AGRICULTURAL TECHNOLOGIES IN MEXICO: A REVIEW OF DEVELOPMENT APPROACHES AND STRATEGIES FROM A RURAL PLANNING PERSPECTIVE

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Abstract

This review analyzes the relationship between agricultural technology and rural development strategies in Mexico, using an inclusive and territorially differentiated planning approach. Through a narrative review with evaluative elements, it examines structural, institutional, and cultural barriers that limit technology adoption by small-scale producers. It identifies deficiencies in the coordination between research centers, public policies, and local actors, as well as the predominance of top-down transfer models. The analysis proposes strengthening territorial innovation systems that integrate participatory co-innovation, cultural relevance, and community-based research. It also proposes differentiating strategies according to the type of agriculture (peasant, corporate, and export) to allocate resources with distributive justice, equity, and efficiency. The study concludes that innovation in rural areas is a technical, social, and political process that requires a profound redesign to contribute to equity, sustainability, and territorial justice.

Keywords: rural development, agricultural innovation, technology transfer, territorial planning.

Introduction

Rural development has been one of the most complex challenges for public policies in Latin America, particularly in countries like Mexico, where structural

inequality between the countryside and the city is manifested not only in terms of income or infrastructure (De Janvry & Sadoulet, 2004), but also in access to knowledge, technology and innovation (Sanabria, 2013). In this context, the incorporation of agricultural technologies has been promoted as an indispensable means of increasing productivity, reducing poverty, and closing the gaps between producers. However, the way in which these technologies have been generated, disseminated, and adopted has been marked by a profound disparity between their potential benefits and their actual transformative capacity in the most disadvantaged sectors (peasants, rural women and youth, indigenous and indigenous peoples, among others) (Binswanger, 1991).

Agricultural technology encompasses innovations, inventions, and discoveries that enable people to improve agricultural production and productivity (Sharma *et al.*, 2022), encompassing equipment, inputs, and practices such as improved seeds, fertilizers, automated irrigation, machinery, and digital practices applied to crop management. These technologies are often developed in research centers and multinational companies, disseminated through standardized strategies, often without an assessment of the social, ecological, and economic contexts where they will be implemented (Cernea, 2005; Figueroa, 1990).

The relationship between agricultural technology and derived benefits requires review from an inclusion perspective. Agricultural development policies have tended to assume that simple technology transfer automatically leads to improvements in rural productivity and income. This linear approach has been widely criticized for omitting structural barriers, such as lack of credit, technical assistance, infrastructure, or markets, which hinder the effective adoption of technologies by small producers (Echeverría & Elliott, 2002; World Bank, 2006).

The problem identified in this review lies in the persistent gap between technology generation and its effective adoption by small-scale producers, who face multiple constraints: low levels of investment and financing that limit research and development of improved varieties; a lack of stable regulatory frameworks, high development costs, liability risks, and limited experience in managing biotech crops; as well as weak seed systems and markets and agricultural support services (Anthony & Ferroni, 2012).

Technological solutions designed by research centers and multinational corporations often respond to the logic of export and profitability. Even public policies have prioritized increasing yields with limited results in reducing poverty (Berdegué, 2002). In this context, state action tends to focus on the dissemination rather than the generation of technologies adapted to the region, neglecting the strategic role of universities and local research.

Faced with this situation, rural development planning requires reinterpretation as a dynamic, integrative process adapted to territorial specificities. Rather than limiting itself to designing policies focused solely on increasing productivity, it is necessary

to formulate strategies that recognize the diversity of actors, territories, resources, and institutional capacities. This requires decentralizing innovation, strengthening local capacities, and directing efforts toward generating localized knowledge (from the territories), constructed in a participatory manner and with an explicit commitment to social equity. As Schejtman and Berdegué (2004) argue, rural territorial development must transcend economic accumulation to consider the social, institutional, and cultural conditions that make innovation possible.

The objective of this review is to critically analyze the relationship between agricultural technology and rural development strategies, incorporating a perspective that recognizes planning as a junction of capabilities, resources, and public policies. It is proposed as a theoretical and methodological contribution aimed at promoting more equitable, sustainable, and effective rural development paths.

