

Silvopastoral Systems in Latin America: A Systematic Review of Productive, Environmental Impacts and Adoption Factors in Sustainable Livestock Production

Armando Pacheco Hernández

Universidad de Oriente, San Miguel, El Salvador

armando.pacheco@univo.edu.sv

Submitted:	Revised:	Accepted:	Published:
Sep 14, 2026	Oct 13, 2026	Oct 24, 2026	Oct 29, 2026

Abstract

Livestock production supports food security, employment, and rural development in Latin America, while conventional extensive grazing systems can contribute to soil degradation, biodiversity loss, deforestation, and greenhouse gas emissions. Silvopastoral systems (SPS), which integrate trees, shrubs, forage species, and livestock, offer an approach to addressing these environmental pressures alongside production objectives. This study aimed to examine the evolution of SPS research, productive performance, environmental contributions, and sociotechnical factors influencing adoption in Latin America. A systematic literature review with qualitative evidence synthesis was conducted using scientific publications indexed in academic databases and published between 2014 and 2025. The synthesis examined reported productive and environmental outcomes alongside the economic, institutional, and cultural conditions shaping implementation. The reviewed studies reported improvements in forage quality, animal nutrition, productive efficiency, animal welfare, and soil fertility. Environmental benefits included biodiversity conservation and contributions to climate change mitigation through carbon sequestration and reduced greenhouse gas emissions. The literature also showed a shift from predominantly ecological and productive assessments toward broader sociotechnical perspectives incorporating institutional arrangements, economic conditions, and cultural practices. Despite these documented benefits, adoption remained constrained by limited access to financing, inadequate technical assistance, weak public policies, and

reluctance to modify established production practices. These findings highlight the importance of connecting technical knowledge with the conditions under which producers make management decisions. The review concludes that scaling SPS requires coordination among producers, researchers, institutions, and policymakers, supported by accessible financing, sustained technical assistance, and effective public policies. By integrating evidence on production, environmental outcomes, and adoption, the study provides a basis for designing strategies responsive to local conditions and advancing sustainable livestock production across Latin America.

Keywords: Silvopastoral Systems; Sustainable Livestock Production; Climate Change Mitigation; Animal Welfare; Latin America

INTRODUCTION

Livestock production represents one of the most strategically important economic activities in Latin America, not only because of its contribution to meat and milk production but also due to its relevance in employment generation, rural livelihoods, territorial occupation, and food security. In many countries across the region, livestock systems constitute a central component of rural economies and serve as a primary source of income for thousands of small, medium, and large-scale producers. However, despite its economic importance, conventional livestock production systems have historically been associated with environmental degradation, inefficient resource utilization, and increasing vulnerability to climate variability. Extensive grazing systems, characterized by low technological integration and simplified pasture monocultures, have contributed to deforestation, biodiversity loss, soil erosion, declining fertility, reduced water infiltration, and increasing greenhouse gas emissions, generating significant sustainability challenges for agricultural landscapes (Jose & Dollinger, 2019; Broom, 2017).

The expansion of conventional cattle ranching has been identified as one of the main drivers of land-use change in tropical and subtropical regions of Latin America. The conversion of native forests into grazing lands has altered ecological processes, fragmented habitats, and reduced ecosystem resilience. This transformation has generated productive systems highly dependent on external inputs and vulnerable to climatic disturbances such as droughts, extreme temperatures, and irregular rainfall patterns. Furthermore, climate change has intensified the pressure on livestock systems by affecting forage availability, animal

performance, and the long-term productivity of rural territories. Under these circumstances, there is increasing recognition that conventional livestock production models are insufficient to address the current environmental, productive, and social demands of sustainable agricultural development.

In response to these challenges, silvopastoral systems (SPS) have emerged as an innovative and sustainable alternative capable of integrating livestock production with ecological restoration and climate resilience. Silvopastoral systems are characterized by the intentional integration of trees, shrubs, forage species, and animals within the same productive unit, generating positive ecological interactions that improve both productivity and environmental sustainability. Unlike conventional grazing systems, SPS promote biological diversity, nutrient cycling, microclimatic regulation, and more efficient resource use, creating multifunctional landscapes that simultaneously support agricultural production and ecosystem conservation (Aryal et al., 2022; Torres et al., 2023).

