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Reference framework for capabilities development in agricultural innovation system

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Abstract
Agricultural Innovation Systems (AIS) approach, arise as tool for better understanding dynamics and complexity of agricultural innovation. The objective of this article is present a framework for AIS capability development, taking as a scientific reference, emerging economy countries experiences. A multi-dimensional methodology of literature review and content analysis is implemented, supported in bibliometric and data mining techniques. The development of capacities in the context of agricultural innovation systems is mediated by the existence of links between actors, which enable social learning processes through networking. AIS, as an approach for the improvement of innovation capacities, emerge in developed countries, with consolidated institutional capacities and constitute an opportunity for the strengthening of the agricultural sector in countries with emerging economies. The analysis of networks, the non-linear perspective of the innovation process and the initiation of research, training, policy and intermediation are the main common themes between AIS and capability building.

Keywords: agricultural innovation systems; capability development; collaborative networks; network analysis.

Marco de trabajo para el desarrollo de capacidades en sistemas de innovación agrícola

Resumen
Los Sistemas de Innovación Agrícola (SIA) se consolidan como un enfoque para analizar y comprender la dinámica y la complejidad de la innovación agrícola. El objetivo de este artículo es presentar un marco para el desarrollo de capacidades en SIA con base en las experiencias de países de economía emergente. Se implementa una metodología de revisión de literatura y análisis de contenido, soportado en técnicas de bibliometría. El desarrollo de capacidades en el contexto de los SIA, se encuentra mediado por la existencia de vínculos entre actores, que posibilitan los procesos de aprendizaje social mediante el trabajo en red. Los SIA, emergen en países con capacidades institucionales consolidadas y constituye una oportunidad de fortalecimiento sectorial agrícola. El análisis de redes, la perspectiva sistémica del proceso de innovación, capacitación, las políticas e intermediación, son los principales temas en común entre los SIA y el desarrollo de capacidades.

Palabras clave: sistemas de innovación agrícola; desarrollo de capacidades; redes de colaboración; análisis de redes.

1. Introduction

1.1. Development of capabilities in Agricultural Innovation Systems

Agricultural innovation is the typical output of the interaction and processes within an Agricultural Innovation System, AIS. Their approaches have evolved from an orientation to technology, between the 1950s and 1980s towards a systems-oriented approach [1]. This systemic orientation has evolved in its objectives from the contextualization of agricultural technologies in farm systems, the construction of local capabilities and the enablement of farmers through agricultural knowledge and

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information systems, to the development of agricultural capability system to generate and respond to change, existing in the approach of Agricultural Innovation Systems [2]. An Agricultural Innovation System, AIS, is "a network of actors or organizations and individuals that, together with their institutions and support policies of the sector, put into social use and economic products, procedures and new or existing methods of organization". The theory and praxis of agricultural innovation systems is ascribed to evolutionary economic theory, which studies the behavior of economic systems from a dynamic perspective, emphasizing the importance of innovation and the development of technology in the evolution of the economy over time [3]. The application of the AIS perspective in developing countries, there is scant evidence of empirical analyzes on the subject [4]. Several studies have addressed agricultural innovation under a linear approach, despite its recognition of the limitations for the analysis of innovation phenomena [2,5] and therefore, the need for systemic approaches [6] that take into account the dynamics and complexity of agricultural innovation is identified.

The development of the systems goes hand in hand with the development of its own components, as well as their capability or ability to learn and innovate. Capability is the ability of individuals, organizations or society to create sustainable development or "the competence of individuals, organizations and society as a whole to satisfactorily manage their matters" [7]. Capability development, CD, is a process that involves multiple stakeholders and whose objective transcends the personal level and covers institutional dimensions.

At a conceptual level, the Resource Based View is the predominant approach for capability analysis [8-10]. This is based on the assessment of the impact of the capabilities, on the performance of the organization [11-12] measured from indicators such as innovation outputs, new products or patents, however, this approach is considered emerging for the analysis of the AIS [13]. Due to the lack of attention given, by the linear exercises to the social, cultural and economic determinants, present in each region, which have not been effectively incorporated and influence the performance of the innovation process [14], the capability development approach in the AIS emerges as a response for understanding, diagnosing, studying and evaluating them. This paper establishes the bases to identify the theoretical limits of this theoretical field in development, identifying the potential research gaps between AIS and CD. It is proposed as a guiding question for the review: what should be the development of capabilities in Agricultural Innovation Systems?

A large amount of literature on capability development and Agricultural Innovation Systems is available, however very few papers are focused on the development of capabilities in Agricultural Innovation Systems. Based on the milestones within the scientific literature, the points of intersection between these two bodies of knowledge can be identified. To determine this intersection, the complementary strategy of combining methods and tools for content analysis, bibliometric and networks, for the construction of the systematic literature review, SLR, is implemented.