Methodology

This research is based on a narrative review with an emphasis on evaluative elements. The review is understood as an interpretive and reasoned analysis of the scientific, technical, and institutional literature related to agricultural technologies and their connection with development strategies from a planning perspective. Unlike systematic reviews, which focus on answering specific empirical questions using quantitative synthesis methods, narrative reviews offer a more flexible and comprehensive approach, especially relevant for addressing the complexity inherent in the interaction between technology, public policy and rural development (Vera-Carrasco, 2009; Guirao-Goris *et al.*, 2007).

This type of review allowed for the integration of multiple theoretical approaches and empirical cases, the identification of knowledge gaps, and the development of conceptual proposals that address the structural challenges observed in the literature. The incorporation of evaluative elements also involves critically assessing the quality, applicability, and relevance of the reviewed approaches, considering their actual or potential impact on small-scale producers and historically excluded rural areas.

Thus, the documents and sources selected for this review respond to four thematic criteria that guide the search and analysis of the material: 1) technologies in agriculture, which considered texts that address the processes, approaches and results of the dissemination of technological innovations (such as improved seeds, fertilizers, irrigation, machinery, digital technologies), especially in Latin American rural contexts, prioritizing documents that critically analyze the gap between technology generation and adoption; 2) rural development planning, which included sources that conceptualize territorial, strategic and participatory planning in rural areas, focusing on the institutional mechanisms for articulation between levels of government, social

actors and development objectives; 3) agricultural policies, which included documents analyzing regulatory frameworks, structural reforms, subsidy schemes, rural extension, and trade agreements as determinants of technological access and appropriation; and 4) agricultural development models, which selected texts that explore historical and contemporary models of agricultural sector development (conservationist, industrial-urban, diffusion, high-profitability inputs), including the differentiated effects based on the scale of production and type of agriculture (peasant, corporate, export).

For the selection of documents based on the thematic criteria, relevance, timeliness, theoretical foundation, and regional applicability were considered. The inclusion of different epistemological perspectives was also assessed: structuralist, institutional, critical, and territorial. Thus, the review was based on a selection of documents composed of academic, institutional, and technical sources from recognized authors, research centers, and multilateral organizations (Table 1).

Table 1. Document selection criteria.

Thematic criteria	Sources	Applicability
Academic and theoretical literature	Figueroa (1990);	Structural analysis of agricultural development and rural poverty
	Schejtman y Berdegué (2004);	Rural territorial development proposal
	Rogers (2003).	Classical theoretical basis on the diffusion of innovations
International institutions and organizations	Documents of the CIMMYT, CIAT, IRRI y CIP;	Emphasis on strategies for technological generation and diffusion
	technical reports of the FAO;	Inclusive agricultural innovation, food security and rural extension
	Reports of the CEPAL.	Development planning, territorial inequality and agricultural policies
Public policies and legislation	Review of national initiatives.	Analysis of agricultural policy programs in Mexico and Latin America
		Rural extension, support for small producers and technology transfer
Case studies	Technical reports, theses, institutional documents and grey literature.	Critical analysis of the current model

Source: Self-elaborated with data from the review.

The search was conducted in a targeted manner using databases such as Scopus, Redalyc, Scielo, Google Scholar, and institutional portals (FAO, CEPAL, CIMMYT), prioritizing materials published in the last two decades, without excluding fundamental classic texts.

Document analysis was carried out in four sequential phases (Figure 1). The first phase involved analytical reading and thematic coding. This stage included categorizing the texts according to theoretical approaches, scales of analysis (local, national, global), and type of actor (institutional, community, international). The second phase involved identifying recurring patterns in the transfer process, proposed solutions, the role of universities, and the direction of production.

