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# Transformations of Social Metabolism through Short Food Supply Chains: Strategies Toward a Sustainable Agri-Food Economy

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## ABSTRACT

The study analyzes how short food supply chains (SFSCs) transform social metabolism in agri-food territories, shaping new ecological, economic, and socio-cultural dynamics. Its general objective was to identify the metabolic transformations derived from the relocalization of productive flows and the strengthening of sustainable agri-food economies. The methodology was qualitative, with a territorial focus and interpretive design, employing semi-structured interviews with rural actors in Huila, Caquetá, and Magdalena between 2023 and 2025. The results reveal a territorialized social metabolism, characterized by ecological circularity, value redistribution, and the reconstruction of community networks. It is concluded that SFSCs reduce dependence on external inputs, strengthen food sovereignty, and improve territorial equity.

**Keywords:** Social Metabolism; Short Supply Chains; Agroecology; Food Sovereignty; Territorial Economy.

## INTRODUCTION

In recent decades, discussions on sustainability and territorial reconfiguration have positioned social metabolism as a central analytical category for understanding the relationships between society and nature (Rodríguez et al., 2024; Kuhmonen, 2024). From the perspective of ecological economics and political ecology, social metabolism allows for the examination of flows of matter, energy, and information that mediate productive, distributive, and consumption processes within agri-food systems (Gómez, 2025; Infante et al., 2017). These flows, being determined by patterns of accumulation, productive specialization, and technological dependence, configure a globalized metabolism characterized by high levels of entropy, inequality, and loss of food sovereignty (Maldonado, 2023; Caixeta et al., 2018).

In response to this scenario, short food supply chains (SFSCs), emerging from the principles of solidarity economy, arise as territorial strategies that seek to reterritorialize the agri-food economy through the reduction of intermediaries, the valorization of peasant labor, and the relocalization of exchanges (Živković et al., 2022). These circuits modify not only economic dynamics but also ecological and cultural ones by strengthening the bonds between producers and consumers, promoting productive diversification, and fostering the circulation of agroecological knowledge (Rodríguez et al., 2021). Thus, SFSCs constitute concrete instruments for reconfiguring rural social metabolism, promoting energy efficiency, equity in value distribution, and ecosystemic sustainability (Gómez et al., 2023; Medina & García, 2020).

Analyzing the transformations of social metabolism through short food supply chains is relevant for identifying how agri-food territories can transition toward fairer and more sustainable models, where material exchanges are accompanied by symbolic exchanges and social trust (Gómez & Barbosa, 2024; González de Molina, 2016).

Understanding these transformations involves identifying the interdependencies among production, circulation, and consumption from a complex systems perspective, which acknowledges the biophysical limits of development and the need to reorganize local economies around principles of circularity, cooperation, and food sovereignty (Fischer-Kowalski, 2020; González de Molina, 2013). Within this framework, the research question is: In what ways do short food supply chains transform social metabolism in agri-food territories and contribute to the configuration of a more sustainable and equitable economy? Based on this question, the general objective is defined as: To analyze the transformations of social metabolism generated by short food supply chains, identifying their ecological, economic, and socio-cultural implications in the transition toward a sustainable agri-food economy.

This approach will make it possible to understand the exchanges between material and social flows that structure local agri-food systems, providing empirical and conceptual evidence for the formulation of public policies, territorial strategies, and development models grounded in the social reappropriation of resources and the relocalization of markets (Alessandrini, 2024; Barbosa & Gómez, 2021).

## METHODOLOGY

This research was conducted under a qualitative and interpretive approach, grounded in the epistemological principles of political ecology, ecological economics, and participatory territorial research (Martínez-Alier, 2011; Páramo, 2008). This approach seeks to understand, from the perspective of local actors, the transformations of social metabolism that emerge from the implementation of short food supply chains in rural agri-food systems (Martínez-Alier, 2011b). Rather than measuring variables, the aim is to interpret the meanings, practices, and social relationships that reconfigure the material, energetic, and symbolic flows within the territory (Aguilera et al., 2020; Bunge, 1969).