At the beginning of this research, the bibliometric approach is used to identify the most relevant literature in terms of visibility and quality of articles and journals [15]. For this test, the indicators of number of appointments and impact factor SJR are selected. A keyword network analysis is implemented based on the metadata extracted from the ISI database, within the Vantage Point software. This analysis facilitates the conceptual modeling and provides a general view of the relationships between constructs and concepts of the bodies of knowledge.

The second moment is developed through content analysis, the identification of the main models of capability development, which serve as support, as nodes for content analysis. This research method is assumed to implement a strict and systematic textual analysis [16]. Within the scientific literature of Agricultural Innovation Systems, the most relevant aspects associated with capability development are identified and codified within the Nvivo software. As a result of these antecedents, in a third moment, the conceptual model is postulated where the theoretical elements are repositioned to provide a new perspective, which provides new directions of analysis and development of these fields.

This paper is divided into three parts, the first one, focused on the description of factors, capabilities and collaborative networks in the AIS, the second one, where special emphasis is placed on the development of capabilities and finally, in which a framework of reference for the development of capabilities in AIS is provided.

2. Methodology

In order to establish a connection between AIS and CD, a systematic review approach of literature, SLR is used, based on bibliometric methods and tools and analysis of word networks. The integration of these methods is complementary [17], considering these and the analysis of networks, facilitate the understanding of the characteristics of the disciplines within the main databases [18] and the content analysis, facilitates the development of the framework of work. The methodology consists of three phases, the first one focuses on the bibliometric analysis, with the aim of identifying the dynamics and the most relevant contributions within the bodies of knowledge [19] of AIS and CD. A network analysis of keywords is carried out, complemented with the analysis of the points of intersection of these two areas, in order to reliably and quickly identify the relationships between the constructs, for the conceptual modeling of the theme. In the second phase, the content analysis is carried out through the identification and characterization of the conceptual models for CD and AIS and the mapping of approaches and units of analysis. During the third phase, the CD and AIS framework, based on the findings of the content analysis, is formulated as a synthesis.

2.1. Delimitation of the sample of articles and bibliometric

To select the first set of articles, a sample is obtained from indexed journals, taking as a reference the impact factor and calculated using the JCR (Journal Citation Report) index of the ISI database, which is one of the bibliometric indicators

of greater relevance [20]. The selection of the database is done taking into consideration that it includes journals from the Scopus database, which implement rigorous processes of article selection, as well as evaluation and monitoring of quality and visibility, through indicators such as the SJR and the Cite score, which complement the JCR indicator. In addition, the ISI includes key information for bibliometric analysis and network analysis, such as: keywords, number of citations and references. All the articles in the database from 2001 to 2017 were considered within the initial search.

The first sample is obtained through the search expression TS = ("agricultural innovation systems") within ISI, generating as a result, 63 articles. So as to extend this initial sample, the truncation operator (*) is implemented, which returns all the words and strings of words that include the root expression that is before the operator. As a consequence, the expression "agr * innovat * system *" is configured. Additionally, the search spectrum is extended with the expression "agr * syst * of innovat *", identified in a field pre-sampling process. The iteration of this equation, yields a result of 100 articles, in which 4 were excluded because they are related exclusively to specific agricultural issues, not associated with innovation.

There is a consensus around the number of citations of an article, as a relevant indicator of its quality, visibility and scientific impact [15,21-22]. With the objective of selecting high quality and visibility papers, the "I" factor is estimated for each article based on two indicators: first, the impact factor of the journal where it is published taken directly from (JCR) and second, the number of citations of the article. This estimate is calculated based on the expression:

$$I = C * (JCR + 1) \quad (1)$$

according to [23]

The population of 100 articles was sorted in descending order based on the "I" estimate and through a Pareto analysis, the articles that comprise 81% of the total impact factor are included. In this way, the sample that corresponds to 20 documents is consolidated.

Given that this estimator “I” excludes recent potentially influential articles, the inclusion of articles published between 2016 and 2017, which are within journals with a JCR impact factor greater than 2, is implemented as an inclusion criterion. Based on it, seven articles are added, which represents a sample of 27 documents for the AIS area.

In order to address the development of capabilities, the ISI search is implemented with the expression: "capability development" with an initial result of 259 articles. To obtain a more representative set of articles, the expression is complemented by the operator (*) to generate the expression "capabilit* develop*", which generates, as a result, a set of 466 articles. This expression includes the phrases " capabilities development " and " capability development ".