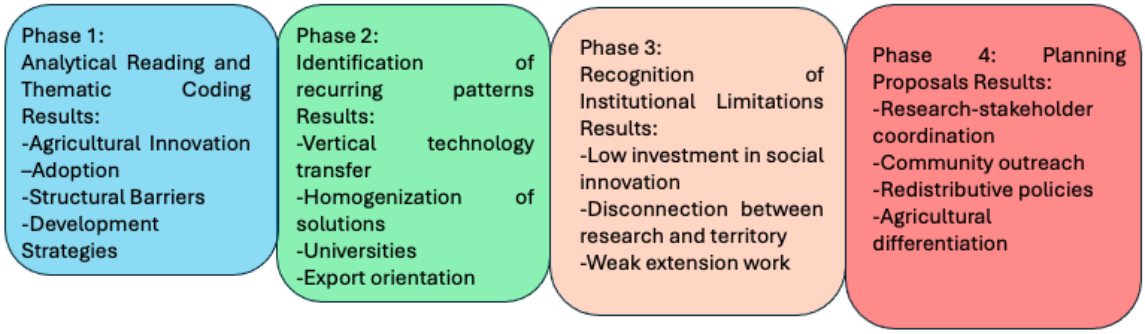

Figure 1. Phases of documentary analysis.
Source: Self-elaborated.

The third phase focused on recognizing institutional limitations, including the disconnect between research centers and rural areas, as well as the weakness of extension work as a planning and support tool. Finally, the fourth phase involved identifying overcoming proposals, such as networked social innovation, participatory knowledge generation systems, the development of appropriate technologies, university-community coordination, and stakeholder-focused territorial planning.

Overall, the study provided a critical interpretation that serves as a basis for analyzing agricultural development planning strategies from an inclusive perspective.

Conceptual foundations

Agricultural development strategies

An analysis of agricultural development strategies in Latin America, and particularly in Mexico, allows for the identification of at least four models that have guided state and international agency intervention in rural areas: the conservation model, the urban industrial impact model, the technological diffusion model, and the high-profitability input model.

The conservation model emphasizes preserving traditional rural production conditions, valuing peasant knowledge (Cervantes-Herrera *et al.*, 2016), natural

resources, and recognizing cultural diversity, but without generating significant transformations in the productive structure or in the market integration of producers. A potential limitation is that it may not generate significant transformations in the productive structure, sustainably improve income, or fully integrate with national development.

The urban industrial impact model is based on the subordination of agriculture to the needs of urban industrial growth. In this approach, the countryside serves as a food supply and resource transfer for industrialization, as occurred during the import substitution model in Mexico (Kay, 2009). Agriculture is not conceived as a strategic sector, but rather as a functional support for urban-industrial growth.

The technology diffusion model (Rogers, 1983) promotes the transfer of externally generated innovations to the agricultural sector through institutional mechanisms such as rural extension, training services, and technology adoption programs. Although this model has been effective in explaining technological changes, such as that of organic agriculture (Padel, 2001), it has also been criticized for its poor adaptation to local contexts and for primarily benefiting producers with greater capital and organizational capacity.

Finally, the high-yield input model is based on technological packages intensive in external inputs (improved seeds, fertilizers, pesticides, machinery), the adoption of which requires high levels of investment. This model is closely linked to the Green Revolution paradigm, which, while allowing for productivity increases in certain regions, deepened structural inequality by excluding low-income producers (Altieri & Nicholls, 2008).

Figueroa (1990) identifies two major structural constraints on agricultural development: the rigidity of agricultural supply and the excess of rural labor. The former refers to the inability of the agricultural sector to respond efficiently to changes in demand, due to factors such as technological backwardness, land concentration, and limited productive infrastructure. The latter refers to the relative overpopulation in the countryside, which results from the low capacity to absorb employment in the urban-industrial sectors, maintaining a large mass of workers in conditions of low productivity and poverty. Both constraints interact to generate a vicious cycle of rural poverty, where low productivity prevents income improvements, and the absence of employment alternatives perpetuates dependence on agricultural work, often under subsistence conditions.

From the structuralist perspective, represented by authors such as Prebisch (1950) and Furtado (1961), agricultural development cannot be conceived as a homogeneous or automatic process. Active state intervention is required to modify the structures that reproduce inequality. In this sense, the linear view of modernization is criticized, which posits an inevitable transition from "traditional" to "modern" forms of production, ignoring the social conflicts, power relations, and structural conditions that impede this transition.

