

# Method of qualitative analysis of innovation dynamics in the transformation of agroecosystems: Bioeconomy in coffee farming policies in Mexico

Torres-Tadeo, César M.<sup>1</sup>; Platas-Rosado, Diego E.<sup>1\*</sup>; Hernández-Arzaba, Juan C.<sup>2</sup>; Tadeo-Castillo, Clotilde I.<sup>3</sup>; Gutiérrez-Salas, Yesenia V.<sup>1</sup>

<sup>1</sup> Colegio de Postgraduados, Campus Veracruz. Tepetates, Manlio Fabio Altamirano, Veracruz, México. C. P. 91700.

<sup>2</sup> Colegio de Postgraduados, Campus Córdoba. Manuel León, Amatlán de los Reyes, Veracruz, México. C. P. 91700.

<sup>3</sup> Universidad Veracruzana. Costa Verde, Boca del Rio, Veracruz, México. C. P. 94294.

\* Correspondence: dplatas@colpos.mx

## ABSTRACT

**Objective:** To propose a qualitative method to analyze the impact of the dynamics of innovation generated by innovation agents on the transformation of agroecosystems, and to apply it to the study of public policies that promote innovation in coffee production in Mexico.

**Design/Methodology/Approach:** A methodological proposal was designed for the qualitative analysis of innovation dynamics in agroecosystem transformation. To do so, first, the elements of circular bio-economics present in the design of public policies were identified. Secondly, the proposal was applied as a case study of public policies for innovation in coffee production in Mexico.

**Results:** a map of innovation dynamics in the transformation of coffee agroecosystems was generated, identifying public policies that affect the innovation of specific structures within coffee-producing agroecosystems, resulting from interactions between innovation agents and the target population. Then, a matrix analysis of public policies for innovation in agroecosystems was designed, and the barriers to disseminating each policy were identified.

**Limitations/Implications of the study:** The study is an exploratory phase aimed at understanding a general phenomenon. It is recommended that in-depth case studies be conducted, with specific objectives. Limitations in access to knowledge were also identified, enabling producers to use public policies better to transform the coffee agroecosystems they manage.

**Findings/Conclusions:** Heterogeneity in the dynamics of innovation in agroecosystems. The transformation in specific structures was identified; therefore, the complementarity potential of public policies to generate innovations at the agroecosystem scale, in its differentiated components. There are also some limitations in access to knowledge, as well as low levels of training for decision-making towards the marketing stage.

**Keywords:** coffee, development, dissemination, transformation.

**Citation:** Torres-Tadeo, C. M., Platas-Rosado, D. E., Hernández-Arzaba, J. C., Tadeo-Castillo, C. I., & Gutiérrez-Salas, Y. V. (2025). Method of qualitative analysis of innovation dynamics in the transformation of agroecosystems: Bioeconomy in coffee farming policies in Mexico. *Agro Productividad*. <https://doi.org/10.32854/dnj9nc67>

**Academic Editor:** Jorge Cadena Iñiguez

**Associate Editor:** Dra. Lucero del Mar Ruiz Posadas

**Guest Editor:** Juan Francisco Aguirre Medina

**Received:** October 24, 2025.

**Accepted:** November 16, 2025.

**Published on-line:** December XX, 2025.

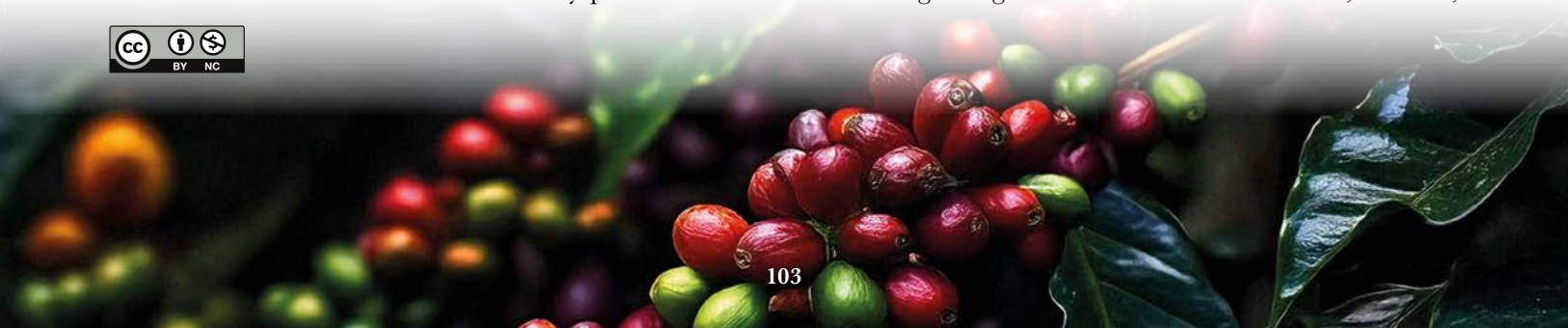
*Agro Productividad*, 18(11). November. 2025. pp: 103-111.

