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National Agricultural Innovation System (NAIS): Diagnosis, Gaps, and Mapping of Actors

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Abstract: This article examines the diagnosis of the Agricultural Innovation System (SIA) in the department of Tolima, Colombia, as part of a project led by the Colombian Ministry of Agriculture and Rural Development and the Technological University of Pereira (TUP), which also evaluated the National Agricultural Innovation System (NAIS) in regions such as Chocó, Bolívar, and Meta. A methodology was used that involved a survey with 58 questions on a Likert scale with 300 participants, evaluated with congruence and relevance indexes, identifying key variables in the operation of the Agricultural Innovation System (AIS). A survey was applied to map actors in the National Innovation System for Higher Education in Agriculture, as well as the participating actors in the regional agricultural innovation systems of Tolima to identify gaps in extension, innovation, development, sustainability, information technology (TI), education, and training. Among the conclusions, it stands out that the associativity subsystem presents the lowest performance and is close to a score of two on the scale of gaps. An evaluation was carried out among the five subsystems, including extension, TI, environmental aspects, and public policy. The department of Tolima shows low performance in innovation and TI, while their extension performance is less weak. In Chaparral, there is a general lag, with innovation being the worst evaluated subsystem. Rovira obtains high scores in most subsystems, although innovation and TI have lower scores. At the national and regional levels, innovation is low, and communication among the NARS actors is insufficient, which highlights the need to promote good practices, strategies, and projects.

Keywords: systems of innovation; national agricultural innovation system; gaps; innovation and development (R&D); extension; training; TI; sustainability

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1. Introduction

Agricultural Innovation Systems (AISs) and National Agricultural Innovation Systems (NARSs) play a crucial role in economic and social development at the local and national levels in the agricultural sector. Through the use of products, processes, and practices, they promote innovation processes with social or economic relevance [1] through use of a network of actors, institutions, and policies, boost and improve productivity, enhance competitiveness, and generate a positive impact on various sectors [2], thus contributing to the closing of gaps. To close these gaps and promote the sustainable development of the agricultural sector, it is essential to implement initiatives that foster innovation in local production systems. Equally, the debate on sustainable development must be considered, which faces two main perspectives: one is represented by authors such as Manioudis and Meramveliotakis [3], who advocate a return to classical political economy and stress the importance of the stage theories of Smith, Mill, and Marx to enrich sustainable development studies with an interdisciplinary approach; while for the other, Klarin [4] argues that sustainable development must address various basic human needs and faces obstacles such as the lack of socioeconomic development and financial resources at the global level, which limits its progress.

Several initiatives in different studies and projects demonstrate the importance of fostering innovation in local productive systems to achieve sustainable economic growth at the local and national levels. The Cuban experience of innovative production systems and arrangements demonstrates that fostering innovation in local systems through policies and interactive learning is crucial for sustainable economic growth at the local and national levels [5]. Knowledge management in the agricultural sector becomes relevant, as observed in the case of the Local Agricultural Innovation System of Pinar del Río [6]; likewise, technological innovation to reduce losses in the fishing and aquaculture industry becomes relevant, as evidenced in the FTT–Thiaroye technique and the Hermosillo Coast, Sonora, where a regional agricultural innovation system is proposed to boost growth, sustainability, and food security [7].

These initiatives highlight the importance of promoting innovation in agricultural and aquaculture systems through collaboration, technology development, stakeholder dialogue, and practical application of knowledge to achieve sustainable development and food security at the local and national levels. For the Colombian context, the evaluation of the National Agricultural Innovation System (NARS) in departments such as Bolívar, Chocó, Meta, and Tolima emphasizes the need to map relationships and communication between the actors involved to close gaps and promote the comprehensive development of the NARS.

For the achievement of these purposes, this article is structured in several thematic sections. First, a theoretical framework is presented that reviews the literature on worldwide case studies related to the Agricultural Innovation System (AIS) to identify strategies, good practices, and relevant projects that drive the development of the system. Secondly, the methodology used to carry out the NARS evaluation is described. Subsequently, the results obtained in the evaluation are presented, highlighting some general findings on the behavior of the system and, in particular, of the department of Tolima. Finally, the discussions and conclusions are presented, in which the aspects evaluated in the general assessment and that of the department of Tolima are analyzed to elucidate the differences and similarities between the systems and to examine the particular situation of the department. In addition, the possible causes of these differences and coincidences are addressed, and the impact that they have on the implementation of development strategies and policies in the department is assessed.

2. Literature Review on SIA

Authors like List [8] and Leontief [9] introduced the first approaches to the innovation system by addressing national production systems relevant to understanding agricultural dynamics in specific regions but they did not focus directly on the NARS. Freeman [10], Lundvall [11], Nelson [12,13], and Metcalfe [14] focused their studies on the systemic approach to innovation at the national level, recognizing the importance of collaborative work and the interactions between economic and institutional structures, which can be applied to the NARS in Bolivar, Chocó, Meta, and Tolima to promote innovation in the agricultural sector, considering the theories of the SIA. This offers several schools of thought that can be valuable for analyzing and improving the NARS in the mentioned regions. For example, the evolutionary economic theory of Nelson and Winter [13] serves to elucidate the evolution of agricultural technology and innovation over time; Nelson's institutional economics [12] may be useful for analyzing the role of institutions in the diffusion of agricultural innovation, while the new regional economic theories may allow for the study of interactions between regions in terms of agricultural innovation and economic development [15]. The perspectives provided by the learning economics approach [16], the economics of innovation [17], and the network theory [18] prove valuable for a deeper understanding of innovation processes and interactions in the NARS context.

In Colombia, the NARS promotes agricultural innovation through policies, programs, and projects that enhance competitiveness, quality of life, and food security by involving a wide range of participants and stimulating the formation of innovation networks (Law 1876 [19]). Regional Innovation Systems (RISs) provide a detailed and contextualized view of innovation processes in a region [11,20], considering particularities to identify strengths and weaknesses, develop appropriate strategies, and foster collaboration among actors for innovation and sustainable development [21].

The Sector Innovation System (SIS) complements the national and regional innovation systems by focusing on innovation within a specific sector, examining actors, dynamics, and relationships to improve competitiveness and productivity [22]. Understanding these systems is vital for diagnosing agricultural systems in Colombia, highlighting historical and contemporary approaches that enrich the perspective on regional agricultural innovation.

2.1. Strategies, Good Practices, and Relevant Projects in the Global Scope of the Agricultural Innovation Systems (AISs)

This section presents the strategies, best practices, and relevant projects within the global scope of the Agricultural Innovation Systems (AISs), analyzing R&D, training, extension, and sustainability subsystems that could contribute to closing the gaps in the proposed evaluation. It begins with the strategies highlighted. Authors such as Nederlof [23] highlight the effectiveness of learning coalitions as multi-factor solutions to local institutional problems. Koutsouris [24] highlights how intermediaries bridge cognitive, informational, and managerial gaps in the AIS. Sseguya [25] provides the importance of relationships and trust in sources for access to agricultural information in Uganda. [26] stresses the relevance of innovation in SIA governance for agricultural productivity and sustainability. Klerkx and Nettle [27] point out how intermediaries and network facilitators catalyze the co-production of innovation in the dairy sector in the Netherlands and Australia. Kilelu [28] emphasizes the usefulness of adaptive intermediaries and platforms to address innovation co-evolution. Kingiri [29] highlights the essential gender perspective in agricultural innovations. These authors, among others, contribute to enriching the evaluation of the NARS, offering key insights to drive innovation and sustainable development in these regions.