The methodological design corresponds to a descriptive-analytical study, based on a multiple case study, which makes it possible to explore different territorial experiences of short food supply chains (Bunge, 1980). This type of study provides a comprehensive view of how the processes of relocalizing economic exchanges influence the reorganization of social metabolism, fostering sustainability, equity, and community resilience (González de Molina & Toledo, 2011). The cases were selected through theoretical–intentional sampling, prioritizing significant experiences based on their organizational trajectory, productive diversity, agroecological practices, and degree of articulation with responsible consumption networks (Barbosa et al., 2020).

The unit of analysis consisted of peasant organizations, agroecological producers, responsible consumers, support institutions, and local actors actively participating in the short food supply chains (Garzón et al., 2023; López & Toledo, 2018). The purpose was to identify how their exchanges, discourses, and collective practices contribute to transforming the flows of social metabolism and strengthening a territorial agri-food economy (Delgado, 2014). The spatial delimitation was defined according to criteria of productive density, presence of local markets, institutional participation, and the existence of direct marketing strategies (Gómez et al., 2025; Rushforth, 2016).

For data collection, several complementary qualitative techniques were employed (Bensman & Leydesdorff, 2009).

First, in-depth semi-structured interviews were conducted with producers, consumers, and community leaders to explore changes in productive practices, perceptions of sustainability, cooperation mechanisms, and strategies for value distribution (Carrizo, 2000; Table 1).

Second, participant observation was carried out in fairs, peasant markets, and associative spaces, which made it possible to record modes of interaction, routines, and discourses that expressed the social reorganization of exchange (Camacho et al., 2023; Bunge, 1997).

Finally, a documentary and contextual review of public policies, development plans, technical reports, and specialized literature was conducted to empirically situate the cases and strengthen analytical triangulation through search equations in nationally and internationally recognized databases and indexes (Denzin, 2012; Tables 2 and 3).

**Table 1.** Characterization of interviewed actors in short food supply chains (Huila, Caquetá, and Magdalena, 2023–2025)

| No. | Department | Municipality / District | Fair/ Space | Actor (role in SFSC) | Sex | Age range | Link to SFSC | Interview date | Technique | Observations |
|---|---|---|---|---|---|---|---|---|---|---|
| E01 | Huila | Neiva | Neiva Farmers' Market – Plaza Los Comuneros | Beekeeping producer (direct sales) | M | 36–45 | Direct producer | 15/06/2023 | Semi-structured interview | Participates in local purchases; manages hives and multifloral honey |

 

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|---|---|---|---|---|---|---|---|---|---|---|
| E02 | Huila | Pitalito | Pitalito Agroecological Fair – Santander Park | Horticultural producer (mixed baskets) | F | 26–35 | Direct producer | 21/10/2023 | Semi-structured interview | Agroecological transition; native seeds and subscription-based sales |
| E03 | Huila | Garzón | Garzón Farmers' Market – Central Plaza | Responsible consumer (neighborhood network) | F | 36–45 | Organized consumer | 12/03/2024 | Semi-structured interview | Coordinates collective orders; emphasis on fresh produce and honey |
| E04 | Caquetá | Florencia | Florencia Farmers' Fair – Plaza San Francisco | Institutional representative (Agriculture Secretariat) | M | 46–55 | Institutional / Local procurement | 5/07/2024 | Semi-structured interview | Local public procurement program; logistical support for fairs |
| E05 | Caquetá | San Vicente del Caguán | Green Market – Main Square | Coordinator of peasant association | M | 36–45 | Organizer / Logistics | 18/11/2024 | Semi-structured interview | Coordinates collective transport and booth rotation |
| E06 | Caquetá | La Montañita | Agroecological Market – House of Culture | Food processor (dairy) | F | 46–55 | Producer–processor | 9/02/2025 | Semi-structured interview | Fresh cheeses; hygiene best practices; basic cold chain |
| E07 | Magdalena | Santa Marta | Agroecological Market – Parque de los Novios | Young agroecological entrepreneur (vegetables) | F | 18–25 | Direct producer | 13/04/2025 | Semi-structured interview | Sells via social media; bicycle delivery |
| E08 | Magdalena | Ciénaga | Ciénaga Farmers' Fair – Sagrado Corazón Park | Artisan fisherman (coastal short chain) | M | 46–55 | Direct producer / Artisan fishing | 22/06/2025 | Semi-structured interview | Early morning sales; coordinates mixed baskets with horticulturalists |
| E09 | Magdalena | Aracataca | Aracataca Agroecological Market – G.G. Márquez Plaza | Honey and fruit producer | M | 26–35 | Direct producer | 9/08/2025 | Semi-structured interview | Integrates beekeeping and fruit farming; reduces intermediation |
| E10 | Magdalena | Fundación | Fundación Farmers' Fair – La Esperanza Park | Community leader (organized consumers) | M | 56–65 | Organized consumer / Fair committee | 5/10/2025 | Semi-structured interview | Promotes local public procurement and food education |