This work is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International license.



## INTRODUCTION

The current structure and functionality of agroecosystems are the result of a historical evolutionary process of transformation regarding their interactions with social, cultural,



political, environmental, and technological elements. Those transformations occur through complex dynamics of innovation, understood as non-linear processes, in which social actors—responsible for generating knowledge, as well as innovation agents and the target population—intervene. To the latter, dissemination strategies aim to advance technological change that improves the quality of life of small producers.

However, the strategies of public policies for agrifood innovation in the public sector are generally oriented towards the inclusion of a certain number of producers with similar characteristics within a given period, to provide knowledge, build technical capacities, subsidize infrastructure, and transfer organizational models. This occurs without considering that the knowledge previously acquired from the producers, as well as the simultaneity with public policies of different levels of government, and the innovation agents from any social organization, institution, or company, generate a collection of information and resources, which explicitly impacts specific components of agroecosystems, not in their entirety.

Consequently, the adoption of innovations in agroecosystems is a social phenomenon in which producers decide to what degree and in what ways the changes offered by the different agents of innovation are implemented. These adoptions depend on the criteria producers use based on their vision, culture, values, and motivations, which result in the adjustments they make. These adjustments are often distant from the expected outcomes of public policies; they generate innovation dynamics that adapt to barriers or limits that are not anticipated in the initial design but emerge in social systems.

This proposal is based on the principles of Ruttan and Hayami's (2011) theory of induced innovation, which postulates that technologies are developed in response to changes in resource availability and societal needs. This study contributes by providing a model and a methodological framework for generating maps of innovation dynamics, facilitating qualitative analysis of the phenomena that motivate innovation adoption in agroecosystems. All of which is done to allow redesigning the factors that interact with agroecosystems, under the paradigm of the transformation.

A case study of bioeconomy in public policies of coffee growing in Mexico is presented. The bioeconomy in agroecosystems is understood as the use of residual biomass from the primary production process, leveraging knowledge to generate new products, processes, and services, aimed at strengthening economic, climatic, and social resiliencies. The objective was to propose a qualitative methodology for analyzing the impact of innovation dynamics generated by innovation agents on agroecosystem transformation, and to apply it to public policies that foster innovation in coffee production in Mexico.

## **MATERIALS AND METHODS**

According to Gülpınar (2024), qualitative studies prioritize experience, addressing research problems determined within the framework of existing theories, handling holistic phenomena and situations in their own singularities in interactions and intersubjective transformation. In addition, the authors behind them make efforts to describe, understand, and interpret, exploring and elucidating factors in depth; to observe intrinsic trends and attitudes, as well as differences and similarities in understanding the phenomena.

A model and methodological framework were developed for the qualitative analysis of the innovation dynamics that influence the transformation of agroecosystems. This proposal focuses on identifying elements of the circular bioeconomy within those processes. A semi-structured interview questionnaire was used for data collection, and thematic analysis was used to identify agents of innovation and the relationships within the transformation dynamics. Thematic analysis is one of the most widely used methods for analyzing qualitative data and offers a structured, flexible framework for identifying, analyzing, and interpreting meaning patterns in datasets (Ahmed *et al.*, 2025). The choice of a qualitative and interpretative approach is justified by the complexity and contextual nature of innovation processes and agroecosystem transformations, which are not easily quantifiable using statistical or numerical methods.

The model and methodological framework thus created were applied to a case study of public policies promoting innovation in coffee production in Mexico, involving beneficiary producers and extensionists. The study was developed from January to June 2024. The non-probabilistic convenience sampling method was used. A matrix of analysis of public policies for innovation in agroecosystems was created to recognize the barriers that limit their dissemination. This allowed strengthening the criteria for the design of public policies of innovation and, finally, comparing the results with the requirements for public policies of bioeconomy in coffee proposed by the International Coffee Organization to evaluate the existence of strategies to strengthen the bioeconomy.

