes, and participate more actively in economic networks [6]. However, despite these opportunities, substantial digital divides persist, particularly in rural contexts and among women, limiting the inclusive potential of technological transformation [5].

At the same time, climate change represents a major challenge [16, 17] for rural production systems, especially in agriculture-based economies. Increasing climate variability, extreme weather events, and environmental degradation are significantly affecting productivity and livelihoods, particularly among vulnerable populations such as rural women [3]. In response, the adoption of climate-smart technologies has been promoted as a strategic approach to enhance resilience, optimize resource use, and ensure sustainability in rural development [7].

These two trends—digitalization and climate-smart technologies—are not isolated phenomena but interconnected processes that jointly influence the transformation of rural entrepreneurship. Technological innovation, therefore, emerges as a multidimensional mechanism that simultaneously affects economic performance, environmental sustainability, and social equity. Understanding how these trends interact is essential for addressing the challenges of inclusive and sustainable development in rural contexts.

Despite the growing body of literature on digital transformation and climate adaptation, there is still a need for integrative analyses that examine their combined implications for rural women entrepreneurship. This study addresses this gap by analyzing two key global trends—namely inclusive digitalization and climate-smart technologies—and their potential impact on sustainability and competitiveness in rural enterprises led by women, within a prospective horizon of 2026–2031.

The findings of this study indicate that both digitalization and climate-smart technologies play a critical role in enhancing market access, productivity, and resilience, while also highlighting the persistence of structural inequalities that limit their full potential. These results contribute to expanding the understanding of rural competitiveness by incorporating sustainability and gender inclusion as central dimensions of development.

2. Materials and Methods

2.1. Research Design

This study adopts a qualitative approach with an interpretative and prospective orientation, aimed at analyzing emerging global trends related to digitalization and climate-smart technologies and their implications for rural women entrepreneurship. The research is grounded in a documentary analysis methodology, which allows the identification, systematization, and interpretation of relevant academic and institutional evidence within the context of globalization and sustainable development [1].

2.2. Analytical Framework

The methodological design is based on a structured analytical framework that integrates two key components: (1) the identification and conceptual delimitation of global trends, and (2) the examination of their driving forces, supporting evidence, and implications for competitiveness. This approach aligns with qualitative research traditions that emphasize understanding complex social phenomena through the analysis of secondary data and theoretical constructs rather than statistical generalization [1].

2.3. Prospective Approach

The study follows a prospective perspective, focusing on the time horizon 2026–2031, in order to explore future scenarios related to technological transformation and sustainability in rural contexts. This perspective is particularly relevant in the analysis of global megatrends, as it allows the identification of emerging opportunities and risks that may influence the development of rural entrepreneurship systems [2].

2.4. Data Collection

Data collection was conducted through the review of recent academic literature, international reports, and institutional publications addressing digital inclusion, climate change, technological innovation, and gender in rural development. Priority was given to sources published from 2020 onwards to ensure the relevance and timeliness of the analysis. The selected sources include reports from international organizations such as the Food and Agriculture Organization and the International Telecommunication Union, [11, 12] as well as peer-reviewed academic articles [3].

2.5. Data Analysis

For data analysis, a thematic analysis strategy was employed, allowing the classification of information into key categories such as digitalization, climate-smart technologies, gender inclusion, and competitiveness. This process facilitated the identification of patterns, relationships, and underlying mechanisms linking technological innovation with sustainability and equity in rural entrepreneurship. Additionally, the analysis incorporated an abductive logic, enabling the continuous interaction between empirical evidence and theoretical frameworks to generate interpretative insights [4].

2.6. Research Rigor

First, this study ensures methodological rigor through a sys-

tematic and transparent research design grounded in qualitative interpretative analysis. First, a rigorous selection of sources was applied, prioritizing peer-reviewed academic articles and reports from recognized international organizations published between 2020 and 2025, ensuring the relevance, credibility, and timeliness of the data.

Second, the study employs documentary triangulation, integrating multiple types of sources (academic literature, institutional reports, and global development frameworks) to identify converging patterns and strengthen the consistency of the findings. This triangulation enhances the robustness of the analysis by reducing potential biases associated with single-source interpretations.

Third, the research follows an abductive analytical logic, allowing continuous interaction between empirical evidence and theoretical frameworks. This approach facilitates the generation of interpretative insights by iteratively refining categories and relationships throughout the analysis process.