*Source: Author's fieldwork, 2023–2025.*

**Table 2.** Example of search equation for the Analytical Category "Social Metabolism"

| **DATABASE** | Search Equation |
|---|---|
| **WoS** | Topic: ("SOCIAL METABOLISM OR METABOLISMO SOCIAL") Indexes = SCI-EXPANDED, SSCI, A&HCI, ESCI. Time period = All years |
| | Topic: ("SOCIAL METABOLISM OR METABOLISMO SOCIAL") Refined by publication years (2000–2025). Indexes = SCI-EXPANDED, SSCI, A&HCI, ESCI. Time period = All years |
| **Scopus** | TITLE-ABS-KEY ("SOCIAL METABOLISM OR METABOLISMO SOCIAL") and limited by publication years 2000–2025 |
| | TITLE-ABS-KEY (("SOCIAL METABOLISM OR METABOLISMO SOCIAL")) |
| | TITLE-ABS-KEY (("SOCIAL METABOLISM OR METABOLISMO SOCIAL")) AND (LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010) OR LIMIT-TO (PUBYEAR, 2009) OR LIMIT-TO (PUBYEAR, 2008) OR LIMIT-TO (PUBYEAR, 2000)) |

*Source: Author's elaboration*

**Table 3.** Example of Search Equation for the Analytical Category "Short Food Supply Chains"

| **DATABASE** | Search Equation |
|---|---|
| **WoS** | Topic: ("CIRCUITOS CORTOS DE COMERCIALIZACIÓN OR SHORT MARKETING CIRCUITS") Indexes = SCI-EXPANDED, SSCI, A&HCI, ESCI. Time period = All years |

 

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|---|---|
| | Topic: ("CIRCUITOS CORTOS DE COMERCIALIZACIÓN OR SHORT MARKETING CIRCUITS") Refined by publication years (2000–2022). Indexes = SCI-EXPANDED, SSCI, A&HCI, ESCI. Time period = All years |
| **Scopus** | TITLE-ABS-KEY ("CIRCUITOS CORTOS DE COMERCIALIZACIÓN OR SHORT MARKETING CIRCUITS") and limited by publication years 2000–2025 |
| | TITLE-ABS-KEY (("CIRCUITOS CORTOS DE COMERCIALIZACIÓN OR SHORT MARKETING CIRCUITS ")) |
| | TITLE-ABS-KEY (("CIRCUITOS CORTOS DE COMERCIALIZACIÓN OR SHORT MARKETING CIRCUITS ")) AND (LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011) OR LIMIT-TO (PUBYEAR, 2010) OR LIMIT-TO (PUBYEAR, 2009) OR LIMIT-TO (PUBYEAR, 2008) OR LIMIT-TO (PUBYEAR, 2000)) |

*Source: Author's elaboration*

The data processing and analysis were carried out following the principles of Grounded Theory (Maldonado, 2014a). Open, axial, and selective coding was applied, allowing the construction of emerging analytical categories, their theoretical interrelation, and the identification of interpretive patterns (Romanelli et al., 2021). In the descriptive phase, topics and categories related to agroecological practices, exchange networks, symbolic values, and perceptions of sustainability were identified (Castro et al., 2017). In the interpretive phase, the connections among these categories were analyzed to understand how short food supply chains transform social metabolism (Laverde et al., 2020). Finally, in the explanatory phase, a conceptual model was formulated integrating empirical findings with the ecological, economic, and socio-cultural dimensions of the territory (Maldonado, 2014b). To ensure rigor, specialized software such as Atlas.ti or NVivo was employed to facilitate systematic coding, comparative analysis, and result traceability (Devi Prasad, 2019).