The scientific literature has consistently documented the ecological benefits associated with silvopastoral systems. The incorporation of arboreal and shrub species contributes to the improvement of soil physical, chemical, and biological properties. Tree roots enhance soil structure and reduce compaction, while leaf litter increases organic matter accumulation and stimulates microbial activity. These processes improve nutrient availability, water retention capacity, and resistance to erosion, contributing to greater ecosystem stability. Studies conducted in different regions of Latin America have shown that silvopastoral systems can significantly improve soil quality compared to conventional pasture systems, generating long-term benefits for agricultural productivity and environmental restoration (Ramírez-Barajas et al., 2019; Díaz Lezcano et al., 2020).

In addition to their ecological contributions, silvopastoral systems have demonstrated substantial productive advantages in livestock production. The integration of trees and shrubs creates diversified forage resources that improve diet quality and increase feed availability throughout the year. Many arboreal species used in SPS provide high protein content, greater digestibility, and additional mineral supplementation, which positively influence animal nutrition and productive performance. Research has shown that cattle managed under silvopastoral conditions often exhibit improved weight gain, increased milk production, better reproductive efficiency, and reduced dependence on commercial feed supplements (López-Vigoa et al., 2017; Palma García & Anguiano Cárdenas, 2015).

Animal welfare has also become an increasingly important dimension in the evaluation of sustainable livestock systems. In tropical and subtropical environments, heat stress represents one of the main factors affecting animal health, behavior, and productivity. Silvopastoral systems contribute significantly to thermal regulation by providing shade and improving microclimatic conditions. The presence of trees reduces solar radiation exposure, lowers ambient temperature, and creates more favorable conditions for grazing behavior, rumination, and rest. Studies have reported reductions in physiological stress indicators, improved behavioral patterns, and higher productive efficiency in animals managed under silvopastoral conditions compared to those in open grazing systems (Huertas et al., 2021).

Another critical contribution of silvopastoral systems lies in their capacity to mitigate climate change. Agriculture and livestock production are major contributors to greenhouse gas emissions globally, particularly methane and nitrous oxide emissions associated with ruminant production systems. SPS contribute to climate mitigation through multiple mechanisms, including carbon sequestration in biomass and soils, improved feed conversion efficiency, reduced methane emissions through enhanced forage quality, and greater ecosystem resilience. Studies conducted in Mexico and other parts of Latin America have demonstrated that silvopastoral systems can significantly increase carbon storage compared to conventional grazing systems, positioning them as an important strategy for climate-smart agriculture (Aryal et al., 2022; Contreras-Santos et al., 2020).

Beyond their productive and environmental advantages, the implementation of silvopastoral systems also involves important social and institutional dimensions. Adoption is not solely determined by technical feasibility or scientific evidence but by the interaction of multiple actors, including producers, researchers, extension agents, policymakers, financial institutions, and rural organizations. These actors influence access to knowledge, financing, technical support, and market opportunities, shaping the conditions under which silvopastoral systems can be adopted and sustained over time.

Despite the growing body of evidence supporting the benefits of SPS, adoption rates across Latin America remain relatively low. Previous studies have identified numerous barriers affecting implementation, including high initial establishment costs, limited access to credit, insufficient technical assistance, weak public policies, cultural resistance, and uncertainty regarding long-term economic returns (Zepeda Cancino et al., 2016; Sandoval et al., 2021; Oliva et al., 2018). These barriers suggest that the limited expansion of SPS cannot

be explained solely by technological limitations but must be understood within a broader socio-technical framework.

A socio-technical perspective allows for a deeper understanding of how technologies such as silvopastoral systems are socially constructed, interpreted, adopted, or rejected within specific territorial contexts. From this perspective, technological innovation is not an isolated process but rather the result of interactions among social actors, institutional structures, cultural practices, and material resources. The successful implementation of SPS depends on the capacity of these actors to build collaborative networks, exchange knowledge, mobilize resources, and adapt technologies to local realities.

Given the increasing urgency of achieving sustainable livestock systems under climate change conditions, understanding both the technical performance and the socio-technical dynamics of SPS has become essential. Therefore, this study aims to analyze the scientific evolution, productive benefits, environmental contributions, and socio-technical conditions influencing the adoption of silvopastoral systems in Latin America through a systematic review of scientific literature. This approach seeks to contribute to a more comprehensive understanding of the factors that facilitate or limit the scaling of silvopastoral systems as a pathway toward sustainable livestock development.