Good practices are enriched by the contributions of various authors who address multiple aspects of agricultural innovation. In such a direction, Douthwaite and Hoffecker [30] highlight the need for a Theory of Change to plan and evaluate alternative pathways in agricultural research, addressing the complexity of agricultural aquatic systems in Zambia and the Philippines. Pigford [31] advocates integrating ecological and agricultural innovation system perspectives into sustainable agricultural innovation to achieve transitions to more sustainable systems. Spendrup and Fernqvist [32] highlight the importance of improving access to agricultural information in Kenya and encouraging the adoption of sustainable practices such as agroforestry through simple practices and subsidies. Cofré-Bravo [33] highlights the adaptation of agricultural innovation support networks as key to meeting farmers' needs and achieving soft skills and ambidexterity. Kamara [34] identifies cognitive drivers of and barriers to the adoption of agricultural innovation systems in the rice industry through the Theory of Planned Behavior.

Concerning relevant projects, various studies contribute to the understanding of agricultural innovation from different approaches. Fielke [35] highlights the importance of reflective monitors in the success of co-innovation projects in the primary sector in New Zealand. Clarkson [36] employs the Theory of Change to assess the impact of the Shamba Shape Up television program on promoting agricultural sustainability through agricultural communication and extension. Vom Broke [37] details how the impact evaluation of the

Sorghum Participatory Sorghum Improvement Program shows how research strengthens individual and collective capacities to innovate agricultural technologies. Barzola [38] explores multi-actor platforms (MSPs) as collaborative networks that achieve different levels of innovation according to objectives and proposed activities. Studies such as RiceAdvice in Africa address essential aspects of agricultural innovation, from practical tools in sub-Saharan regions to innovation platforms in cocoa production in Ghana and accountability in digital agricultural R&D in Australia [39].

2.2. Case Studies on AIS and NARS

Case studies on AIS and NARS at the global level have also become available tools for identifying good practices, strategies, and projects, understanding challenges, and generating recommendations, thus contributing to improving the implementation of agricultural innovation systems and promoting sustainable rural development. Table 1 details case studies on AIS in the worldwide sphere; some cases are highlighted, identifying the actors involved, the problems they address, and the functioning of these systems, all of which are very useful for the closing of gaps in the context of the department of Tolima.

Table 1. Case studies on AIS in the worldwide sphere.

Description	Problem Addressed	Actors Involved	How Does the Innovation System Work?
China compares rural and urban innovation systems and proposes a theoretical structural model of rural innovation systems [40].	Rural decline, poverty, unsustainability, poor land management, etc.	Government, congress, public sector, nonprofit companies, etc.	The study examines previous theories, proposes a three-dimensional model, and points out the challenges to strengthening rural innovation and contributing to national development and rural revitalization. In addition, it uses mixed methods to analyze niche activities in intensive greenhouse agriculture and promote the transition to sustainable methods through conceptual frameworks and farm management approaches.
The study explores the processes of transitioning to sustainable methods in agriculture through four niche initiatives in the greenhouse sector [41].	Sustainability, resource depletion, pollution, etc.	Farmers, distributors, co-operatives, processors, etc.	This article uses mixed methods to analyze four case studies in the intensive agriculture system of Almeria, employing diverse conceptual frameworks and multi-stakeholder approaches to explore activity niches. It uses Gliessman's five levels of the agroecology framework as a guide for the transition to sustainable methods in the agrifood system.

Table 1. *Cont.*

Description	Problem Addressed	Actors Involved	How Does the Innovation System Work?
Social networks play a key role in agricultural innovation by providing farmers with information, knowledge, and resources to boost their innovation efforts, while formal institutions advise on techniques and technologies for apple crops in the Kashmir Valley, India [42].	Apple tree canker disease, productivity, and sustainability.	Government organizations, advisors, farmers, policy makers, businesses, traders, processors, transporters, input suppliers, regulatory agencies, extension services, service providers, and civil societies are involved in the agricultural context.	This study collected primary and secondary data from a variety of sources, including focus group discussions and the specialized literature, to explore the actors and processes of knowledge generation in the agricultural system. It also provided a platform for future studies on informal innovations and social networks in different aspects of horticulture and the analysis of interactions between informal and formal actors in the innovation and sustainability system.
This study in Mexico focused on air pollution, drought, urban heating, energy expenditure, extreme temperature fluctuations inside buildings, and poor or contaminated soils [43].	Urban agriculture in Mexico City is analyzed as an innovation system that includes boundaries, dynamics, institutions, knowledge, and learning cultures, being an integral part of the ecological infrastructure for urban sustainability and resilience, where vertical and rooftop gardens play an important role in the greening of cities.	Institutions, industries, government, NGOs, private companies, households, and start-up companies of young academic graduates.	Between 2007 and 2012, the Mexico City government invested USD 6 million in 2800 urban agriculture projects, benefiting 15,700 inhabitants and supporting 3000 families with rooftop gardens and green roofs on schools and government buildings, thus fostering small-scale, sustainable urban agriculture in the city.
Smart agriculture improves efficiency and sustainability through technologies such as IoT and drones. This study in Antioquia, Colombia, analyzes the banana chain and simulates interactions between actors to develop technological capabilities and address productivity and sustainability problems [44].	Low productivity of banana crops and unsustainable crops.	Agents, explorers, intermediaries, and exploiters.	This paper presents an agent-based model that simulates interactions and learning in a competitive environment, representing demands as opportunities for innovation. The model is split into five procedures that include the construction of offers, decision rules, and the local learning process, allowing one to observe the specialization patterns and accumulation of capabilities of competing agents.
This article analyzes the role of digital platforms, using the case study of KisanMitr, in connecting and facilitating the agricultural innovation and entrepreneurship ecosystem [45] in India.	Sustainability in the pandemic.	Governments and farmers.	Digital platforms can be the backbone of integrated agricultural innovation systems, but it is important to keep the focus on farmers, foster mutual engagement, and address potential governance issues to have a meaningful impact.

Source: Own elaboration based on the authors referenced inside the table.

The review and analysis of research studies and case studies allowed us to draw important conclusions about the agricultural innovation system in different geographical contexts. Each study addresses specific challenges of the agricultural sector in its country, highlighting the relevance of innovation as a key tool to address problems such as rural decline, poverty, unsustainability, pollution, and low crop productivity. The results highlight the need to strengthen the rural innovation system in China, the transition toward sustainability in Spain with the active participation of farmers, distributors, and co-operatives, the crucial role of social networks in agricultural innovation in India, and the importance of urban agriculture in Mexico as part of the ecological or agricultural infrastructure. In addition, the relevance of smart agriculture in Colombia and the need for mixed approaches and methods to address the complexity of the agricultural innovation system are underscored. The consideration of these aspects is of great importance for future research on practices, projects, and strategies that promote sustainability and agricultural development at both regional and national levels.