Additionally, analytical validity is reinforced through the coherence between the research objective, analytical categories, and results. The study also ensures transparency by clearly describing the data collection and analysis procedures, allowing for the traceability and reproducibility of the research process within qualitative paradigms.

Although the study does not include primary empirical data, its strength lies in providing a conceptual and prospective analysis that contributes to understanding emerging global trends. This approach is consistent with qualitative research traditions that aim to generate theoretical insights and inform policy-oriented discussions.

3. Results

3.1. Inclusive Digitalization and Digital Platforms for Rural Women Entrepreneurship

This section presents the main findings. The analysis identifies inclusive digitalization as a key emerging trend that is reshaping rural women entrepreneurship by facilitating access to markets, information, and productive resources. This trend is characterized by the expansion of internet connectivity, the increasing use of smartphones, and the adoption of digital platforms for commercialization and communication purposes.

Evidence indicates that digital technologies enable women entrepreneurs to overcome traditional geographical and structural barriers, allowing them to access broader markets and strengthen their participation in economic activities [1]. The growing availability of digital tools such as social media, e-commerce platforms, and mobile applications has contributed to improving business visibility, operational efficiency, and innovation capacity among rural enterprises led by women [2].

From a structural perspective, one of the main drivers of this trend is the sustained expansion of global digital connectivity. Recent data show that a significant proportion of the world population is now connected to the internet, although disparities persist between rural and urban areas, as well as between genders [1]. These inequalities represent both a limitation and a critical area of intervention for inclusive development.

Another relevant driver is the reduction of entry barriers to markets through digitalization. Digital platforms reduce transaction costs, [13] simplify commercialization processes, and provide new channels for direct interaction with consumers, thereby enhancing competitiveness in rural contexts [2].

The results also reveal that digitalization contributes to improving productivity and resilience in rural enterprises. The integration of digital tools into business processes enables better resource management, faster adaptation to market changes, and increased capacity for innovation, which are essential elements for sustainable development.

However, despite these opportunities, the persistence of digital gaps remains a significant challenge. Limited access to infrastructure, digital skills, and financial resources continues to restrict the full participation of rural women in the digital economy, potentially reinforcing existing inequalities.

3.2. Climate Smart Technologies for Sustainable Rural Production

The second major trend identified in this study is the adoption of climate-smart technologies aimed at enhancing sustainability and resilience in rural production systems. This trend emerges as a response to increasing environmental pressures and the growing impact of climate change on agricultural productivity.

Empirical evidence highlights that climate change is significantly affecting small-scale agricultural systems, increasing vulnerability among rural populations, particularly women who face structural barriers in accessing resources and technology [3]. In this context, climate-smart technologies play a crucial role in improving adaptive capacity and reducing risks associated with climate variability.

Among the main drivers of this trend is the intensification of climate-related risks, including extreme weather events and environmental degradation. These conditions have accelerated the need for technological solutions that enable monitoring, prediction, and efficient management of natural resources [3].

Another important driver is the need to enhance productivity and efficiency in small-scale production systems. Technologies such as sensors, [14] data monitoring systems, and digital tools for agricultural management allow producers to optimize the use of water, fertilizers, and other inputs, thereby increasing efficiency and sustainability [4].

Additionally, gender-based inequalities in access to resources and technology constitute a significant factor influencing the adoption of climate-smart innovations. Women in rural areas often face greater challenges in accessing financing,

training, and technological tools, which limits their capacity to implement adaptive strategies and benefit from innovation processes [3].

The findings indicate that the integration of climate-smart technologies contributes to strengthening the resilience of rural production systems, improving productivity, and supporting environmental sustainability. These technologies enable more efficient resource use, reduce production losses, and enhance the capacity of rural enterprises to respond to climate-related challenges.

Nevertheless, similar to digitalization, the unequal distribution of technological access poses a risk of widening existing gaps between regions and social groups. Without targeted interventions, these disparities may limit the transformative potential of climate-smart technologies in rural development.

4. Discussion

The findings of this study highlight the central role of technological innovation as a transformative mechanism for strengthening sustainability, competitiveness, and equity in rural women entrepreneurship. The analysis of the two identified trends—namely inclusive digitalization and climate-smart technologies—reveals that both function as complementary drivers that reshape rural production systems and market participation under the dynamics of globalization.