METHODS

Research Design

This study was conducted through a **systematic literature review** with a qualitative integrative approach to synthesize current scientific evidence on silvopastoral systems (SPS) and their contribution to sustainable livestock production. Systematic reviews provide a rigorous and transparent methodology for identifying, evaluating, and synthesizing existing scientific knowledge, allowing the identification of consistent findings, research trends, knowledge gaps, and future research opportunities.

Unlike traditional narrative reviews, this study followed a structured methodological process to ensure the reproducibility and reliability of the evidence synthesis. The review integrated scientific studies employing quantitative, qualitative, and mixed-methods approaches, enabling a comprehensive understanding of the productive, environmental, economic, and institutional dimensions associated with silvopastoral systems.

The methodological approach adopted in this study was based on qualitative evidence synthesis, which facilitated the comparative interpretation of research findings generated under diverse methodological designs. This strategy made it possible to identify common patterns related to livestock productivity, ecosystem services, environmental sustainability, and the factors influencing the implementation of silvopastoral systems across different production contexts.

Literature Search Strategy

A systematic search of scientific literature was conducted using internationally recognized academic databases that index research in agriculture, livestock production, agroforestry, environmental sciences, and rural development. The databases consulted included Google Scholar, SciELO, Redalyc, Latindex, Dialnet, and EBSCOhost, selected because of their broad coverage of peer-reviewed publications related to sustainable livestock systems.

The search strategy was developed using combinations of controlled descriptors and free-text keywords in both English and Spanish. The principal search terms included *silvopastoral systems*, *sustainable livestock production*, *livestock agroforestry*, *silvopastoral adoption*, *animal welfare*, *carbon sequestration*, *biodiversity conservation*, *climate change mitigation*, *sistemas silvopastoriles*, *ganadería sostenible* and *agroforestería pecuaria*. Boolean operators (AND, OR, and NOT) were used to broaden or refine the search results according to the objectives of the review.

The literature search focused primarily on scientific articles published between 2014 and 2025, prioritizing recent studies that reflect current advances in the design, implementation, environmental performance, and sustainability of silvopastoral systems.

Study Selection

The identification and selection of studies followed a multi-stage screening process. Initially, titles and abstracts were reviewed to determine their relevance to the objectives of the study. Subsequently, the full text of potentially eligible publications was examined to verify compliance with the established inclusion criteria.

Only peer-reviewed scientific articles published in indexed journals were included. Eligible studies addressed silvopastoral systems from at least one of the following perspectives: livestock productivity, animal welfare, ecosystem services, biodiversity

conservation, soil quality, carbon sequestration, climate change mitigation, technological adoption, rural development, or sustainable agricultural management.

Publications lacking sufficient methodological information, duplicate records, conference abstracts, technical reports, theses, editorials, and documents not directly related to silvopastoral systems were excluded. This selection process ensured the inclusion of a representative and scientifically robust body of literature suitable for comparative analysis.

Data Organization and Analysis

The selected publications were organized using a literature review matrix designed to facilitate the systematic extraction and comparison of information. The matrix included variables such as authorship, year of publication, country or region of study, research objectives, methodological approach, principal findings, and the main contributions of each study to the understanding of silvopastoral systems.

Subsequently, a qualitative comparative analysis was performed to identify similarities, differences, recurring patterns, and emerging research trends across the selected studies. Rather than quantifying effect sizes, the analysis focused on integrating scientific evidence to provide a comprehensive interpretation of the multiple dimensions that characterize silvopastoral systems.

To improve the analytical consistency of the review, the evidence was organized into five thematic categories representing the principal areas of research identified in the literature:

1. **Sustainability and productive performance of silvopastoral systems**, including studies on livestock productivity, forage quality, production efficiency, animal nutrition, and animal welfare.
2. **Ecosystem services and environmental benefits**, encompassing biodiversity conservation, ecological restoration, soil quality improvement, water regulation, carbon sequestration, greenhouse gas mitigation, and climate resilience.
3. **Determinants of silvopastoral system adoption**, including socioeconomic, cultural, technological, financial, and institutional factors influencing implementation by livestock producers.

4. Innovation, knowledge transfer, and policy support, covering technical assistance, extension services, capacity building, technology transfer, public incentives, governance mechanisms, and institutional frameworks that facilitate sustainable livestock transitions.

5. Research trends, knowledge gaps, and future perspectives, integrating studies that identify emerging scientific challenges, opportunities for innovation, and priorities for future research on sustainable livestock production through silvopastoral systems.

This thematic organization enabled a comprehensive comparison of scientific evidence from different geographical regions and production systems while facilitating the identification of converging and diverging findings reported in the literature.