Structuralist approaches claim that agricultural development models exported from developed countries are inadequate for Latin American realities, and that the uncritical adoption of technologies can deepen the marginalization of peasant sectors (Kay, 2009; Echeverría & Elliott, 2002).

Diffusion of innovations

The diffusion of innovations theory, proposed by Rogers (2003), establishes that the adoption of new technologies occurs through a process in which individuals or social groups go through the stages of awareness, persuasion, decision-making, implementation, and confirmation. This process depends on communication channels (formal and informal), the time it takes for each individual to adopt the innovation, and the social characteristics of the system.

Rogers (2003) identified five types of adopters: innovators, early adopters, early majority, late majority, and laggards. According to this theory, the adoption rate depends on the innovation's compatibility with users' values and needs, its complexity, observability, relative advantage, and testability.

Although Rogers' model has been widely used, its application in rural contexts in the Global South has been questioned. Vertical diffusion, from international research centers to rural communities, has proven ineffective in many cases. This type of transfer ignores local conditions, social dynamics, and the ancestral knowledge of producers. Furthermore, it reproduces relationships of technological dependence and limits food sovereignty (Cernea, 2005; Altieri & Toledo, 2011).

The main criticism is that this transfer model assumes producers are passive agents, recipients of external knowledge, when they are active subjects with their own knowledge and distinct rationales. The lack of contextual adaptation and participation in knowledge generation has been one of the causes of the failure of many agricultural innovation programs.

ONGs, international organizations such as the FAO, the BID, the WB, and international research centers (CIMMYT, CIAT, IRRI, CIP) have for decades promoted the dissemination of agricultural innovations with the goal of reducing poverty and increasing productivity. While they have achieved significant successes, particularly in strategic crops, their impact on rural sectors has been limited due to the technocratic nature of their approaches and the lack of coordination with local institutions.

The market, for its part, acts as a selective diffusion mechanism, where the most profitable technologies expand rapidly, while those that do not guarantee immediate benefits are left behind. This deepens inequalities, as low-income producers cannot access high-cost technologies or compete with large agroindustries (Schejtman & Berdegué, 2004).

Rural development planning

Rural strategic planning is understood as a decision-making process aimed at the structural transformation of rural areas, which articulates stakeholders, resources, knowledge, and public policies based on shared objectives. Unlike normative and centralized planning, strategic planning is based on environmental analysis, the recognition of local capacities, and the participation of multiple stakeholders (CEPAL, 2015; FAO, 2020). This approach allows for the design of differentiated strategies according to the characteristics of the area, overcoming the homogeneity with which rural policies have traditionally been conceived.

Administrative and political decentralization is a key component for effective rural development planning. It involves transferring powers and resources to local governments and encouraging the active participation of communities, peasant organizations, universities, and other territorial stakeholders (Bebbington, 2007).

The territorial approach proposes understanding development not only as economic growth, but as a process of social construction that recognizes cultural identity, local ecosystems, and the history of the territory. This entails replacing top-down intervention models with participatory planning processes, where rural stakeholders themselves define priorities and solutions.

One of the most persistent shortcomings of innovation and development policies has been the failure to differentiate strategies based on the type of market to which production is directed. While agriculture for export requires specific standards, certifications, and technologies, production for local markets or self-consumption requires adapted, accessible, and culturally relevant innovations.

Differentiated rural planning allows for the design of specific policies for peasant agriculture, focused on improving access to appropriate technology, basic infrastructure and short marketing channels, without requiring their transformation into agro-exporting companies (Altieri & Toledo, 2011).

Review of the Mexican experience

The history of economic development in Mexico, particularly during the import substitution period (1930–1982), reflects a clear subordination of the agricultural sector to the national industrialization project. During this period, the State implemented a development strategy focused on the growth of the urban-industrial sector, using rural surpluses in the form of cheap food, low rural wages, and fiscal transfers to finance industrialization (Appendini, 2001; Warman, 2001). This orientation meant that, far from being a priority sector in itself, agriculture was conceived as a source of resources for other sectors, specially manufacturing, which led to a systematic neglect of its structural and innovative capacities.