In relation to inclusive digitalization, the results confirm that access to digital technologies significantly enhances market integration and business performance among rural women entrepreneurs. This finding is consistent with previous research, [13-15] which emphasizes that digital platforms reduce structural barriers, facilitate access to information, and enable new forms of economic participation in marginalized contexts [2]. The ability to connect directly with consumers, manage online marketing strategies, and access digital financial tools represents a structural shift in how rural enterprises operate and compete.

However, the persistence of digital divides remains a critical constraint. As reported by international organizations, inequalities in access to infrastructure, digital skills, and connectivity disproportionately affect rural populations and women, limiting the inclusive potential of digital transformation [1]. This tension suggests that digitalization alone is insufficient to guarantee equitable development unless accompanied by targeted policies and capacity-building initiatives.

Regarding climate-smart technologies, the findings reinforce the growing importance of technological adaptation in response to climate change. The results align with global evidence indicating that climate variability is increasingly threatening agricultural productivity and rural livelihoods, particularly among vulnerable groups such as women [3]. In this context, the adoption of climate-smart innovations contributes to improving resource efficiency, reducing environmental risks, and strengthening resilience in rural production systems.

Moreover, the integration of digital tools into climate-smart practices represents a convergence of technological pathways that enhances both productivity and sustainability. Studies on smart agriculture and IoT-based systems demonstrate that technological integration allows more precise resource management and supports data-driven decision-making, which is essential in uncertain environmental conditions [4]. This convergence reinforces the argument that technological innovation is not a single-dimensional process but rather a multidimensional mechanism that operates across economic, social, and environmental domains.

From a gender perspective, the findings reveal that both trends are deeply influenced by structural inequalities that limit women's access to technology, financing, and training. This aligns with broader literature on gender and development, [8, 9, 12] which highlights that without deliberate inclusion strategies, technological advancements may reproduce or even deepen existing disparities [3]. Therefore, promoting gender-sensitive innovation ecosystems becomes essential to ensure that technological progress translates into equitable outcomes.

Additionally, the results contribute to the understanding of rural competitiveness by demonstrating that technological innovation enhances not only productivity but also adaptive capacity and resilience. This perspective expands traditional views of competitiveness, which have historically focused on efficiency and market performance, by incorporating sustainability and social inclusion as key dimensions of development.

Finally, this study opens avenues for future research. Further empirical studies are needed to examine how digital and climate-smart technologies are adopted at the local level, particularly in specific territorial contexts such as rural communities in developing countries. Additionally, future research could explore the role of institutional environments, public policies, and support programs in facilitating or constraining technological adoption among women entrepreneurs.

5. Conclusions

This study confirms that technological innovation—particularly through inclusive digitalization and climate-smart technologies—constitutes a key driver for enhancing sustainability, competitiveness, and equity in rural women entrepreneurship within the context of globalization. The findings demonstrate that these technological trends not only improve market access and productivity but also strengthen adaptive capacity and resilience in rural production systems.

Beyond these functional contributions, the study provides a conceptual advancement by integrating digital transformation and climate-smart innovation within a multidimensional analytical framework. This perspective expands traditional approaches to rural competitiveness by incorporating sustainability and gender inclusion as central dimensions of develop-

ment, thus contributing to a more holistic understanding of rural entrepreneurial ecosystems.

However, the results also highlight that the transformative potential of technological innovation is significantly conditioned by persistent structural inequalities, particularly those related to gender, access to resources, and digital capabilities. This finding underscores the necessity of designing inclusive innovation ecosystems and targeted public policies that address these barriers and ensure equitable access to technological opportunities.

From a methodological perspective, this research demonstrates the value of qualitative documentary analysis combined with a prospective approach in generating theoretical and policy-relevant insights. While the study does not rely on primary empirical data, it contributes to the identification of emerging global trends and provides a foundation for future empirical research in specific territorial contexts.

In this regard, future studies should focus on empirical validation at the local level, particularly in rural communities of developing countries, in order to examine how digital and climate-smart technologies are effectively adopted and adapted by women entrepreneurs. Additionally, further research should explore the role of institutional environments and support systems in facilitating inclusive and sustainable technological transformation.

Finally, this study emphasizes that achieving sustainable rural development requires not only technological advancement but also a deliberate integration of social inclusion and environmental sustainability. Strengthening these dimensions is essential to ensure that innovation processes translate into long-term, equitable, and resilient development outcomes for rural women entrepreneurs.