3. Methodology

The methodology employed in this study focuses on an evaluation designed to address and mitigate the gaps identified in the regions under study, a practice widely used in various contexts that has been applied to the evaluation or diagnostic/profile profiling/mapping studies/mapping of regions, sectors, and companies with the aim to innovate, evaluate systems, monitor progress, assimilate, enrich practices, manage projects, and protect the environment [46]. Some examples include the identification of gaps in innovation capabilities in 460 companies in Quindío—Colombia [47]; the application of a methodology to manage innovation and technology in a small company in Armenia—Colombia [48]; the analysis of the technological profile of Colombian companies with a focus on Antioquia [49]; and the evaluation of innovation in Nutrianalysis [50], among other studies. These examples illustrate the relevance and applicability of the methodology to innovation management in various business and regional environments in Colombia.

A mixed-approach methodology was used, involving a literature review and a survey with 58 Likert-type scale questions involving 300 participants, which can be found in the Supplementary Materials Table S1: Instrument for collecting information (agreement 20220464, Ministry of Agriculture and Rural Development and Universidad Tecnológica de Pereira). The relevance and congruence indexes were used to validate each of the questions that formed part of the final instrument applied to the 300 productive units. These indexes were evaluated by experts in innovation systems, innovation management, and technology management. In terms of congruence, the experts assessed whether each variable and its four states were related to the objective of establishing an innovation management model in a company in the functional ingredients and products sector. A value of "1" was assigned for "congruent", "−1" for "not congruent", and "0" if there were doubts about the congruence of the variable and its four states, following the approach of Pascual and Gil [51]. On the other hand, concerning relevance, the experts evaluated whether the content of each variable and its four states reflected the importance of the innovation management model in a company in the functional ingredients and products sector. This assessment was made on a Likert scale from 1 to 5, from "not relevant at all" (1) to "totally relevant" (5). Both indices, congruence and relevance, were used to identify key variables in the functioning of the Agricultural Innovation System (AIS).

The other steps involved in this evaluation are described in Figure 1.

The four departments (regions) were selected by the Ministry of Agriculture and Rural Development of Colombia, and the evaluation was assigned through a project of the National Royalties System to the Technological University of Pereira. It is hoped that this study will, in the future, become a pilot that can be applied with the same instrument to the 32 departments of Colombia. The data from the sample of 1205 observations were coded with the Excel 2013 for Windows tool for operationalization and then imported into the statistical software R 4.3.1 and RStudio 4.3.1. The 8 municipalities analyzed have populations that vary between 5100 and 50,370 inhabitants, with notable differences among them, such as in Bolívar and Chocó, where the variations are less than 10,000 and

1000 inhabitants, respectively, while in Meta, the difference between municipalities such as Cabuyaro and Vistahermosa exceeds 20,000 inhabitants.

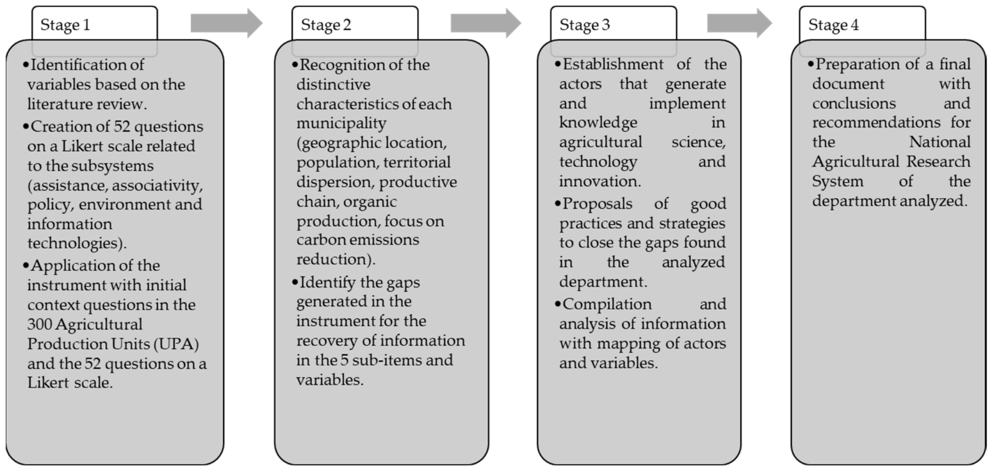

Figure 1. Proposed phases. Source: Own elaboration.

4. Results

In the framework project, 8 municipalities with populations ranging from 5100 to 50,370 inhabitants were analyzed. San Juan Nepomuceno and Santa Rosa del Surin Bolívar, as well as Juradó and San José del Palmar in Chocó, have outstanding differences in population. San Juan Nepomuceno shows an urban trend in Bolivar, while the municipalities of Chocó have a mainly rural distribution. Cabuyaro in Meta stands out for having an average of 23 hectares per farm, while Tolima, Chaparral, and Rovira have an average of less than 8.5 hectares. Juradó in Chocó has the smallest amount of land, with 3.9 hectares per property. Cabuyaro and Santa Rosa del Sur have the largest cultivated areas, while the municipalities of Chocó have the smallest cultivated area, with Juradó being the lowest, with only one hectare due to fishing.

In terms of production lines, the following prevail: cattle ranching in Cabuyaro and Vista Hermosa; tuna and catfish fishing in Juradó; cocoa farming in Santa Rosa del Sur, San José de Palmar, Vista Hermosa, and Chaparral; and yam farming in San Juan Nepomuceno. Water use varies among the municipalities analyzed: Aljibe in Santa Rosa del Sur, rainwater in Juradó, and water from natural sources in Rovira, Vista Hermosa, and San José del Palmar. Family labor is important in all municipalities, especially in Juradó and Santa Rosa del Sur. Membership in agricultural producer organizations is common in most municipalities, except in San José del Palmar, Chaparral, and Cabuyaro. The formalization of agricultural collective figures is high in Vista Hermosa and Rovira, and lower in San José del Palmar and Cabuyaro. The altitude varies significantly, from 5 m above sea level in Juradó to 1489 m in Rovira.

In terms of land tenure, most of the properties are owned in Juradó, San José del Palmar, Cabuyaro, Vista Hermosa, and Rovira. Participation in socioenvironmental programs is low in general, but participation in Vista Hermosa in illicit crop substitution programs, in Santa Rosa del Sur in productive alliances, and in Rovira in associations stands out.

4.1. Indicators in Subsystems for User Classification

A statistical model was developed in RStudio to analyze the indicators of the National Agricultural Innovation System (SNIA) in a survey involving the departments of Chocó, Bolívar, Meta, and Tolima. Five subsystems were studied through surveys to describe the classification of users: assistance, associativity, TI, environment, and public policy. The information was systematized in Excel and, subsequently, in the programming software for statistical analysis, RStudio 4.3.1.

As shown in Figure 2, the result shows that associativity is the category with the lowest performance by achieving a score close to two on the gap scale. The results on technical assistance highlight the orientation toward productive cycles in Q64, with a scale rating of 2.3. Formalization in the registration of machinery has the lowest score of 1.2. The category of public policy stands out, where respect for land use obtained the best rating of 2.7.