The delimitation of the sample procedure, used in AIS is replicated for the development of capabilities, based on the Pareto principle and the estimator “I” of equation (1). In this way, we obtain a sample of 43 articles for CD, which constitutes the second sample set of the review. Consequently, of the union of the two sets, 27 for AIS and 43 for CD, a total of 80 articles is consolidated, which are the object of the content analysis implementation.

3. Results and discussion

The approach and methods of analysis of agricultural innovation systems have been developed by researchers from developed countries who have had the interest and resources for the analysis of innovation systems in "less developed countries". Among the most influential institutions and authors are Wageningen University Research and Professor Laurens Klerkx from this institution.

3.1. Bibliometric analysis of AIS sample

Within a set of 84 articles of AIS, four authors are identified who gather 50% of documents as follows: Klerkx (20 articles, 24%), Schut (8 articles, 9.5%), Hickey (7 articles, 8.3%), Bastiaans, Leeuwis, Rodenburg and Turner (5 articles, 6.92%). The peak of article production is known in 2015 (20 articles, 23.8%). These figures show an increasing trend in the number of publications in the analysis period.

In relation to the percentage distribution of the research areas, 68% of the articles are published in journals attached to the areas of Agricultural knowledge, Economics and Business, while Environmental Sciences and Ecology represent 10% of the publishing.

In reference to the institutions of origin of the research, Wageningen University Research leads this category with 30% of the publications, followed by Agresearch New Zealand with 8%. Among the funding institutions, New Zealand Dairy Farmers Through Dairynz 5% and CGIAR Research Program on Climate Change Agriculture and Food Security CCAFS 5% stand out.

The analysis of geographical origin of the research shows, in descending order, the countries that lead the research in AIS, to: i) Holland, 40.5%, ii) New Zealand, 16.7% and iii) Canada 10.8%. In Latin America, Mexico represents 3.57% and Brazil 2.38%.

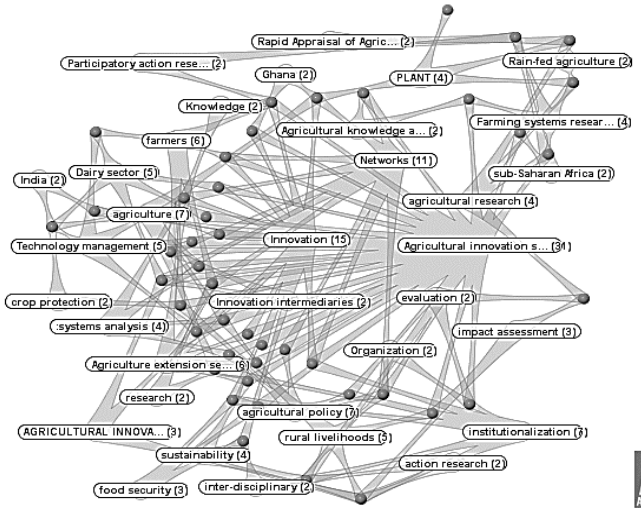

Figure 1. Keywords network in AIS.
Source: [1] Authors from Vantage Point.

To identify features and patterns within the body of knowledge, the frequency and proximity of keywords are examined through a cluster analysis with Vantage Point software, VP, (see Fig. 1). As the information source of the analysis, the metadata of the sample of articles is used, including titles and keywords exported from the ISI WOS interface. By scanning this data, the analysis database is purified within VP, as a means to eliminate repetition in the records.

For the interpretation of results of the frequency of occurrence of key terms, categorization criteria are established: thus: i) high frequency: those concepts that appear more than 10 times; ii) average frequency, those notions that appear in the range of 4 to 9 times, and iii) frequency lowers those terms that appear between 2 and 3 times.

Sets are identified as follows: i) high frequency: Agricultural innovation system, innovation, networks; ii) average frequency: agriculture, agricultural policy, institutionalization, farmers, extension agriculture, technology management, dairy sector, rural livelihoods, plant, farming systems research, agricultural research, system analysis, sustainability; and iii) low frequency: food security, agricultural innovation, impact assessment, rapid appraisal of agriculture, rain-fed agriculture, Ghana, Participatory action research, knowledge, agricultural knowledge, India, Sub-Saharan Africa, evaluation, innovation intermediaries, crop protection, organization, research, action research, inter-disciplinary.

While the emergence of the term innovation and AIS, it is predictable given its inclusion in the search equation, highlights the term "network". This finding confirms the determining and constitutive nature of the networks for AIS. The terms of low frequency reveal the renewed interest in critical areas such as food security in a context of climate change, as well as the need to develop knowledge intermediation schemes for agricultural innovation.