During the 1940s and 1950s, agricultural growth was promoted through major hydraulic infrastructure projects, support for strategic crops, and public credit, enabling

a significant expansion of production. However, these benefits were concentrated in the most productive regions and among farmers with greater access to land, credit, and technology. Beginning in the 1960s, with the consolidation of the Green Revolution model, the logic of agricultural intervention shifted toward a technocratic approach, with an emphasis on productivity and yield, to the detriment of social equity (Hewitt, 1976).

This functionalist view of agriculture limited the possibility of building a solid foundation for rural development. The Mexican countryside was divided between a technologically advanced, export-oriented corporate agriculture and a backward peasant agriculture with limited access to resources, technical assistance, and technological innovation (Calva, 2001).

The introduction of the high-yield input model, promoted by the Green Revolution programs in partnership with international research centers, marked a radical shift in the logic of agricultural production. This model promoted the intensive use of improved seeds, fertilizers, pesticides, machinery, and technical irrigation, with the goal of significantly increasing productivity per hectare.

Although this approach achieved significant increases in staple grain production, it also generated profound segmentation in access to and utilization of available technologies. Its implementation was largely directed toward areas with high agricultural potential, where infrastructure and capital existed to absorb the costs of technological packages, excluding large sectors of peasants and small-scale producers (Toledo, 1990; Altieri & Toledo, 2011).

The model failed to consider the structural limitations of small producers, such as access to credit, land, or markets. It also failed to offer solutions adapted to diverse agroecological conditions, nor did it value local knowledge. Consequently, the technologies promoted were neither affordable nor relevant to those most in need of improved productivity. This exclusion fueled a cycle of marginalization, loss of autonomy, and rural migration, consolidating a dual pattern of agriculture in the country: on the one hand, agribusiness integrated into international trade; on the other, impoverished peasant agriculture (Calva, 2001; Eakin, 2005).

The technology transfer system in Mexico has been characterized by a centralized and vertical logic (Solleiro *et al.*, 2017). For decades, the main decisions regarding research, development, and technology dissemination were made by national government agencies or international centers, with little participation from local governments, regional universities, or the producers themselves.

This model was based on the idea that technology could be developed in a specialized center and then disseminated to rural areas through extension or training programs. However, this logic failed to consider the cultural, ecological, and socioeconomic diversity of Mexican rural areas. In fact, it has been found that even in rural areas operated under the same program, the effects have been heterogeneous

due to the cultivation orientation and the use of certain innovations such as seeds or machinery (Ramírez *et al.*, 2022). The transferred technologies were, in many cases, inadequate for local conditions, both due to their cost and their technical design (Altieri & Nicholls, 2008).

In contrast, a decentralized approach to technological innovation would involve the coordination of local actors such as producers, universities, technicians, and municipal governments in the generation, validation, and adoption of adapted technologies. This participatory model would allow for the development of more relevant, accessible, and sustainable solutions. Successful experiences with agroecological innovation, such as those promoted by peasant organizations or autonomous universities, show that decentralization can significantly improve technological appropriation processes and strengthen productive autonomy (Altieri & Toledo, 2011; Bebbington, 2007).

One of the main weaknesses of Mexico's agricultural development system has been the disjointed nature of the most important components of the innovation process: research, strategic planning, and operational implementation. This fragmentation is reflected in the existence of programs that are technically well-designed but lack connection to local capacities, lack inter-institutional coordination, and have little evaluation of results.

In many cases, research agendas have been defined from a technocratic or commercial perspective, failing to address the real needs of the territories. State planning, for its part, has operated in a sectoral manner and has been insensitive to the heterogeneity of the countryside. Finally, implementation mechanisms, such as rural extension, have suffered from budget cuts, deprofessionalization, or political capture (Boege, 2008; FAO, 2020).