The validity and reliability of the study were ensured through triangulation strategies of techniques and sources, combining interviews, observation, and document review (López et al., 2025; Martens et al., 2022). Theoretical saturation was assumed as the analytical closure criterion—that is, the data collection process concluded when additional information no longer contributed new, significant elements to the analysis. For this study, ten interviews were conducted across three Colombian departments between 2023 and 2025 (Rendón & Gómez, 2020; Van Eck & Waltman, 2009).

## RESULTS

The results of the study demonstrated that short food supply chains (SFSCs) act as dynamic agents of social metabolism within the analyzed agri-food territories (Rodríguez et al., 2018). Through localized processes of production, distribution, and consumption, structural transformations were observed in three interdependent dimensions: ecological, economic, and socio-cultural. These transformations revealed that SFSCs operate as mechanisms of metabolic reorganization, capable of reducing system entropy, redistributing value, and strengthening territorial identity (Saravia, 2020; Gómez, 2024; Tables 4, 5, and 6).

### Ecological Dimension: Circularity and Metabolic Efficiency

In the ecological dimension, the results showed a reduction in dependence on external inputs and a gradual transition toward diversified agroecological practices. Producers involved in SFSCs adopted strategies such as the use of organic fertilizers, crop rotation, and the integration of silvopastoral systems. These actions reduced pressure on local ecosystems and fostered a circular metabolism, where agricultural residues are reincorporated into the productive cycle (Gómez, 2022; Sobczak-Malitka & Drejerska, 2024).

Likewise, a decrease in energy consumption and carbon footprint associated with food transportation was verified, as a direct result of the geographical proximity between production and consumption. These transformations confirm that SFSCs contribute to a low-entropy metabolism, aligned with the principles of contemporary ecological economics (Fischer-Kowalski, 2011; Giampietro et al., 2023).

**Table 4.** Relationship between short food supply chains and the ecological transformation of social metabolism

| Ecological aspect | Observed transformation | Metabolic implication | Source |
|---|---|---|---|
| Reduction in agrochemical use | Substitution with bio-inputs and composting | Decreased exogenous dependence on energy and materials | Altieri & Nicholls (2022); Gudynas (2014) |

 

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|---|---|---|---|
| Agroecological diversification | Polycultures, crop rotations, recovery of native seeds | Greater ecosystem resilience and closure of local cycles | Toledo & Barrera-Bassols (2021); Delgadillo (2014) |
| Reduction in transport and packaging | Direct sales and local circuits | Lower ecological footprint and reduced energy loss | Fischer-Kowalski (2011); Blanco (2016) |
| Circular waste management | Composting and organic reuse | Feedback of material flows | Giampietro et al. (2023); Carrillo (2015) |

*Source: Author's elaboration.*

**Economic Dimension: Value Redistribution and Productive Autonomy**

From the economic perspective, the results showed a process of economic value reappropriation by producers, accompanied by the consolidation of new forms of cooperation and solidarity-based commercialization. Income derived from direct sales increased between 15% and 30% compared to traditional channels, improving financial stability and enabling investment in sustainable technologies (Gjokaj et al., 2025; Casas, 2017).

Similarly, SFSCs promoted hybrid forms of mixed economies, where market transactions coexist with exchanges based on reciprocity and trust. This shift represents a transition toward a territorial economic rationality, where criteria of sufficiency and community well-being replace those of accumulation and competition. These trends are consistent with diverse approaches in economic science, such as solidarity economy, ecological economics, and evolutionary economics (Garzón et al., 2022; Martínez, 2010).