An unstructured survey was administered to 10 producers in Puebla and Veracruz who benefit from public policies for innovation in coffee production to identify elements in the design of these policies that meet the criteria of a circular bioeconomy.

## RESULTS AND DISCUSSION

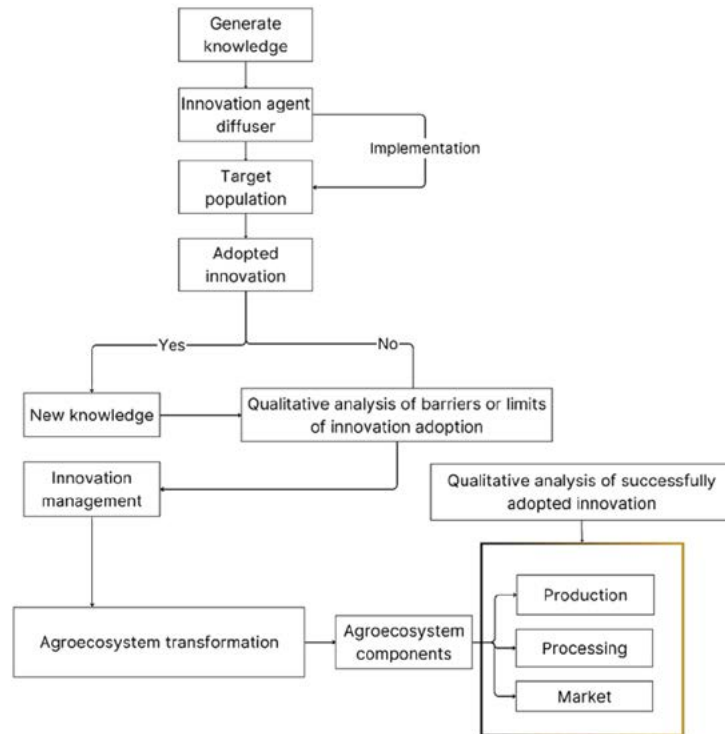
The application of the proposed methodology enabled us to understand the dynamics of induced innovation that have promoted the transformation of the structure and functioning of agroecosystems. It also facilitated the identification of the social and economic conditions that enabled the adoption of new knowledge, thereby generating a map of innovation dynamics. This map shows the transformation in specific components of agroecosystems and identifies barriers or limits to innovation in the territory. All of which facilitate pertinent updates in the process of innovation dynamics, thereby promoting technological change.

The methodological proposal focused, in a first stage, on 1: Proposing a research objective regarding innovation dynamics in the transformation of agroecosystems; 2: Surveying decision-makers about the changes in structure and functioning of their agroecosystems that have occurred over the last generations in their family.

Then, on 3: Identifying the agents of induced innovation that have generated changes in the structure and functioning of agroecosystems, in the processes of production, processing, marketing and consumption; towards 4: Generating a map of induced innovation dynamics that connects the graphs of the innovation agents to those components of the agroecosystems where technological change has been generated (Figure 1).

In the second stage, the model proposes 1: To prepare the analysis matrix of the innovations induced in the agroecosystem studied, which is composed of the following