As a result, the knowledge generated by research centers does not effectively reach producers. At the same time, agricultural development plans are often disconnected from local realities, and public policies reproduce a homogeneous and reductionist vision of the rural world.

Rural development planning that seeks to be effective must correct these flaws by creating territorial innovation systems that coherently integrate research capabilities, local demands, and implementation mechanisms with a participatory and multi-stakeholder approach (Schejtman & Berdegué, 2004; CEPAL, 2015).

Towards more effective planning

The analysis of Mexico's experience in agricultural technology development revealed the persistence of structural limitations and institutional practices that limit technological innovation processes among small producers. This scenario raises the need to reorient rural planning toward an inclusive, decentralized, and participatory model capable of recognizing and leveraging the country's agroecological and

sociocultural diversity. Within this framework, the proposals seek to strengthen institutional capacities, optimize territorial coordination, and establish differentiated innovation frameworks that respond to the specificities of each region.

Agricultural innovation in Mexico has historically depended on international institutions and organizations that identify the sector's problems and potential solutions. However, these centers operate under global frameworks that prioritize technology standardization. More effective planning requires reorienting efforts toward coordination between national research centers and regional public universities, which possess contextualized knowledge, community collaboration networks, and underutilized technical capabilities (Boege, 2008).

National agricultural universities and research centers possess strategic advantages, such as location, experience, talent, and infrastructure, that enable them to lead the development of rural human capital, essential elements for economic and social development. Through job training systems, innovative models, and learning communities, they can provide the intellectual support necessary to modernize agriculture and boost the local economy (Yun-feng, 2012).

On the other hand, there is evidence suggesting that higher education with a territorial focus is not only relevant at the basic levels, but also at the university level, where it can be articulated with regional networks and innovation systems. This allows institutions to act as development hubs, adapting their teaching and research to the needs of the territory and fostering the transfer of knowledge to producers, entrepreneurs, and communities (Bryden, 2007).

At the same time, higher agricultural education institutions can expand their reach beyond the agricultural sector, strengthening the sustainable management of natural resources and connecting with other educational levels. Through partnerships with local stakeholders and dialogue with public policymakers, they can become beacons of local tradition and knowledge, while integrating global innovations. Thus, these institutions consolidate their position as catalysts for rural development, poverty reduction, and food security (Atchoaréna, 2005).

This coordination could give rise to local innovation systems in which the processes of experimentation, validation, and technological adaptation respond to the specific needs of each territory. Such systems, by incorporating agroecological and sociocultural diversity, would overcome the vertical and homogeneous orientation of technology transfer, favoring the relevance and sustainability of solutions. They would also contribute to strengthening local capacities through training processes, internships, field placements, and knowledge generation with direct participation of producers, strengthening the links between universities, communities, and research centers. Finally, this approach would facilitate multi-stakeholder territorial coordination, integrating public policies, institutional resources, and local knowledge into differentiated innovation schemes aimed at inclusive rural development.

The persistence of institutional barriers in agricultural extension processes is reinforced by cultural factors. One of the main shortcomings of the traditional extension model has been its weak anchoring in the sociocultural realities of the Mexican countryside, evidenced by the implementation of outreach programs that have ignored the linguistic diversity, traditional knowledge, worldviews, and agroecological practices of indigenous and peasant communities. The prevalence of mechanistic and unidirectional approaches, lacking consideration for local ecological conditions, has limited its effectiveness (Altieri & Toledo, 2011).

Rebuilding institutional capacities for technology dissemination, from a culturally and ecologically relevant perspective, requires the training of extension workers with intercultural competencies, active listening skills, pedagogical skills, and agroecological knowledge. It also demands strengthening ties between institutions, communities, and social organizations through the adoption of participatory methodologies that promote the dialogue of knowledge and the co-creation of solutions.

In this context, the implementation of a community outreach program inspired by the rural doctor model appears to be a viable option. This model, based on the incorporation of trained young professionals who spend time in rural communities, live with their residents, and participate in the diagnosis and resolution of productive problems, has proven effective in the field of public health by reducing territorial gaps through proximity, building trust, and personalized care (Guirao-Goris *et al*., 2007).