Finally, the integrated analysis allowed the identification of the principal contributions of silvopastoral systems to sustainable livestock production, as well as the environmental, economic, and institutional challenges that continue to limit their widespread implementation. This methodological approach provided a robust analytical basis for discussing current scientific evidence and proposing future research directions aimed at promoting resilient, productive, and environmentally sustainable livestock systems.

RESULTS AND DISCUSSION

The analysis of the selected literature indicates that silvopastoral systems (SPS) generate consistent benefits across productive, environmental, and social dimensions, confirming their relevance as an integrated strategy for sustainable livestock production. The evidence reviewed shows that SPS positively influence multiple components of livestock systems, improving productive efficiency while simultaneously strengthening ecological and social sustainability.

From the nutritional perspective, silvopastoral systems improve forage quality by increasing crude protein content, enhancing digestibility, and promoting greater dietary diversification for grazing animals. The incorporation of trees, shrubs, and forage species contributes to more efficient feed utilization, which is reflected in improved animal productivity, better feed conversion rates, and greater resilience during periods of forage scarcity or adverse climatic conditions (López-Vigoa et al., 2017; Palma García & Anguiano Cárdenas, 2015; Chará et al., 2020; Jiménez-Santiago et al., 2019; Martínez-Hernández et al., 2019; Nota et al., 2024).

In terms of natural resource management, the literature demonstrates that SPS contribute significantly to soil improvement, water regulation, and biodiversity conservation. The integration of arboreal vegetation promotes nutrient cycling, organic matter accumulation, and enhanced soil structure, while also reducing erosion and improving ecosystem stability. These ecological interactions allow productive systems to maintain environmental functionality while reducing land degradation processes (Sandoval et al., 2021; Apan-Salcedo et al., 2021; Trejo Arista, 2023).

Regarding animal welfare, the reviewed studies indicate that silvopastoral systems reduce thermal stress by providing shade and favorable microclimatic conditions for livestock. These conditions improve animal comfort, support the expression of natural behaviors, and contribute to better physiological responses. As a result, animals managed under SPS frequently show improved health status, increased productivity, and lower mortality rates compared with conventional grazing systems (Jose & Dollinger, 2019; Broom, 2017; Huertas et al., 2021; Murga-Orrillo et al., 2025; Améndola et al., 2016).

From an environmental perspective, SPS play a strategic role in climate change mitigation. The incorporation of trees and perennial vegetation increases carbon sequestration in biomass and soils, while improved forage quality contributes to reducing greenhouse gas emissions associated with livestock production. Additionally, these systems support biodiversity conservation, ecological restoration, and the provision of multiple ecosystem services within agricultural landscapes (Aryal et al., 2022; Chará et al., 2020; Contreras-Santos et al., 2020; Torres et al., 2023).

From a socioeconomic perspective, the adoption of SPS depends on a combination of economic, institutional, and cultural factors. Variables such as implementation costs, access to knowledge, technical assistance, public incentives, and producers' perceptions significantly influence adoption processes. The literature also highlights that economic uncertainty and cultural resistance toward changes in conventional livestock management can limit the scalability and long-term sustainability of these systems (Jose & Dollinger, 2019; Apan-Salcedo et al., 2022; Borda, 2023; Vargas-de la Mora et al., 2021; Romero-Mena et al., 2024).

Finally, the evolution of scientific research on silvopastoral systems reveals a progressive expansion of conceptual and methodological approaches. Over time, research has evolved from emphasizing ecological restoration and productive performance toward

more comprehensive perspectives that integrate environmental sustainability, animal welfare, climate resilience, and socio-technical adoption processes. This evolution reflects both scientific progress and the growing global demand for sustainable livestock production systems

The analysis of the different research stages identified in this review demonstrates a progressive transition from studies primarily focused on environmental restoration toward more comprehensive analytical perspectives that integrate productive performance, ecological sustainability, and socio-technical dimensions. This evolution reflects not only scientific progress in the study of silvopastoral systems (SPS), but also the increasing need to address livestock sustainability through multidisciplinary approaches.

The findings of this study confirm that SPS have been consistently validated in terms of productive efficiency, environmental conservation, and animal welfare. Nevertheless, their limited expansion across Latin America suggests that their implementation cannot be explained exclusively through technical performance indicators. Instead, their adoption must be understood within a broader socio-technical context, where social, institutional, and economic interactions significantly influence the implementation process.