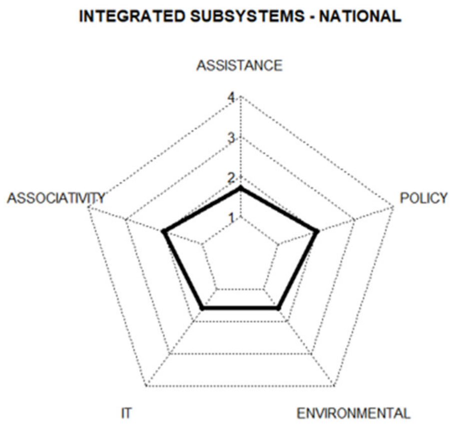

Figure 2. Grouping subsystems—National. Source: Own elaboration with the RStudio tool.

As shown in Figure 3, land use in Tolima complies with the guidelines of the land use plan (Q26) in the dimensions analyzed in the public policy subsystem, obtaining a score of 3.3. However, in the area of the TI subsystem, the dimensions evaluated show lower evidence for the department of Tolima, around 1.5 points.

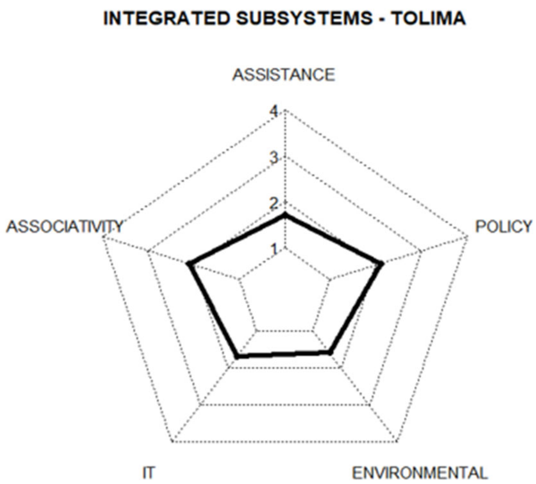

Figure 3. Grouping subsystems—Tolima. Source: Own elaboration with the RStudio tool.

As can be seen in Figure 4, associativity is the highest-rated subsystem in Chaparral (Tolima). The promotion of associative production scores 2.3 points. Participation in training programs on NARS-related topics (Q43) is the least valued condition in the TI subsystem.

Concerning the municipality of Rovira (Tolime), the TI subsystem, as can be seen in Figure 5, received higher scores than most of the other municipalities studied in the sample. Actions for the promotion of research (Q34) and building a culture of innovation (Q38) received ratings above 2 points. The environmental category obtained lower scores within the municipality. The water study (Q69) received a rating of 1.2.

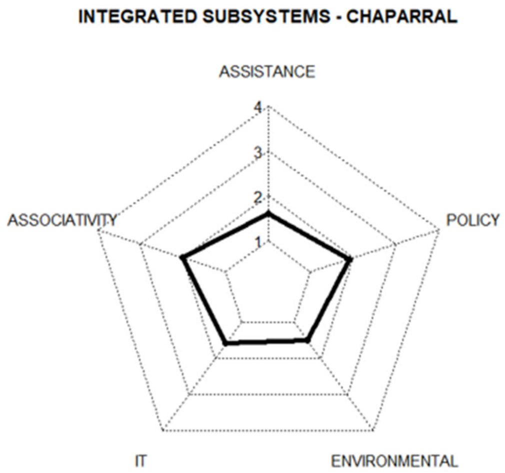

Figure 4. Grouping subsystems—Chaparral. Source: Own elaboration with the RStudio tool.

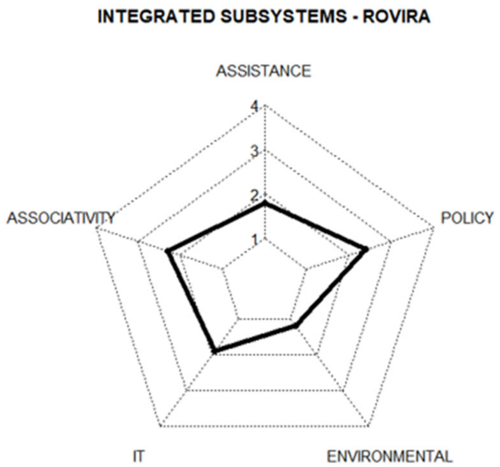

Figure 5. Grouping subsystems—Rovira. Source: Own elaboration with the RStudio tool.

Table S2, which is included in the Supplementary Materials, shows the scores obtained in different user classification subsystems for each municipality. Variability is observed in the scores for each category, indicating differences in the performance of the municipalities in terms of technical assistance, associativity, and environmental policy. Some municipalities, such as Cabuyaro and Rovira, show higher overall scores, while San José del Palmar obtains lower scores in several categories. This suggests the existence of gaps and aspects for improvement in each municipality concerning these subsystems.

4.2. NARS Subsystem Indicators

Concerning the NARS subsystem indicators, the results, as shown in Figure 6, show that Chocó has the lowest indicators, while Meta has the highest values. No department obtained an average score higher than 2 in the subsystems evaluated, which indicates the presence of gaps concerning the NARS subsystems and a tendency toward low scores. The results are shown in radar graphs, as shown in the following figure entitled Grouping Subsystems (National), to visualize the level of progress in each subsystem in each department and municipality analyzed. This reveals gaps in the five grouping subsystems, including extension, R&D, training, sustainability, innovation, and TI, with the promotion of associativity being a prominent aspect. In Tolima, low performance is observed in all subsystems, with the innovation and TI subsystems lagging the farthest behind. The use of TI shows the best performance, while participation in R&D processes has the lowest rating in the department. The extension subsystem is lagging the least but still has gaps to overcome.

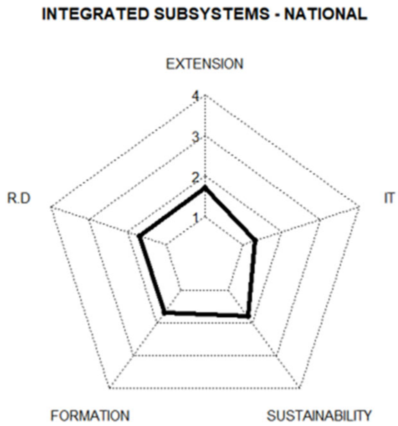

Figure 6. Grouping subsystems—National. Source: Own elaboration with the RStudio tool.

As shown in Figure 7, the lowest score was obtained for the presence of people contributing to R&D processes, with 1.2 points. In the extension subsystem, the promotion of associativity received the highest rating, with 2.7 points. In the R&D subsystem, productive transformation through social promotion obtained an outstanding score of 2.2. In the sustainability category, the application of sustainable models and agroforestry practices obtained the highest scores, with 48 and 75 points, respectively.

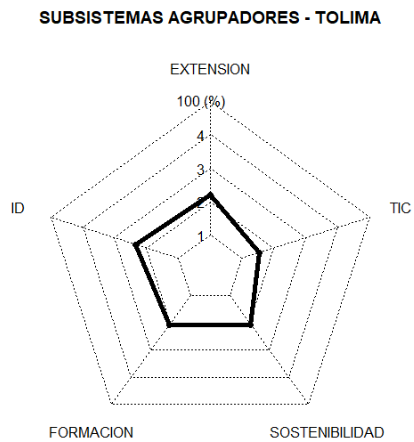

Figure 7. Grouping subsystems—Tolima. Source: Own elaboration with the RStudio tool.