Model of innovation dynamics in agroecosystem transformation

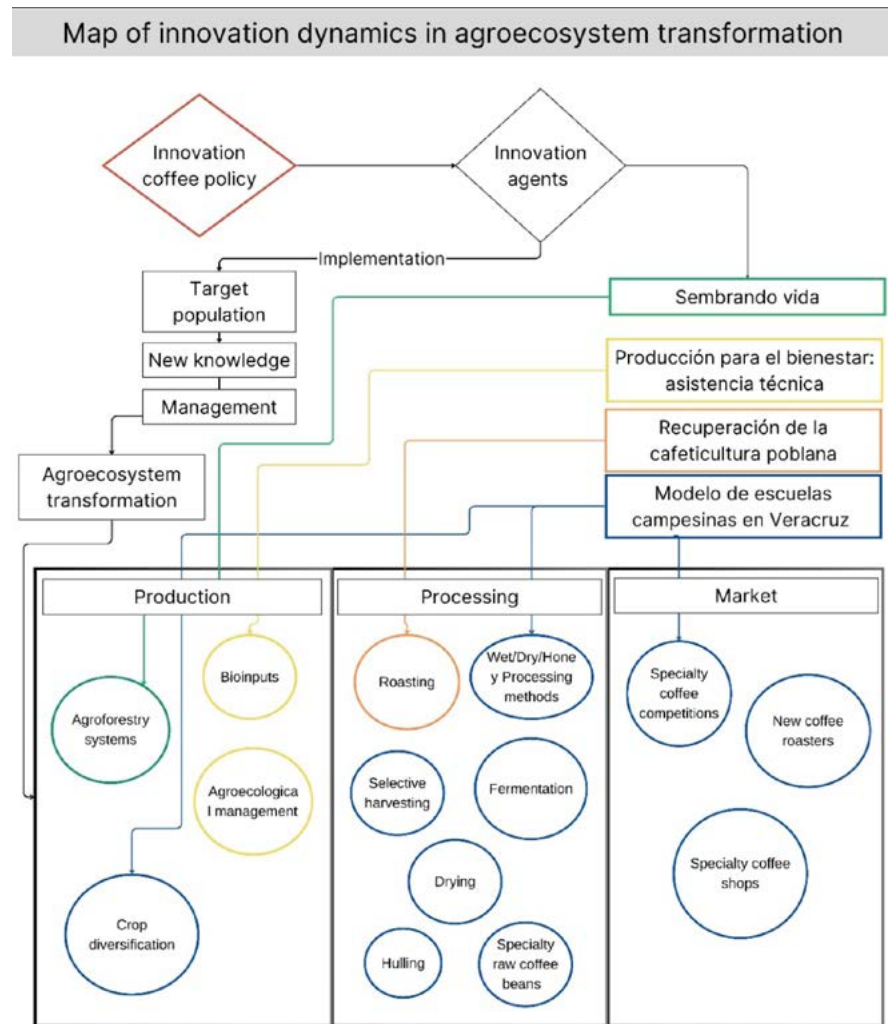


**Figure 1.** Model of innovation dynamics in the transformation of agroecosystems (prepared by the authors with their own original data).

categories: Innovation agent, induced innovation, transformation of the agroecosystem, social and economic conditions, and barriers or limits. In the matrix, keywords are added that help to understand the phenomenon of induced innovation dynamics. The purpose is to clarify the success and failure factors and to provide innovation agents with valuable information for reformulating dissemination strategies. Subsequently, 2: To indicate, in qualitative terms, the factors identified in the field research, map, and analysis matrix that were effective in the transformation of the agroecosystem as a result of technological change. Also, identifying the factors that caused failures in the adoption of innovations.

The map of innovation dynamics of public policies on coffee growing in agroecosystems shows four public policies in this sector. Two of which are public policies of national scale: “Planting Life” (Sembrando Vida) and “Technical Assistance in Production for People’s Welfare” (Producción para el Bienestar Asistencia Técnica). The other two are public policies at the state scale: “Coffee growing recovery in Puebla” (Recuperación de la cafecultura poblana) and “A Model of Farming Schools in Veracruz” (Modelo de escuelas campesinas en Veracruz) (Figure 2).

“Sembrando Vida” has an impact on innovations in coffee agroecosystem production by promoting the establishment of agroforestry systems and crop diversification. A typology of elderly producers and housewives is identified, as they spend most of their time in their



**Figure 2.** Map of innovation dynamics in the transformation of agroecosystems (prepared by the authors with their own original data).

territories. This program provides a monthly payment to the producer as beneficiary, although production is generally limited.