From this perspective, SPS can be interpreted as productive technologies whose viability depends on the effective articulation among multiple stakeholders, including livestock producers, extension technicians, government agencies, research institutions, and rural organizations. Each of these actors participates under different conditions of knowledge, resources, interests, and institutional influence, shaping how these systems are adopted, adapted, or, in some cases, rejected in different territorial contexts.

One of the most relevant findings of this study is the existence of a structural contradiction. Although previous studies have widely documented the productive, environmental, and welfare benefits associated with SPS—including higher productivity, improved animal comfort, carbon sequestration, and biodiversity conservation (Aryal et al., 2022; López-Vigoa et al., 2017; Chará et al., 2020)—these systems have not yet become a dominant livestock production model in the region. This finding suggests that the principal limitations affecting their expansion are not primarily technological, but rather socio-institutional in nature.

The functioning and consolidation of SPS appear to be more evident in territories where effective articulation exists between scientific knowledge, local experience, access to

financing, institutional support, and collaborative learning networks. Under these conditions, producers are more likely to successfully integrate silvopastoral practices into their production systems, generating stable productive and environmental benefits over time.

In contrast, adoption remains limited in contexts where these institutional and social articulations are weak. The literature identifies multiple structural barriers, including limited technical assistance, high initial establishment costs, insufficient economic incentives, restricted access to training, and the persistence of conventional livestock production models, all of which constrain the implementation of SPS (Apan-Salcedo et al., 2022; Marroquín-Pugas et al., 2022).

Additionally, the reviewed studies reveal the existence of tensions between contrasting production rationalities. Conventional livestock systems often prioritize short-term economic returns based on simplified productive landscapes, whereas silvopastoral systems require a medium- and long-term management vision that integrates productive, environmental, and social objectives. This difference in productive logic can generate uncertainty and resistance among producers, particularly under conditions of financial risk or limited institutional support.

Overall, the scientific evolution of SPS research reflects a growing recognition that their adoption depends not only on productive or ecological performance, but also on social organization, institutional coordination, and economic viability. This transition highlights the importance of moving beyond purely technical approaches toward integrated strategies capable of addressing the complexity of contemporary livestock systems.

Finally, the large-scale expansion of silvopastoral systems in Latin America depends on the strengthening of socio-technical alliances that facilitate coordination among stakeholders. These alliances promote knowledge co-production, experience exchange, improved access to financial and technical resources, and the adaptation of technologies to local territorial conditions, thereby increasing the probability of adoption and long-term sustainability.

CONCLUSION

These findings show that silvopastoral systems involve multiple stakeholders whose interactions shape complex production dynamics in livestock landscapes. Conventional

extensive livestock systems generate environmental and productive problems such as soil degradation, biodiversity loss and climate vulnerability. Silvopastoral systems emerge as a viable alternative that integrates productivity, natural resource conservation and animal welfare. Their adoption depends not only on technical performance but also on social, economic, institutional and territorial conditions. Collaboration among knowledge, financing, extension services and institutions enhances successful implementation. Main barriers include limited credit, weak extension and persistent traditional practices. Therefore, expansion depends on strengthening alliances and institutional coordination.