As can be seen in Figure 8, Grouping Subsystems: Chaparral, the municipality of Chaparral is lagging behind in all of the conditions analyzed, with scores between 1 and 2 in each of the subsystems studied. The extension subsystem is the best rated, with 1.7 points, while the innovation subsystem received the lowest rating, with 1.4 points. Only the extension and R&D subsystems have conditions above two points.

As shown in Figure 9, the municipality of Rovira in Tolima recorded a score of two for all subsystems, except for the innovation and TI subsystem, which was rated at an average of 1.4. Promotion of extension service (Q25) and associativity (Q27) recorded the best scores, 2.7 and 3, for the extension subsystem. Likewise, sustainability and training scored around two in most of the conditions evaluated.

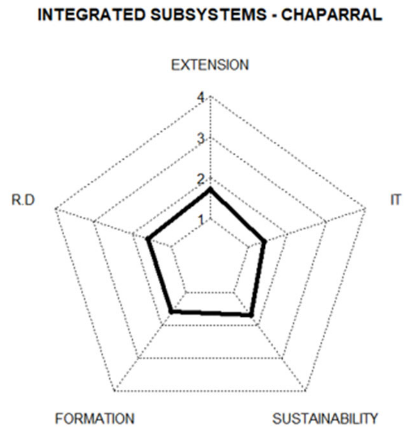

Figure 8. Grouping subsystems—Chaparral. Source: Own elaboration with the RStudio tool.

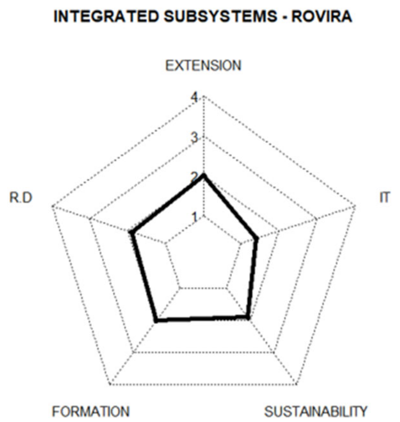

Figure 9. Grouping subsystems—Rovira. Source: Own elaboration with the RStudio tool.

Table S3 shows the NARS gaps grouped by municipality, which can be found in the Supplementary Materials. The innovation and TI subsystem is the one with the lowest value in each of the departments analyzed. Extension is the best-rated subsystem in Tolima. The sustainability subsystem registers the lowest performanc in Bolivar, being surpassed in Chocó by the sustainability subsystem. In the department of Meta, the lowest rating corresponds to the training subsystem. In the municipalities, the promotion of associativity and the availability of extension services stand out, as does as the favorable image of the profile of extensionists.

Table S4, which can be found in the Supplementary Materials, presents the gap report for each question for each department. In the gap analysis grouped by subsystems, the municipalities San Juan Nepomuceno and Santa Rosa del Sur in Bolivar describe lower performance in the innovation and TI subsystem. The same trend is observed in San José del Palmar in Chocó, Vista Hermosa and Cabuyaro in Meta, and Chaparral and Rovira in Tolima. Juradó in Chocó describes a lower indicator in the innovation and development (R&D) subsystem.

Table 1, Information Collection Instrument, shows how the results corresponding to each of the indicators from 23 to 78 in various regions were obtained. At the national level, the indicators vary in a range from 1.31 to 2.72. The highest values are found for indicators 26 and 27, related to sustainability innovation and TI, respectively. In the department of Bolivar, the indicators range between 1.21 and 2.82. Indicator 27, which refers to TI, registers the highest value, while indicator 23 has the lowest value. In the case of Chocó, indicator values range from 1.01 to 2.75. Indicator 27, related to TI, shows the highest value, while indicator 23 has the lowest value. In the department of Meta, the indicators range from 1.21 to 2.98. Indicator 26, which refers to sustainability and innovation, presents the highest value, while indicator 23 has the lowest value. In Tolima, the values of the indicators range between 1.29 and 3.28. Indicator 26, related to sustainability and innovation, registers the highest value, while indicator 64 has the lowest value. In general, it can be observed that the indicators vary in each region and that there are significant differences between departments. The indicators related to sustainability and innovation and TI are the ones with the highest values in general.

4.3. Stakeholder Mapping

Table S5, which can be found in the Supplementary Materials, presents a detailed analysis of the key actors in the agricultural and rural sectors in Colombia, addressing aspects such as training, extension organizations, project implementers, and collaborations, providing a comprehensive view of their contribution to sustainable development and innovation, among other topics.

4.4. Weighting Matrix and Gaps in the Articulation of SNCTI Actors in the Regions

Concerning the matrix of weighting and gaps in the articulation of SNCTI actors in the regions, it is found, as shown in Table S6, which can be found in the Supplementary Materials, that when analyzing the variable of collaboration in scientific articles, the following values were obtained in co-authorship over the population: Tolima (0.00001493), Meta (0.00001328), Bolivar (0.00000235), and Chocó (0.00000364). In the above example, Tolima has the best result by population for the variable collaboration in scientific article writing, so it is assigned the maximum score, which is 5.

According to the analysis of gaps in the relationships between the actors of the National Science, Technology, and Innovation System in the field of agriculture and the findings of the weighting matrix, Tolima leads in the relationship between SNCTI actors in agricultural issues, followed by Meta, Chocó, and Bolívar. Common gaps include the lack of collaboration in industrial protection via patents, the scarcity of technoparks, and the absence of technology transfer offices in the departments. Specific gaps include the low publication of scientific articles in Bolívar and Chocó and limited dynamics in projects registered with the Rural Development Agency in Bolívar. In terms of financing resource management, Tolima and Bolivar have a low performance, while Meta has moderate performance. In addition, Bolivar and Chocó have a low performance in agricultural associations, and the presence of indigenous reserves is minimal in Bolivar and Meta. Bolivar has the lowest performance in terms of research groups recognized by Minciencias in agriculture and related fields.

Table S7, which can be found in the Supplementary Materials, shows the main gaps identified in the department of Tolima in four aspects: extension, R&D, sustainability, training and innovation, and TI. For each aspect, the average and mode of the assigned scores are presented. The gaps corresponding to each aspect are identified, such as the lack of technical assistance in the productive units, the lack of active participation in the development of innovation-based sustainability, the lack of knowledge about education and training projects, and the lack of people involved in R&D&I activities and strategic alliances. In addition, the highest score achieved in each aspect is indicated, such as the presence of technical assistance and people involved in R&D&I activities and strategic alliances.

In Figure 10, a series of questions related to the National Agricultural Innovation System (NARS) were evaluated. These questions have been scored, and an ideal state represented by a score 4 has been established. The following is a summary highlighting the NARS questions along with their rating and ideal status. This analysis provides an overview of the current situation of the NARS and allows for the identification of areas for improvement or gaps.