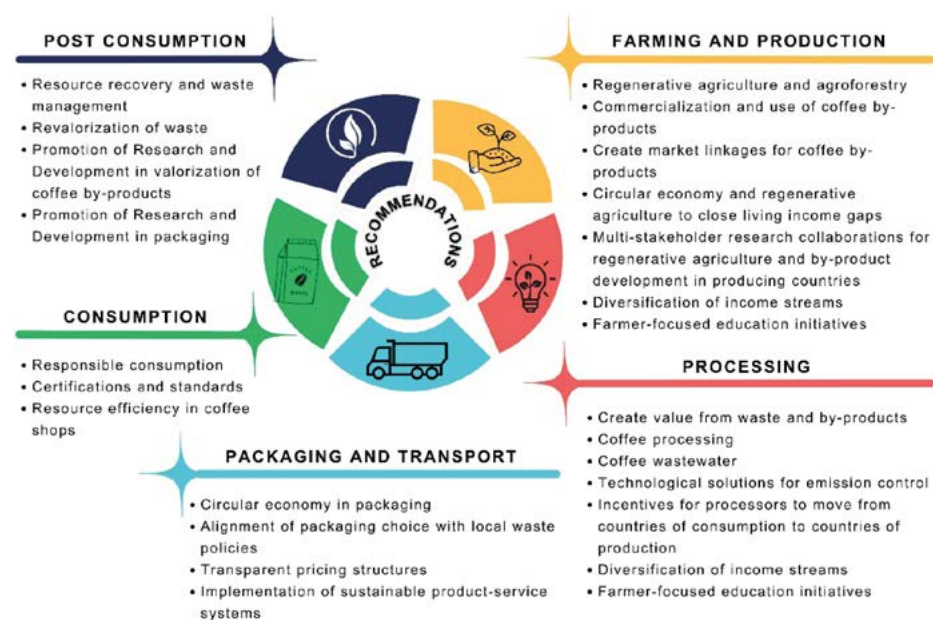
“Producción para el Bienestar Asistencia Técnica” has a greater reach in beneficiaries per territory. Its focus is on training in agroecological management, through a dissemination program with concise objectives for a defined period. Among those, the generation of bio-inputs that reduce production costs while improving the sustainability of production in environmental terms. However, some producers reject this program, arguing that it demands more effort. Yet they receive the same price for their coffee in local markets because the commercial coffee sales prices govern those in their territory, as it is sold to intermediaries. There is also a linkage with the agroecological tianguis (the traditional street market) of the government initiative, whose purpose is to open markets for the agroecological coffee produced by the program’s beneficiaries, as well as to reach new consumers.

The program for the “Recuperación de la caficultura poblana” focused on strengthening the acquisition of machinery and equipment to process and add value to coffee. The producers who used the program more were those with greater business knowledge, because they identified differentiated coffee markets. Whereas some of the cherry coffee producers sold the equipment, such as cherry pulpers and roasters, due to lack of interest in integrating more processes and immediate money needs, coupled with a lack of training of the benefited producers in some territories.

Finally, the scope of the public policy “Modelo de escuelas campesinas en Veracruz” was identified, which has a dissemination model similar to “Producción para el Bienestar Asistencia Técnica”. It affects innovation in production, processing, and marketing, and trains beneficiary producers to sell their coffee in the specialty coffee market. Producers participate in coffee fairs and quality competitions, where they connect with roaster businesses and entrepreneurs. The main reason for this is that coffee growers are located far from markets in nearby cities or from logistics companies that ship their coffee to customers in other states. Once they find customers, their challenge is to maintain production to meet market demand, as they are mainly small-scale producers.

Coffee farmers acquire knowledge from various innovation agents and make their own decisions about adoption. In designing this method, we investigated producers who have already made verifiable changes to their production systems.

At different stages of the coffee production and marketing processes, a variety of barriers can impede the dissemination of innovation (Gruenhagen & Parker, 2019). To address these barriers, changes are needed at each stage; these should address the specific needs of the production process. To exemplify this, we present the criteria of Bioeconomy for coffee, which should be considered in public policies in the sector (Figure 3).



**Figure 3.** Public policy recommendations based on the criteria of the Bioeconomy in Coffee. Source: adapted by the authors from ICO (2024).

The innovations generated by public policies were identified in the analysis matrix we created (Table 1). The innovations adopted were selected for their specific impact on the agroecosystem's transformation. We also identified the barriers or limits that prevent maximum use; we evaluated the presence or absence of practices in bioeconomy in the design of the public policies analyzed.

Innovations can strengthen the different emerging resilience approaches in coffee farming (Moat *et al.*, 2017). When reductions in rainfall or temperature increases are considered, there is a need to examine the impact of climate change on coffee production (Bracken *et al.*, 2023).

Climate change negatively affects coffee production by impacting quality and yields. Tanner *et al.* (2014) indicated that, although the concept of resilience is increasingly inspiring research and public policy design, the transfer of ecological theory to social systems still leads to a weak commitment to the political, social, and normative aspects of the adaptation to climate change. Such resilience is the ability of all people throughout generations to maintain and improve their opportunities for a better life and welfare, despite environmental, economic, social, and political disturbances. This resilience is supported by human action and empowerment in individual and collective operations, and is reflected in human rights, which are key in the dynamic processes of social transformation.