REFERENCES

- Améndola, L., Solorio, F. J., Ku-Vera, J. C., Améndola-Massiotti, R. D., Zarza, H., & Galindo, F. (2016). Social behaviour of cattle in tropical silvopastoral and monoculture systems. *Animal*, 10(5), 863–867. <https://doi.org/10.1017/S1751731115002475>
- Apan-Salcedo, G. W., Jiménez-Ferrer, J. G., Nahed-Toral, J., Pérez-Luna, E., & Piñeiro-Vázquez, A. T. (2021). Massification of silvopastoral systems: A long and winding road. *Tropical and Subtropical Agroecosystems*, 24(3). <https://doi.org/10.56369/tsaes.3524>
- Apan-Salcedo, G. W., Nahed-Toral, J., Pérez-Luna, E., Piñeiro-Vázquez, Á., & Jiménez-Ferrer, G. (2022). Level of adoption of silvopastoral techniques in the Sierra Madre de Chiapas, Mexico. *Tropical and Subtropical Agroecosystems*, 25(2), Article 61.
- Aryal, D. R., Morales-Ruiz, D. E., López-Cruz, S., Tondopó-Marroquín, C. N., Lara-Nucamendi, A., Jiménez-Trujillo, J. A., Pérez-Sánchez, E., Betanzos-Simon, J. E., Casasola-Coto, F., Martínez-Salinas, A., Sepúlveda-López, C. J., Ramírez-Díaz, R., La O Arias, M. A., Guevara-Hernández, F., Pinto-Ruiz, R., & Ibrahim, M. (2022). Silvopastoral systems and remnant forests enhance carbon storage in livestock-dominated landscapes in Mexico. *Scientific Reports*, 12, Article 16769. <https://www.nature.com/articles/s41598-022-21089-4>
- Borda, P. (2023). *Factors influencing the adoption of silvopastoral systems in the province of Misiones, Argentina* [Specialization thesis, National University of Misiones].
- Broom, D. M. (2017). Components of sustainable animal production and the use of silvopastoral systems. *Revista Brasileira de Zootecnia*, 46(8), 683–688. <https://doi.org/10.1590/S1806-92902017000800009>
- Chará, J., Reyes, E., Peri, P., Otte, J., Arce, E., & Schneider, F. (2020). *Silvopastoral systems and their contribution to the efficient use of resources and the Sustainable Development Goals*. Food and Agriculture Organization; CIPAV.
- Contreras-Santos, J. L., Falla-Guzmán, C. K., Rodríguez, J. L., Fernando-Garrido, J., Martínez-Atencia, J., & Aguayo-Ulloa, L. (2023). Carbon stock in silvopastoral systems: A study in the Middle Sinú, Colombia. *Agronomía Mesoamericana*, 34(1), Article 49138. <https://revistas.ucr.ac.cr/index.php/ragromeso/article/view/4744>

- Contreras-Santos, J. L., Martínez-Atencia, J., Cadena-Torres, J., & Falla-Guzmán, C. K. (2020). Evaluation of carbon accumulated in soil in silvopastoral systems of the Colombian Caribbean. *Agroonomía Costarricense*, 44(1), 29–41. <https://doi.org/10.15517/rac.v44i1.39999>
- De la Peña-Domene, M., Ayestarán-Hernández, L. M., Márquez-Torres, J. F., Martínez-Monroy, F., Rivas-Alonso, E., Carrasco-Carballido, P. V., Pérez-Cruz, M. N., Chang-Landa, F. A., & Martínez-Garza, C. (2022). Sistemas silvopastoriles enriquecidos: Una propuesta para integrar la conservación en la producción ganadera en comunidades rurales de Los Tuxtlas, México. *Acta Botanica Mexicana*, (129), Article e1925. <https://doi.org/10.21829/abm129.2022.1925>
- Díaz Lezcano, M. I., Gamarra Lezcano, C. C., Ruiz Díaz, S., & Vera de Ortiz, M. (2020). Organic matter content in soils of silvopastoral systems established in the Paraguayan Central Chaco. *Revista de la Sociedad Científica del Paraguay*, 25(2), 131–143. <https://doi.org/10.32480/rscp.2020.25.2.131>
- Huertas, S. M., Bobadilla, P. E., Alcántara, I., Akkermans, E., & van Eerdenburg, F. J. C. M. (2021). Benefits of silvopastoral systems for keeping beef cattle. *Animals*, 11(4), Article 992. <https://doi.org/10.3390/ani11040992>
- Jiménez-Santiago, Á., Jiménez-Ferrer, G., Alayón-Gamboa, A., Pérez-Luna, E. J., Piñeiro-Vázquez, Á. T., Albores-Moreno, S., Pérez-Escobar, M. G., & Castro-Chan, R. (2019). Quantifying ruminal fermentation and methane production using the in vitro gas technique in the forages of a sheep silvopastoral system in Chiapas, Mexico. *Revista Mexicana de Ciencias Pecuarias*, 10(2), 298–314. <https://doi.org/10.22319/rmcp.v10i2.4529>
- Jose, S., & Dollinger, J. (2019). Silvopasture: A sustainable livestock production system. *Agroforestry Systems*, 93(1), 1–9. <https://doi.org/10.1007/s10457-019-00366-8>
- Lerma-Lasso, J. L., Bacca-Acosta, P. P., Obando-Enríquez, B. G., Castro-Rincón, E., & Cardona-Iglesias, J. L. (2023). Silvopastoral systems: Sustainability of high mountain livestock systems. *Pastos y Forrajes*, 46, 1–9.
- López-Vigoa, O., Sánchez-Santana, T., Iglesias-Gómez, J. M., Lamela-López, L., Soca-Pérez, M., Arece-García, J., et al. (2017). Silvopastoral systems as an alternative for sustainable animal production. *Pastos y Forrajes*, 40(2), 83–95.
- Marroquín-Pugas, O., Montero-Solís, F. M., Luis-Santiago, M. Y., Cruz-Gallegos, E., & Cisneros-Saguilán, P. (2022). Limitantes y oportunidades para implementar sistemas silvopastoriles en la costa de Oaxaca, México. *Revista Mexicana de Agroecosistemas*, 9(1), 49–59. <https://revistaremaeitvo.mx/index.php/remae/article/view/30>
- Martínez-Hernández, J. L., Villanueva, M. L., Balderas, D. H., & Clavero, A. (2019). Silvopastoral system with *Leucaena* can increase total available forage. *Tropical and Subtropical Agroecosystems*, 22, 331–357.
- Murga-Orrillo, H., Arévalo López, L. A., Mathios Flores, M. A., Cáceres Coral, J., García, M. R., Guerra Teixeira, A. A., & Valderrama, N. L. M. (2025). Silvopasture and altitudinal gradient reduce heat stress in livestock production in the Peruvian tropics. *Frontiers in Animal Science*, 6, Article 1521790. <https://doi.org/10.3389/fanim.2025.1521790>
- Murgueitio, E., Barahona, R., Chará, J. D., Flores, M. X., Mauricio, R. M., & Molina, J. J. (2015). The intensive silvopastoral systems in Latin America sustainable alternative