This analysis provides a clear and concise understanding of the areas requiring attention and improvement concerning the questions assessed. In this regard, we have identified and evaluated various gaps related to the topic in question. These gaps are reflected by acute ratings for each question, where states 1 to 3 indicate the presence of a gap.

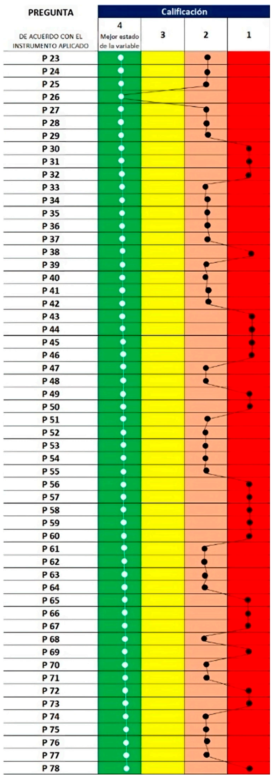

Figure 10. Gaps identified in the NARS of the department of Tolima—Colombia. Source: Own preparation.

5. Discussion

The analysis in this article reveals significant findings for understanding and enhancing the National Agricultural Innovation System (NARS) in the Department of Tolima, Colombia. The analysis of the discrepancies and convergences between the general evaluation and the specific context of Tolima in terms of challenges in the agricultural sector underscores the importance of addressing the unique problems of each region and recognizing the local particularities that influence development strategies. The identification of gaps and challenges in the agricultural sector in Tolima is distinguished by its dependence on external inputs and the lack of coordination between academia and the government.

In line with the literature on AIS and NARS, the fundamental importance of collaboration, dialogue, and technology development as crucial drivers for innovation and sustainable development in the sector is underlined. Experiences in different countries, such as Cuba, India, and Mexico, provide valuable lessons on how collaboration among diverse stakeholders, adaptation to local needs, and a focus on specific areas of innovation can have a positive impact on food security and rural development [37–41]. However, it is important to consider the specific conditions in Colombia regarding existing stakeholders, their interests, power relations, and available resources.

Based on the review of the literature on Agricultural Innovation Systems (AISs) at the global level, the discussion of the findings of the above studies reveals important implications for agricultural innovation and sustainable development in different regional contexts. The analysis of niche initiatives in intensive agriculture in Spain provides concrete examples of key actions in R&D and technology transfer, as well as an exploration of the transition to sustainable methods in agriculture, which is essential for the long-term support of agricultural sustainability.

On the other hand, the study conducted in India highlights the crucial role of social networks in agricultural innovation, underscoring their contribution to the generation of knowledge and its transfer to technical assistance processes and institutional support. In addition, it highlights the importance of advice on agricultural techniques and technologies for the formulation of education and training programs, which can significantly improve productivity and efficiency in the department of Tolima.

The analysis of investment in sustainable urban agriculture in Mexico shows the potential of this approach to positively impact the income of productive units, suggesting new ways to address economic challenges in urban environments. The study conducted in Colombia also highlights the need to analyze the banana chain and the interactions between the different actors in the agricultural system to improve technical assistance, agricultural extension, and water resource management.

Finally, the use of digital platforms to connect the agricultural innovation ecosystem in India offers technological solutions that can improve efficiency and decision making in agricultural production. Taken together, these studies demonstrate the importance of adopting comprehensive and collaborative approaches to address agricultural challenges, drawing on lessons learned from diverse experiences globally. The implementation of these actions may contribute to closing the identified gaps by capitalizing on the lessons learned from the aforementioned innovation experiences. Participation in the Regional Innovation Systems (SIRs) and the Sector Innovation System (SIS) offers the department of Tolima the opportunity to improve competitiveness and productivity at the national and regional agricultural level and provides insights into how strategies, best practices, and projects can be adapted to address the specific challenges of each territory. The analysis of niche initiatives in intensive agriculture, together with the role of social networks in agricultural innovation and investment in sustainable urban agriculture, offers unique insights and practical contributions to address the challenges identified in Tolima and other agricultural regions under study. Taken together, this research study points to promising avenues for improving the NARS and fostering sustainable agricultural development in Colombia.

It is important to consider certain aspects for future complementary studies in the area of Agricultural Innovation Systems (AISs) in this direction: (1) There is a need to compare the identified gaps not only among a larger number of departments but also with the status of such gaps both nationally and in other countries and regions; (2) so far, only four departments have been evaluated using the tool developed for this study, but it would be convenient to extend these evaluations to all departments in a systematic way, with time intervals that allow for the temporal evolution of each variable/gap to be analyzed; and (3) there is a great opportunity to develop a web tool containing the questions used in this study, which would make it easier to obtain answers in real-time, with lower costs and the possibility of responding to the assessment using information technologies.

6. Conclusions

The results of the survey in Tolima indicate that extension is a critical aspect of the functioning of the Agricultural Innovation System (SIA), and significant gaps were found in this area. Other relevant variables were identified, and strategies and recommendations compiled from various sources were proposed to close these gaps in the five subsystems analyzed in the producer survey. These sources include Garcia's master's thesis (2019), research on sustainability and sustainable innovation systems </t0/>, and studies and manuals on innovation.

The analysis of gaps in the National System of Agricultural Science, Technology, and Innovation reveals that Tolima leads the relationships with Meta, Chocó, and Bolívar. Common gaps are identified, such as a lack of collaboration in industrial protection, the scarcity of technoparks, and the absence of technology transfer offices. Specific gaps include low publication rates of scientific articles in Bolívar and Chocó, limited dynamics in projects of the Rural Development Agency in Bolívar, and low performance of Bolívar in terms of research groups recognized by Minciencias in agriculture.

Regarding the National Agricultural Research and Technological Development Subsystem, it is recommended that research capabilities in agricultural innovation are strengthened, prioritizing the conservation of knowledge, avoiding brain drain, and promoting systematic technology transfer to small and medium-sized producers. Research should be focused on the needs and agricultural vocations of the region, with a long-term holistic vision and continuity in state policies. In addition, it is suggested to establish mechanisms to manage and disseminate the knowledge generated, as well as to investigate strategies to improve research and development and the adoption of knowledge by primary producers.

Concerning the National Training and Education System for Agricultural Innovation, it is recommended to strengthen and develop educational programs in different areas, including middle, technical, university, and non-formal, as well as establishing high-quality virtual programs to train primary producers and their families. The importance of social capital is highlighted, and it is suggested to invest in the training and development of human talent aligned with the regional interests and challenges. It is necessary to improve the communication between the actors in the system and increase dissemination and networking through education and training projects and programs.

For the National Agricultural Extension Subsystem, it is essential to create favorable spaces and platforms that foster interaction and synergy between primary farmers, researchers, and other actors of the National Agricultural Innovation System (NARS), adding value at all levels of the agricultural production chain. The need to increase dissemination and improve communication among stakeholders through projects, plans, and training and education programs is highlighted.

Given the processes of innovation and TI, we suggest taking advantage of the capacities of institutions at the national and regional levels to provide training on innovation and new business models to the actors of the National Agricultural Innovation System (SNIA, for its acronym in Spanish). In addition, it is recommended to expand communication through projects and collaborations with universities, technology development centers, technology parks, innovative companies, and incubators to strengthen collaboration and promote innovation in the NARS.