Each coffee-producing region where agroecosystems are located faces challenges that differ from those in other areas regarding the potential to adopt innovations through public policies that contribute to resilience at the agroecosystem scale. Scientific research should be specific and relevant in identifying actions adaptable to the emerging properties of

**Table 1.** Matrix of analysis of public policies for innovation in agroecosystems.

| Public Policy Programs (Name)                    | Innovation   | Agroecosystem transformation  | Barriers or thresholds   | Bioeconomical practices |
|--|--|---|--|-------------------------|
| Sembrando vida                                   | Agroforestry production system   | Redesign of the agroecosystem   | Primarily, the self-consumption scale  | Yes                     |
| Producción para el bienestar: asistencia técnica | Agroecological practices and the manufacture of bio-inputs                     | Composting area, planned production, diversification, waste use                             | Little or no reach to a differentiated market, investment of time in new processes               | Yes                     |
| Recuperación de la cafecultura poblana           | Coffee processing infrastructure   | Vertical integration of production processes, redesign of the agroecosystem, and management | Only market-oriented coffee producers, of varying quality, took advantage of the infrastructure. | No                      |
| Modelo de escuelas campesinas en Veracruz        | Training for the production of specialty coffee, with agroecological practices | Specialty coffee selection and processing area, roasting, and packaging                     | Geographically located at long distances from points of sale or logistics or transport companies | No                      |

agroecosystems, and in establishing and monitoring particular lines of action implemented in the territories. To this day, some elements that can be cataloged within bioeconomy initiatives are identified, but in an incipient way, and only in the manufacture of bioinputs with resources available on the coffee farms of the region, in the case of governmental programs “Sembrando Vida” and “Modelo de escuelas campesinas en Veracruz”.

According to Torres-Tadeo *et al.* (2025), bioeconomic agroecosystems are those that have undergone a transformation of knowledge in their determinants over time, thereby giving rise to non-linear innovation patterns between innovation agents and producers. Based on this, research on value networks for knowledge is proposed to understand the causes of functionality and the motivations for adopting innovations in agroecosystems. This means exploring what drives producers’ interest in adopting diversification strategies to create new products and services that address the effects of climate change on rural households.

Contreras-Medina *et al.* (2020) proposed that knowledge creation is critical to improve sustainable practices in coffee production and supply chains. The innovation dynamics in the transformation of the coffee agroecosystems analyzed show a complementarity where those components pertinent to the production, transformation, and marketing processes are aligned to adopt value-added oriented strategies towards obtaining specialty coffee, which then is supplied in differentiated markets. On the other hand, Lachenmeier *et al.* (2024) indicated that the use of coffee by-products has economic, nutritional, and environmental potential.

Regarding the analyzed programs, the bioeconomy paradigm is incipient, yet only from a public policy perspective. Those elements identified still show causal effects of the adoption of agroecological innovations, and they remain far from being a central objective in public discussion of public policies in coffee farming. According to Venus *et al.* (2024), the transition to a circular bioeconomy requires innovation across many sectors, particularly in social aspects. Ubertino *et al.* (2016) observed that social capital is the most critical element in the adoption of innovation by coffee producers. According to Gebru *et al.* (2024), the criteria for the production stage in coffee systems are those that improve producers’ welfare.

## CONCLUSIONS

Understanding innovation dynamics and their impact on the structural transformation of coffee agroecosystems enables us to identify more specific phenomena in innovation that need to be studied, such as the relevance and potential of expected results over a given period. The structures of agroecosystems are potentially transformable in response to social and functional conditions, which are not always anticipated in the dissemination of public innovation policies.

The acceptance or rejection phenomena identified in the research show the causes of interest for designing new public policies or strengthening those currently in place. Mainly, in determining the interests and socioeconomic possibilities of the different types of producers, to evaluate the degree to which they are prone to adopt or reject specific innovations.

The qualitative approach at the agroecosystem scale facilitates a broad study of poorly understood phenomena in system functioning. For example, actions and consequences stemming from public policies strengthen resilience.