**Table 5.** Relationship between short food supply chains and economic transformations of social metabolism

| **Economic aspect** | **Observed transformation** | **Structural effect** | **Source** |
|---|---|---|---|
| Elimination of intermediaries | Direct sales at fairs and agroecological markets | Greater appropriation of added value | Renting, Marsden & Banks (2022); Paz & Infante (2020) |
| Cooperativism and solidarity networks | Alliances between producers and consumers | Strengthening of local social and economic capital | FAO (2023); Contreras, Paredes & Turbay (2017) |
| Rural financial stability | Increased family income and reduced vulnerability | Economic sustainability of productive units | Goodman (2021); Medina & García (2020) |
| Organizational innovation | New logistical and digital sales channels | Diversification of value flows and economic resilience | Nicholls et al. (2024); Meyer (2020) |

*Source: Author's elaboration*

**Socio-Cultural Dimension: Identity, Trust, and Community Cohesion**

In the socio-cultural dimension, the results show a revaluation of peasant labor and a reconstruction of the social fabric based on local market spaces (Medina & García, 2021). SFSCs became spaces of community encounter, where trust, cooperation, and the transmission of agroecological knowledge were strengthened. Peasant fairs, in particular, functioned as cultural and educational exchange arenas, in which consumers and producers redefined the act of buying and selling as an ethical and relational process (Gómez, 2024c; Rodríguez et al., 2016).

An increase in the participation of women and youth in the management and leadership of associations was also identified, contributing to the democratization of productive and commercial processes. This socio-cultural reconfiguration of social metabolism aligns with the perspectives of Latin American political ecology and contemporary rural sociology (Gómez et al., 2021; Martínez et al., 2010).

**Table 6.** Relationship between Short Food Supply Chains and Socio-Cultural Transformations of Social Metabolism

| **Socio-cultural aspect** | **Observed transformation** | **Social and symbolic outcome** | **Source** |
|---|---|---|---|
| Strengthening of social capital | Trust networks between producers and consumers | Reconfiguration of community fabric | Guzmán & Woodgate (2022); Barbosa, Rojas & Gómez (2021) |
| Revaluation of local knowledge | Transmission of agroecological and culinary knowledge | Cultural continuity and food sovereignty | Toledo & Barrera-Bassols (2021); |

 

| | | | |
|---|---|---|---|
| | | | Craviotti & Wilches (2015) |
| Inclusion of women and youth | Leadership in associations and markets | Social equity and democratization of labor | FAO (2023); Gómez, Nieto & Martínez (2024) |
| Territorial identity | Relocalization of consumption and peasant pride | Cultural and symbolic reaffirmation of the territory | Martínez-Alier (2021); Coraggio et al. (2016) |

*Source: Author's elaboration.*

## DISCUSSION

The results obtained make it possible to affirm that short food supply chains (SFSCs) constitute an essential component in the reconfiguration of the social metabolism of agri-food territories, operating simultaneously on the material flows, economic structures, and social relationships that sustain rural life. This research confirms the statements of Purnomo et al. (2023) and Franco et al. (2023), which propose that social metabolism not only reflects the biophysical appropriation of nature by society but also the cultural and institutional mediations that determine the way such appropriation takes place. SFSCs emerge as instruments capable of reversing the linear and extractive logic of the agro-industrial metabolism, replacing it with a circular, local, and relational metabolism, grounded in agroecological and reciprocity-based principles (Gómez, 2024b; Bhatt et al., 2022).

In the ecological dimension, the reduction of external inputs and the relocalization of energy flows observed in SFSCs demonstrate a process of metabolic decoupling from the dominant agro-industrial model (Bianchi & Richiedei, 2023). These findings are consistent with the theses of Giampietro et al. (2012), which emphasize the need to redesign socio-economic systems to reduce their material and energy intensity. The adoption of agroecological practices, circular waste management, and the reduction of transport-related emissions reveal that SFSCs contribute to a more efficient and resilient metabolic reorganization (Escobar, 2018). In this sense, the ecology of the territory becomes an active component of the economic system, reintroducing principles of ecological self-regulation within productive and commercial spheres (Escamilla et al., 2023; Dematteis & Governa, 2005).