To promote a sustainable National Agricultural Innovation System (NARS), it is recommended to focus on eco-innovation and green innovation, promoting sustainable and socially and environmentally responsible practices. In addition, it is suggested to establish intermediary entities and create a hub for agricultural innovation to facilitate interaction and mediation among the actors in the system.

Previous studies on innovation systems have been successful in applying a systematic approach to innovation theory and practice in various organizations, sectors, regions, and countries. With the results obtained in this evaluation, new elements are added to the theory of innovation systems by proposing the measurement of sustainability and information technology variables, aspects on which the first studies on innovation systems had not focused.

In conclusion, the results of this study can be of great use to public policy decision makers, both at the level of the department studied and the country and for other regions with similar characteristics in their innovation systems. This is because they could propose public calls for projects and strategies to address the identified gaps and promote in this way new research in technological and competitive surveillance, foresight, innovation models, R&D&I strategies, and in general, activities and projects to close the gaps found and drive the innovation system.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16083294/s1. Table S1. Information gathering instrument. Table S2. Gaps in user classification by municipality. Table S3. NAIS grids grouped by municipality. Table S4. Gaps per question by department. Table S5. A detailed analysis of the key players in the agricultural and rural sectors in Colombia. Table S6. Gaps in the relationships between the actors of the National Science, Technology, and Innovation System in the field of agriculture: findings from the weighting matrix. Table S7. Tolima: main gaps obtained.

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Writing—original draft, L.F.G.C.; Writing—review & editing, J.I.Q.S.; Visualization, J.F.M.S.; Supervision, D.A.A.T.; Project administration, J.W.Z.S.; Funding acquisition, L.M.S.G. and D.A.A.T. All authors have read and agreed to the published version of the manuscript.

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References

1. Plataforma de Agricultura Tropical. Marco Común sobre el Desarrollo de Capacidades para los Sistemas de Innovación Agrícola: Antecedentes Conceptuales. CAB Internacional, Wallingford, Reino Unido. 2017. Available online: http://www.fao.org/in-action/tropical-agriculture-platform/commonframework/es/ (accessed on 1 January 2024).
2. Organización para la Cooperación y Desarrollo Económico. Sistemas de Innovación Agrícola: Un Marco Para Analizar el Papel del Gobierno. Publicaciones de la OCDE. 2013. Available online: https://www.oecd.org/publications/agricultural-innovation-systems-9789264200593-en.htm (accessed on 1 January 2024).
3. Manioudis, M.; Meramveliotakis, G. Broad strokes towards a grand theory in the analysis of sustainable development: A return to the classical political economy. *New Political Econ.* **2022**, *27*, 866–878. [CrossRef]
4. Klarin, T. The Concept of Sustainable Development: From its Beginning to the Contemporary Issues. *Zagreb Int. Rev. Econ. Bus.* **2018**, *21*, 67–94. [CrossRef]
5. Alcázar Quiñones, A.T. Metodología "Arreglos y Sistemas Productivos Innovativos Locales" en municipios cubanos. *Retos De La Dir.* **2017**, *11*, 198–212. Available online: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2306-91552017000200013&lng=es&tlng=pt (accessed on 1 January 2024).
6. Benítez Odio, M.; Martínez Robaina, A.; Herrera Gallo, M.; Páez Fernández, P.L.; del Busto Concepción, A. Estrategia para implementar la gestión del conocimiento en el Sistema de Innovación Agropecuario Local. *Coodes* **2020**, *8*, 45–56. Available online: http://coodes.upr.edu.cu/index.php/coodes/article/view/267 (accessed on 1 January 2024).
7. FAO. La Técnica de Procesamiento FTT-Thiaroye, una Innovación Para la Reducción de Pérdidas Poscosecha en la Pesca y la Acuicultura. Documento presentado en el Primer Congreso Internacional sobre Prevención de la Pérdida de Alimentos, 2015, Roma. 2015. Available online: http://www.fao.org/food-loss-reduction/news/details/es/c/369935/ (accessed on 1 January 2024).
8. List, F. *The National System of Political Economy*; Vernon Press: Wilmington, DE, USA, 1841.
9. Leontief, W.W. *The Structure of the American Economy, 1919–1929: An Empirical Application of Equilibrium Analysis*; Harvard University Press: Cambridge, MA, USA, 1941.
10. Freeman, C. *Technology Policy and Economic Performance: Lessons from Japan, London*; Pinter Publishers: London, UK, 1987.
11. Lundvall, B.A.; Johnson, B. Sistemas nacionales de innovación y aprendizaje institucional. *Comer. Exter.* **1994**, *44*, 695–704.
12. Nelson, R.R. (Ed.) *National Innovation Systems: A Comparative Analysis*; Oxford University Press on Demand: New York, NY, USA, 1993.
13. Nelson, R.R.; Winter, S.G. The Schumpeterian tradeoff revisited. *Am. Econ. Rev.* **1982**, *72*, 114–132.
14. Metcalfe, J.S. Technology systems and technology policy in an evolutionary framework. *Camb. J. Econ.* **1995**, *19*, 25–46. [CrossRef]
15. Storper, M. Regional technology coalitions are An essential dimension of national technology policy. *Res. Policy* **1995**, *24*, 895–911. [CrossRef]
16. Foray, D.; Lundvall, B.-A. *The Knowledge-Based Economy: From the Economics of Knowledge to the Learning Economy*; Employment and Growth in the Knowledge-Based Economy: Paris, France, 1996.
17. Dosi, G. The Nature of the Innovation Process. In *Technical Change and Economic Theory*; Dosi, G., Freeman, C., Nelson, R., Silverberg, G., Soete, L., Eds.; Pinter: London, UK, 1988; pp. 221–238.
18. Hakansson, H. Industrial technology development: A network approach. *J. Prod. Innov. Manag.* **1987**, *4*, 163–165.
19. Calderón González, J. Implementation of the National Agricultural Innovation System–SNIA, regulated by Law 1876 of 2017 in Colombia. 2020.
20. Robledo, J. *Introducción a la Gestión Tecnológica*; Universidad Nacional de Colombia Sede Medellín: Medellin, Colombia, 2010.
21. Padilla-Pérez, R.; Vang, J.; Chaminade, C. Regional innovation systems in developing countries: Integrating micro and meso-level capabilities. In *Handbook of Innovation Systems and Developing Countries*; Edward Elgar Publishing: Cheltenham, UK, 2009.