Translating this approach to the agricultural sector would involve community internships by graduates of agricultural, environmental, or related programs, under institutional support. The constant presence of these professionals, combined with their technical knowledge and integration into the community, would facilitate adaptive diffusion processes aimed at the adoption of innovations and strengthening local capacities. This process could lay the foundation for the development of rural youth leadership, with the potential to revitalize the social fabric of the countryside and reduce forced migration.

The effectiveness of this model requires the provision of institutional incentives, technical monitoring mechanisms, and coordination with universities, research centers, and local governments. Incorporating participatory evaluation components, ongoing training, and generating evidence on the results achieved would be key to its sustainability.

On a broader level, tariff and pricing policies have played a decisive role in structuring Mexican agriculture. However, their design has disproportionately favored certain business sectors, without considering the redistributive impacts on the peasant production base. Equity-oriented planning requires evaluating these policies based on criteria of distributive justice, regional equity, and economic sustainability (Calva, 2001; CEPAL, 2015). A comparison between the Sugarcane Product System and the coffee value chain in Mexico clearly illustrates the resulting asymmetries, (Table 2).

Table 2. Asymmetries of sugarcane and coffee.

Aspect	Cane Product System	Coffee Value Chain
Predominant type of producer	Large agro-industrialists and ejidatarios with contract	Small producers, mostly indigenous
Market orientation	National and industrial (refinery)	Export and promotion of niches (organic, fair trade)
Intermediation	Highly regulated	Highly fragmented
Pricing policy	Negotiated centrally with agribusiness	Fluctuating, dependent on the international market
Government supports	High, focused	Dispersed, with territorial programs

Source: Self-elaborated.

While sugarcane receives concentrated support and preferential tariffs, coffee, with more than 500,000 small producers, suffers from international market volatility and limited institutional support. This disparity highlights the urgent need to design differentiated instruments that recognize the structural conditions of each chain and promote equity in access to the benefits of agricultural trade (SIAP, 2022; SAGARPA, 2018).

Differentiation of planning by type of agriculture

Agricultural planning requires recognition of the structural heterogeneity of the Mexican countryside, characterized by the coexistence of agricultural forms with divergent logics, capabilities, and needs. The imposition of uniform policies has resulted in ineffectiveness and regressive biases, systematically favoring the most established actors.

The differentiation of planning into three axes constitutes a strategy to optimize the allocation of resources and maximize impacts:

Peasant agriculture, whose sustainability demands the strengthening of comprehensive support in access to land, appropriate technologies, short marketing channels, solidarity financing and training, in order to dignify its role as a food producer, custodian of biodiversity and cultural actor (Altieri and Nicholls, 2008).

Corporate agriculture, which requires the establishment of incentives linked to job creation, integration with regional chains, and compliance with socio-environmental standards, based on criteria of sustainability, social responsibility, and environmental compliance.

Export agriculture, for which regulations that prevent social exclusion, water hoarding, and environmental degradation are essential, complemented by fiscal, tariff, and investment policies aimed at comprehensive territorial development.

The implementation of this differentiation scheme would promote a more equitable and efficient distribution of public resources, increasing productivity, social inclusion, and sustainability, and strengthening the resilience and sovereignty of the agri-food system.

Conclusions

The analysis of agricultural development strategies and technological innovation processes in Mexico highlights the need to rethink rural planning from an inclusive, territorially differentiated, and socially just perspective. The research shows that the dominant technology transfer model, focused on vertical and standardized solutions, has limited adoption by small producers by failing to consider the agroecological and sociocultural realities of the territories.

It is observed that the coordination between universities, research centers, government agencies, and community actors is essential for building territorial innovation systems. These systems must integrate applied research, participatory co-innovation, and community outreach, ensuring that knowledge generation responds to local needs and potential.

Likewise, planning must differentiate strategies and instruments for small-scale, corporate, and export agriculture, allocating public resources and regulatory frameworks equitably and efficiently. Only in this way will it be possible to promote a resilient and sustainable agrifood system capable of reducing the structural gaps that persist in the Mexican countryside.

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