From the economic perspective, the results demonstrate that SFSCs foster a fairer redistribution of value within the agri-food chain, reducing intermediary dependence and strengthening the financial autonomy of small producers (Rincón & Gómez, 2023). This evidence aligns with the work of Renting, Marsden, and Banks (2003) and Goodman et al. (2012), who argue that alternative food networks serve as a pathway to democratize market access and generate more balanced territorial economies. Beyond monetary benefits, SFSCs reveal the emergence of new economic rationalities: producers make decisions guided not only by profit, but also by ecological stability, social recognition, and collective well-being. This marks a transition from market-centered logic toward hybrid forms of solidarity economy, consistent with contemporary frameworks of Latin American ecological economics (Raftowicz et al., 2024; Gómez, 2024a).

In the socio-cultural dimension, SFSCs are consolidated as spaces of symbolic reconstruction of social metabolism (Gómez & Barbosa, 2023). The results show that peasant and agroecological markets function as arenas for cultural and political exchange, where trust ties between producers and consumers are renewed (Maldonado, 2017). This finding aligns with Toledo and Barrera-Bassols (2008), who emphasize the importance of biocultural memory as the foundation of sustainability. The active participation of women and youth in production and marketing processes confirms the hypothesis that SFSCs help democratize rural social structures and re-signify agricultural work as a practice of territorial care (Rendón & Gómez, 2022). Thus, peasant identity is strengthened not only as an economic category but as a political and cultural expression of resistance against the homogenizing logics of the global market (Rosero & Gómez, 2025; Drejerska, 2023).

The triangulation of these three dimensions allows us to affirm that SFSCs generate a reterritorialization of social metabolism, where material, energetic, and symbolic flows are reorganized under principles of proximity, cooperation, and equity. This confirms the premise of Altieri and Nicholls (2022) and FAO (2024): local agri-food systems act as living laboratories for the transition toward sustainable economies. The identified metabolic transformation is not limited to the technical domain of production but entails a redefinition of the society–nature relationship, in which the territory recovers its integrative function across ecological, economic, and cultural processes (Rodríguez, 2025a; 2025b).

From a critical standpoint, these findings highlight significant public policy challenges. The consolidation of SFSCs requires physical infrastructure, regulatory instruments, and institutional support that recognize their strategic role in rural planning. Moreover, it is necessary to overcome the fragmentation of environmental, agricultural, and social policies, fostering a territorial governance framework grounded in ecological justice and

 

food sovereignty (Martínez-Alier, 2015). In this context, SFSCs should not be understood merely as market mechanisms but as socio-ecological devices of post-extractivist transition, capable of articulating environmental sustainability, economic equity, and social cohesion (Karakaya et al., 2025; Escobar, 2011).

Indeed, short food supply chains transform social metabolism by reestablishing material and symbolic connections between production and consumption, while simultaneously strengthening the autonomy of territories and their capacity to regenerate natural resources and social capital (Martínez et al., 2024; Maldonado, 2021). These experiences reaffirm that sustainability is not a technological attribute, but rather a political and cultural construction emerging from the interaction among communities, ecosystems, and local economies (Purvis et al., 2019). Consequently, SFSCs are consolidated as integral strategies of transition toward a sustainable agri-food economy, coherent with the principles of circularity, ecological justice, and territorial sovereignty (Mengoni et al., 2025; Maldonado, 2018).

## CONCLUSIONS

The integration of the three dimensions—ecological, economic, and socio-cultural—made it possible to construct a reterritorialized model of social metabolism, in which short food supply chains (SFSCs) operate as nodes of socio-ecological articulation. This model explains how the relocalization of food exchanges reduces system entropy (ecological dimension), redistributes value (economic dimension), and strengthens social cohesion (cultural dimension). The results demonstrate that social metabolism is not merely a biophysical process, but rather a social construction imbued with meanings, institutions, and practices that define territorial sustainability.

SFSCs are consolidated as an integrated post-extractivist transition strategy, redefining the relationship between society and nature while reinforcing food autonomy, local control over resources, and community governance. These transformations confirm that sustainability cannot be measured solely in terms of technical efficiency, but rather in terms of the capacity of territories to regenerate their ecological and social bonds.

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