## REFERENCES

- Ahmed, S. K., Mohammed, R. A., Nashwan, A. J., Ibrahim, R. H., Abdalla, A. Q., M. Ameen, B. M., & Khedhir, R. M. (2025). Using thematic analysis in qualitative research. *Journal of Medicine, Surgery, and Public Health*, 6, 100198. <https://doi.org/10.1016/j.glmedi.2025.100198>
- Bracken, P., Burgess, P. J., & Girkin, N. T. (2023). Opportunities for enhancing the climate resilience of coffee production through improved crop, soil and water management. *Agroecology and Sustainable Food Systems*, 47(8), 1125-1157. <https://doi.org/10.1080/21683565.2023.2225438>
- Contreras-Medina, D. I., Contreras-Medina, L. M., Joaliné Pardo-Núñez, Olvera-Vargas, L. A., & Rodríguez-Peralta, C. M. (2020). Roadmapping as a Driver for Knowledge Creation: A Proposal for Improving Sustainable Practices in the Coffee Supply Chain from Chiapas, Mexico, Using Emerging Technologies. *Sustainability*, 12(14), 5817-5817. <https://doi.org/10.3390/su12145817>
- Gebru, N. Z., Tadesse, T., & Wae, W. (2024). Impact of adopting improved Arabica varieties on the livelihood of organic coffee producers' of Ethiopia: Continuous treatment approach. *Cogent Food & Agriculture*, 10(1). <https://doi.org/10.1080/23311932.2024.2303831>
- Gruenhagen, J. H., & Parker, R. (2019). Factors driving or impeding the diffusion and adoption of innovation in mining: A systematic review of the literature. *Resources Policy*, 65, 101540-101540. <https://doi.org/10.1016/j.resourpol.2019.101540>
- Gülpinar, M. A. (2024). A model proposal for qualitative data analysis, interpretation, and reporting: contextuality, reflectivity, and narrativity. *Primary Health Care Research & Development*, 25, e55. doi:10.1017/S1463423624000562
- ICO— International Coffee Organization (2024). Beyond coffee: Towards a circular coffee economy. [https://www.ico.org/documents/cy2023-24/CDR\\_Overview\\_2022\\_23.pdf](https://www.ico.org/documents/cy2023-24/CDR_Overview_2022_23.pdf)
- Lachenmeier, D.W., Weller, P., Farah, A., Lagman, M.C.A., Fabian, M., del Castillo, M.D., Schwarz, S. (2024). Shaping the Future of Coffee: Climate Resilience, Liberia's Rise, and By-Product Innovation—Highlights from the International Coffee Convention 2023 (ICC2023). *Foods* 2024, 13, 832. <https://doi.org/10.3390/foods13060832>
- Moat, J., Williams, J., Baena, S., Wilkinson, T., Gole, T. W., Challa, Z. K., Sebsebe Demissew, & Davis, A. P. (2017). Resilience potential of the Ethiopian coffee sector under climate change. *Nature Plants*, 3(7). <https://doi.org/10.1038/nplants.2017.81>
- Ruttan, V. W., & Hayami. (2011). Induced Innovation Theory and Agricultural Development. Oxford University Press eBooks, 10–20. <https://doi.org/10.1093/acprof:osobl/9780199754359.003.0002>
- Tanner, T., Lewis, D., Wrathall, D., Bronen, R., Cradock-Henry, N., Huq, S., Lawless, C., Nawrotzki, R., Prasad, V., Rahman, M. A., Alaniz, R., King, K., McNamara, K., Nadiruzzaman, Henly-Shepard, S., & Thomalla, F. (2014). Livelihood resilience in the face of climate change. *Nature Climate Change*, 5(1), 23-26. <https://doi.org/10.1038/nclimate2431>
- Torres-Tadeo, C. M., Pérez-Vázquez, A., Platas-Rosado, D. E., Tadeo-Castillo, C. I., & Gutiérrez-Salas, Y. V. (2025). Bibliometric analysis of scientific research: bioeconomy and climate change. *Agro Productividad*. <https://doi.org/10.32854/zyqa0n79>
- Ubertino, S., Mundler, P., & Tamini, L. D. (2016). The Adoption of Sustainable Management Practices by Mexican Coffee Producers. *Sustainable Agriculture Research*, 5(4), 1-1. <https://doi.org/10.5539/sar.v5n4p1>
- Venus, T. E., Beale, C., & Villalba, R. (2024). Innovation and Networks in the Bioeconomy: A Case Study from the German Coffee Value Chain. *Circular Economy and Sustainability*. <https://doi.org/10.1007/s43615-024-00357-7>