22. Malerba, F. Sectoral system of innovation: A framework for linking innovation to the knowledge base, structure, and dynamics of sectors. *Econ. Innov. New Technol.* **2005**, *14*, 63–82. [CrossRef]
23. Nederlof, E.S.; Röling, N.; Van Huis, A. Pathway for agricultural science impact in West Africa: Lessons from the Convergence of Sciences program. *Int. J. Agric. Sustain.* **2007**, *5*, 247–264. [CrossRef]
24. Koutsouris, A. Facilitating Agricultural Innovation Systems: A Critical Realist Approach. *Stud. Agric. Econ.* **2012**, *114*, 64–70. [CrossRef]
25. Sseguya, H.; Mazur, R.; Abbott, E.; Matsiko, F. Information and communication for rural innovation and development: Context, quality, and priorities in southeast Uganda. *J. Agric. Educ. Ext.* **2012**, *18*, 55–70. [CrossRef]
26. Moreddu, C.; Van Tongeren, F. Improving agricultural productivity sustainably at a global level: The role of agricultural innovation policies. *EuroChoices* **2013**, *12*, 8–14. [CrossRef]
27. Klerkx, L.; Nettle, R. Achievements and challenges of innovation co-production support initiatives in the Australian and Dutch dairy sectors: A comparative study. *Food Policy* **2013**, *40*, 74–89. [CrossRef]
28. Kilelu, C.W.; Klerkx, L.; Leeuwis, C. Unraveling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development program. *Agric. Syst.* **2013**, *118*, 65–77. [CrossRef]
29. Kingiri, A.N. A review of innovation systems framework as a tool for gendering agricultural innovations: Exploring gender learning and system empowerment. *J. Agric. Educ. Ext.* **2013**, *19*, 521–541. [CrossRef]
30. Douthwaite, B.; Hoffecker, E. Towards a complexity-aware theory of change for participatory research programs working within agricultural innovation systems. *Agric. Syst.* **2017**, *155*, 88–102. [CrossRef]
31. Pigford, A.A.E.; Hickey, G.M.; Klerkx, L. Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions. *Agric. Syst.* **2018**, *164*, 116–121. [CrossRef]
32. Spendrup, S.; Fernqvist, F. Innovation in agri-food systems–a systematic mapping of the literature. *Int. J. Food Syst. Dyn.* **2019**, *10*, 402–427. [CrossRef]
33. Cofré-Bravo, G.; Klerkx, L.; Engler, A.Y. Combinaciones de vínculos, puentes y vinculaciones de capital social para la innovación agrícola: Cómo los agricultores configuran diferentes redes de apoyo. *Rev. De Estud. Rural.* **2019**, *69*, 53–64.
34. Kamara, L.I.; Dorward, P.; Lalani, B.; Wauters, E. Unpacking the drivers behind the use of the Agricultural Innovation Systems (AIS) approach: The case of rice research and extension professionals in Sierra Leone. *Agric. Syst.* **2019**, *176*, 102673. [CrossRef]
35. Fielke, S.J.; Nelson, T.; Blackett, P.; Bewsell, D.; Bayne, K.; Park, N.; Rijswijk, K.; Small, B. Hitting the bull's-eye: The role of a reflexive monitor in New Zealand Agricultural Innovation Systems. In Proceedings of the 12th European International Farming Systems Association (IFSA) Symposium, Social and Technological Transformation of Farming Systems: Diverging and Converging Pathways, Newport, UK, 12–15 July 2016; pp. 1–13.
36. Clarkson, G.; Garforth, C.; Dorward, P.; Mose, G.; Barahona, C.; Areal, F.; Dove, M. Can the TV makeover format of edutainment lead to widespread changes in farmer behavior and influence innovation systems? Shamba Shape Up in Kenya. *Land Use Policy* **2018**, *76*, 338–351. [CrossRef]
37. Vom Brocke, K.; Kondombo, C.P.; Guillet, M.; Kaboré, R.; Sidibé, A.; Temple, L.; Trouche, G. Impact of participatory sorghum breeding in Burkina Faso. *Agric. Syst.* **2020**, *180*, 102775. [CrossRef]
38. Barzola Iza, C.L.; Dentoni, D.; Omta, O.S.W.F.Y. The influence of Multi-Stakeholder Platforms on farmers' innovation and rural development in emerging economies: A systematic literature review. *J. Agribus. Dev. Emerg. Econ.* **2020**, *10*, 13–39. [CrossRef]
39. Zossou, E.; Saito, K.; Assouma-Imorou, A.; Ahouanton, K.; Tarfa, B.D. Participatory diagnostic for scaling a decision support tool for rice crop management in northern Nigeria. *Dev. Pract.* **2021**, *31*, 11–26. [CrossRef]
40. Yin, X.; Chen, J.; Li, J. Sistema de innovación rural: Revitalizar el campo para un desarrollo sostenible. *Rev. De Estud. Rural.* **2022**, *93*, 471–478. [CrossRef]
41. Giagnocavo, C.; de Cara-García, M.; González, M.; Juan, M.; Marín-Guirao, J.I.; Mehrabi, S.; Rodríguez, E.; van der Blom, J.; Crisol-Martínez, E. Reconectar a los agricultores con la naturaleza a través de transiciones agroecológicas: Nichos interactivos y experimentación y el papel de los sistemas de innovación y conocimiento agrícola. *Agricultura* **2022**, *12*, 137. [CrossRef]
42. Alaie, S.A. Conocimiento y aprendizaje en el sistema de innovación hortícola: Un caso del valle de Cachemira en la India. *Rev. Int. Estud. Innovación* **2020**, *4*, 116–133. [CrossRef]
43. Dieleman, H. Enfoque de Sistema de Innovación para la Agricultura Urbana: Estudio de Caso de la Ciudad de México. *Innovaciones Agric. Sosten.* **2019**, 79–102. [CrossRef]
44. Quintero, S.; Giraldo, D.P.; Garzón, W.O. Análisis de los Patrones de Especialización de un Sistema de Innovación Agropecuaria: Un Estudio de Caso sobre la Cadena Productiva del Banano (Colombia). *Sustentabilidad* **2022**, *14*, 8550. [CrossRef]
45. Poti, S.; Joy, S. Plataformas digitales para conectar actores en el espacio agtech: Conocimientos sobre el desarrollo de plataformas a partir de la investigación de acción participativa en KisanMitr. *Rev. Investig. Empres. India* **2022**, *14*, 65–83. [CrossRef]
46. Morin, J. *L'Excellence Technologique*; Publi Union: Paris, France, 1985; ISBN 54-956-275-3.
47. Sossa, J.W.Z.; Gonzalez, J.A.R.; Reveiz, R.E.; Gómez, C.A.G.; Uribe, J.H.D.; Garcés, J.G. Capacidades de innovación. Medición de capacidades de innovación en 460 empresas de Quindío–Colombia. *Rev. Espac.* **2016**, *37*, 2.
48. Sossa, J.W.Z.; Zarta, R.H. Aplicación de una Metodología de Gestión de Innovación y Tecnología en una Empresa de Alimentos en Armenia–Colombia. *Rev. Electrónica Gestión Pers. Tecnol.* **2013**, *6*, 54–65.
49. Sossa, J.W.Z.; Castro, A.F.; Burbano, J.H.E.; Franco, D.H.G. Análisis del Perfil Tecnológico en Empresas Colombianas. Aplicación en 42 empresas de Antioquia-Colombia. *Espacios* **2012**, *33*, 16.

50. Belalcázar Otálora, C.D.; Rodríguez Monroy, D.A. *Diagnóstico de innovación NUTRIANÁLISIS*; Universidad EAFIT: Medellín, Colombia, 2015.
51. Gil, B.; Pascual-Ezama, D. La metodología Delphi como técnica de estudio de la validez de contenido. *An. Psicol. Ann. Psychol.* **2012**, *28*, 1011–1020. [CrossRef]