- to face climatic change in animal husbandry. *Cuban Journal of Agricultural Science*, 49(4), 541–552. <https://cjas.science.com/index.php/CJAS/article/view/500>
- Nota, G., Svensk, M., Barberis, D., Frund, D., Pagani, R., Pittarello, M., Probo, M., Ravetto Enri, S., Lonati, M., & Lombardi, G. (2024). Foraging behavior of Highland cattle in silvopastoral systems in the Alps. *Agroforestry Systems*, 98(2), 491–505. <https://doi.org/10.1007/s10457-023-00926-z>
- Nuncio Ochoa, M. G. J., Pérez Olivera, A. F., Gómez Ramos, B., Trujillo Pádua, V., Díaz Maldonado, I. J., Oviedo Boyso, J., Salinas Delgado, V., & Román Bravo, R. M. (2024). Adaptation of tree legumes in a silvopastoral system for sheep in a temperate climate. *Revista ESPAMCIENCIA*, 15(2), 7–15. https://doi.org/10.51260/revista_espamciencia.v15i2.482
- Oliva, M., Leiva, S., Collazos, R., Vigo Mestanza, C. N., & Maicelo, J. L. (2018). Factors that influence the adoption of silvopastoral technologies with native species *Alnus acuminata* (aliso). *Agrociencia Uruguay*, 22(2), Article e23. <https://agrocienciauruguay.uy/index.php/agrociencia/article/view/23>
- Palma García, J. M., & Anguiano Cárdenas, J. M. (2015). Silvopastoral systems in the improvement of livestock production. In *Livestock in Latin America and the Caribbean* (pp. 375–389). Universidad de Colima.
- Ramírez-Barajas, P. J., Santos-Chable, B. E., Casanova-Lugo, F., Lara-Pérez, L. A., Tucuch-Haas, J. I., Escobedo-Cabrera, A., Villanueva-López, G., & Díaz-Echeverría, V. F. (2019). Macro-invertebrate diversity in silvopastoral systems of Southern Quintana Roo, Mexico. *Revista de Biología Tropical*, 67(6), 1383–1393. <https://doi.org/10.15517/rbt.v67i6.36944>
- Romero-Mena, A. G., Tzec-Gamboa, M., Álvarez-Rivera, O. O., Ramírez y Avilés, L., & Solorio-Sánchez, F. J. (2024). Los sistemas silvopastoriles y las barreras socio-ecológicas que limitan su adopción. *Bioagrociencias*, 17(1), 52–58. <https://doi.org/10.56369/BAC.5402>
- Romero-Mena, A. G., Tzec-Gamboa, M., Álvarez-Rivera, O. O., Ramírez y Avilés, L., & Solorio-Sánchez, F. J. (2025). Advances and challenges in silvopastoral systems in Mexico. *Bioagrociencias*, 18(1), 45–52.
- Sáenz-Ceja, J. E., Sáenz-Reyes, J. T., Muñoz-Flores, H. J., Rueda-Sánchez, A., Castillo-Reyes, F., & Castillo-Quiroz, D. (2022). Potential areas for establishing silvopastoral systems with *Pinus lawsonii* and two forages in Michoacán, Mexico. *Ecosistemas y Recursos Agropecuarios*, 9(3), Article e3282. <https://doi.org/10.19136/era.a9n3.3282>
- Sales-Baptista, E., & Ferraz-de-Oliveira, M. I. (2021). Grazing in silvopastoral systems: Multiple solutions for diversified benefits. *Agroforestry Systems*, 95(1), 1–6. <https://doi.org/10.1007/s10457-020-00581-8>
- Sandoval, D., Fernández, J. C., González, C., Solarte, A., Holmann, F., Quintero, M., Castro, A., & Zapata, C. (2021). *Reporte técnico: Factores que influyen en la adopción de sistemas silvopastoriles en el piedemonte Andino-Amazónico del Departamento del Caquetá, Colombia* (Publicación CIAT No. 517). Centro Internacional de Agricultura Tropical; CIPAV; Patrimonio Natural. <https://alliancebioiversityciat.org/publications-data/reportes-tecnico-factores-que-influyen-en-la-adopcion-de-sistemas-silvopastoriles>
- Sandoval Pelcastre, A. A., Ramirez Mella, M., Rodríguez Ávila, N. L., & Candelaria Martínez, B. (2020). Tropical trees and shrubs with potential to reduce the production of