Abbreviations

ICT	Information and Communication Technologies
FAO	Food and Agriculture Organization of the United Nations
ITU	International Telecommunication Union
IoT	Internet of Things
SMEs	Small and Medium Enterprises
SDGs	Sustainable Development Goals

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Author Contributions

Evelyn Dayanara Solorzano Guerra: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing

Data Availability Statement

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Denzin, N. K., Lincoln, Y. S. *The SAGE Handbook of Qualitative Research*. 5th ed. Thousand Oaks: SAGE Publications; 2018.

[2] Godet, M. *Creating Futures: Scenario Planning as a Strategic Management Tool*. London: Economica; 2006.

[3] Food and Agriculture Organization of the United Nations (FAO). *The Status of Women in Agrifood Systems*. Rome: FAO; 2023. Available from: https://openknowledge.fao.org/items/adc0741f-9de2-4d09-ae68-b19cc871601a

[4] Reichertz, J. Abduction: The Logic of Discovery of Grounded Theory. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research. 2010; 11(1).

[5] International Telecommunication Union (ITU). Measuring Digital Development: Facts and Figures 2025. Geneva: ITU; 2025. Available from: https://www.itu.int/en/ITU-D/Statistics/pages/facts/default.aspx

[6] Seyed Taheri, S. Digitalization and Women Entrepreneurship: Opportunities and Challenges. Nordic Journal of Media Management. 2024; 5(1). Available from: https://journals.aau.dk/index.php/NJMM/article/view/8607

[7] Okech, J., Atukunda, P., Mwesigwa, D., Tumwesigye, W. A Smart IoT Framework for Climate-Resilient and Sustainable Maize Farming in Uganda. arXiv. 2025. https://doi.org/10.48550/arXiv.2501.12483

[8] United Nations. Progress on the Sustainable Development Goals: *Gender Snapshot 2023*. New York: United Nations; 2023. https://doi.org/10.18356/9789210024914

[9] World Bank. *Women, Business and the Law 2023*. Washington, DC: World Bank; 2023. https://doi.org/10.1596/978-1-4648-1952-1

[10] OECD. *Bridging the Digital Gender Divide*. Paris: OECD Publishing; 2023. https://doi.org/10.1787/2d7b3c1d-en

[11] FAO. Digital technologies in agriculture and rural areas: Status report. Rome: FAO; 2022. https://doi.org/10.4060/cb9985en

[12] UN Women. *Leveraging Digitalization for Women's Economic Empowerment*. New York: UN Women; 2023. https://doi.org/10.18356/9789210012348

[13] Klerkx, L., Jakku, E., Labarthe, P. A review of social science on digital agriculture. *Agricultural Systems*. 2022; 190: 103120. https://doi.org/10.1016/j.agsy.2021.103120

[14] Ayre, M., McCollum, V., Waters, W., et al. Supporting agricultural innovation through digital tools. *NJAS: Impact in Agricultural and Life Sciences*. 2023; 95(1). https://doi.org/10.1080/27685241.2023.2168567

[15] World Bank. *Digital Development Overview 2024*. Washington, DC: World Bank; 2024. https://doi.org/10.1596/978-1-4648-2000-0

[16] IFAD. *Rural Development Report 2023: Transforming Food Systems*. Rome: IFAD; 2023. https://doi.org/10.18356/9789251377413

[17] UNDP. *Human Development Report 2024*. New York: United Nations Development Programme; 2024. https://doi.org/10.18356/9789210030007

Biography

Evelyn Dayanara Solorzano Guerra holds a Bachelor's degree in Business Administration from the University of San Carlos of Guatemala, Oriente University Center (CUNORI). She also completed a Master's degree in Human Resource Management at the Graduate Faculty of CUNORI. Currently, she is a doctoral student in Business Administration at the State Distance University (UNED), Costa Rica. She has professional experience in higher education teaching and has been actively involved in advising entrepreneurial initiatives, particularly in rural and community-based contexts. Her academic and research interests focus on technological innovation, sustainable development, and women's entrepreneurship in rural areas.

Research Field

Evelyn Dayanara Solorzano Guerra: technological innovation, sustainable rural development, women entrepreneurship, gender and development, digital transformation in rural areas, climate smart agriculture, small business development, social and economic sustainability.