- methane in ruminants. *Tropical and Subtropical Agroecosystems*, 23(2). <https://doi.org/10.56369/tsaes.3061>
- Saucedo-Uriarte, J. A., Oliva-Cruz, S. M., Maicelo-Quintana, J. L., Meléndez-Mori, J. B., & Collazos-Silva, R. (2022). Silvopastoral arrangements with *Alnus acuminata* and their effect on productive and nutritional parameters of the forage component. *Revista Mexicana de Ciencias Pecuarias*, 13(2), 573–583. <https://doi.org/10.22319/rmcp.v13i2.5007>
- Torres, B., Bravo, C., Torres, A., Tipán-Torres, C., Vargas, J. C., Herrera-Feijoo, R. J., Heredia-R, M., Barba, C., & García, A. (2023). Carbon stock assessment in silvopastoral systems along an elevational gradient: A study from cattle producers in the Sumaco Biosphere Reserve, Ecuadorian Amazon. *Sustainability*, 15(1), Article 449. <https://doi.org/10.3390/su15010449>
- Torres Rivera, J. A., Arellano Gámez, L., & López Ortiz, S. (2023). Livestock landscapes and carbon storage. *Avances en Investigación Agropecuaria*, 27(Suppl. 2), 9–10.
- Trejo Arista, L. K. (2023). *Estudio de sistemas silvopastoriles diversificados en el trópico mexicano* [Doctoral dissertation, Universidad Autónoma Chapingo]. <https://repositorio.chapingo.edu.mx/items/adec2945-8442-483f-af8c-e6362698a5d2>
- Trejo-Arista, L. K., Cortés-Díaz, E., Martínez-Hernández, P. A., & Huerta-Bravo, M. (2023). Sistemas silvopastoriles: Una estrategia para la resiliencia ambiental en empresas ganaderas. *Pastos y Forrajes*, 46, Article e19.
- Vargas-de la Mora, A. L., Castillo-Santiago, M. A., Randhir, T. O., Hernández-Moreno, M. C., Cach-Pérez, M. J., & Camacho-Valdéz, V. (2021). Know to improve: Factors that influence the transition towards silvopastoral systems in the Chiapas coast. *Tropical and Subtropical Agroecosystems*, 24(3), Article 108. <https://doi.org/10.56369/tsaes.3689>
- Yadav, A., Gendley, M. K., Sahu, J., Patel, P. K., Chandraker, K., & Dubey, A. (2019). Silvopastoral system: A prototype of livestock agroforestry. *Pharma Innovation Journal*, 8(2), 76–82.
- Zepeda Cancino, R. M., Velasco Zebadúa, M. E., Nahed Toral, J., Hernández Garay, A., & Martínez Tinajero, J. J. (2016). Adoption of silvopastoral systems and the sociocultural context of producers: Support and limitations. *Revista Mexicana de Ciencias Pecuarias*, 7(4), 471–488. <https://doi.org/10.22319/rmcp.v7i4.4282>