The examination of the frequencies and relationships of the first order of the study area, agricultural systems, highlights the influence of agricultural policies (7) and of the institutional (7) and extension (6) subsystems. This result shows the determining character of these three variables, for the performance of the AIS. In this sense, associated with the most frequent word, innovation, agriculture is directly associated (7), since agricultural innovation is the natural outlet of this process and sustainability (4) and systemic analysis (4). These last two terms show the methodological tendency to approach a sustainable approach in agriculture.

3.2. Content analysis of AIS

There is no agreement on the definition of AIS, however, key factors are identified within the concepts evidenced in this study. In this sense, AIS is understood as: sets, subsystems [24] or public or private networks [25] of: institutions [7,26], actors, organizations and individuals [3] of complex and dynamic nature [6,27,28] interrelated [24,29] and self-organized [30] that, in conjunction with supporting institutions and policies in the agricultural sector [26], contribute to the production, exchange and use of knowledge [2,30-32] new technologies, new or existing skills, products, processes and organizational forms [3], for the generation of agricultural innovation and the creation of impact on the performance of sector innovation [6] at the regional, national or global level [29,33].

As a contribution to the construction of the AIS concept, from those identified in the literature, it is postulated as: "A system made up of people, organizations and processes, based on human, technical and technological capabilities, to transfer and transform technology (in all its dimensions, hard and soft), that intensifies the sustainability and favors the productivity of the agricultural sector, with the purpose of satisfying human needs."

As a way to perform the approach of the investigations within the sample, the mapping of the research approaches is constructed, which is summarized in Table 1.

Table 1
Research approach in AIS sample

Approach	Method	Frequency (%)
Qualitative (70.37%)	Case study	33.33%
	Conceptual	3.7%
	Literature Review	25.93%
	Longitudinal Case study	3.7%
	Crossover Case Study	3.7%
Quantitative (7.41%)	Sample	3.7%
	Social modeling Networking sites.	3.7%
Mixed (22.2%)	Qualitative + Quantitative	
	Total	22.2%
		100%

Source: The Authors.

Table 2.
Units of analysis identified in AIS sample.

Units of analysis description	Frequency (%)
Networks	33.30%
Farmers	7.40%
Knowledge intermediation	7.40%
Micro-level interactions.	3.70%
Structure of the info network	3.70%
Innovation platforms	3.70%
Agricultural innovation	3.70%
Support networks	3.70%
Agricultural innovation	44.40%
Crops	7.4%
Restrictions for sustainable intensification	3.7%
AIS Performance	3.7%
Dairy sector innovation	3.7%
Big Data	3.7%
Agricultural training systems	3.7%
Innovation Process	3.7%
Links-ties	3.7
Farmers sector	3.7%
Irrigation system	3.7%
Food security	3.7%
AIS Subsystems	22.3%
Agricultural research	7.4%
Resilience	7.4%
Extension	3.7%
Institutional	3.7%
Total	100%

Source: The Authors.

The predominant research focus on the sample is the qualitative one and the most frequent method is the case study. This finding validates the conception of the approach of agricultural innovation systems, as of an emerging nature. In addition, mixed methods represent the second most frequent research approach, reinforcing the need to address this issue, through various methods, to facilitate their understanding.

As a complementary study to the focus analysis, a survey of units of analysis were conducted. Table 2 shows the summary of the findings of this test.

Three large groups emerge within the units of analysis, which is an indication of where the AIS investigations are centered. One of the main groups is the research of collaborative work networks focused on farmers. There are analyzed variables that facilitate the performance of AIS such as the structure of the network, the interactions. The intermediation of knowledge and its effects on agricultural innovation stand out as central elements of agricultural innovation.

As a typical result of the agricultural innovation process, agricultural innovation is, in percentage terms, the most frequent unit of analysis with 44.4%. These investigations focus mainly on crops as well as mechanisms and strategies to improve their performance.

The third major group within the units of analysis, refers to the critical components or subsystems for the performance of AIS such as research, extension and the institutional component.

Although the search for terms associated with AIS does not include reference to capabilities, there is ample reference about this area within the sample. Characteristics are identified within the orientation of the capabilities, as a method to boost the performance of the AIS, from the individual to collective levels. From this perspective, capabilities are understood, such as skills for: i) new technical competencies, ii) individual and collective effectiveness, iii) ability to reflectively learn, iv) use of links with other actors, and vi) improvement of collective actions [6].

At the communal level, the complexity and dynamics of the AIS requires understanding how collective and individual capabilities are strengthened within the system, for collaborative network interaction, which is crucial for the system performance [34].

3.2.1. Capabilities in AIS

The characteristics of this interaction are centered on adaptability [35] and self-organization [36], bases for the generation of resilience at the system level [37]. It highlights the ability of interaction within dyad as research and industry [38] and at the system level, between the components or subsystems of the AIS, with the environment. Collective skills and their development are a social process [39] based on the capability for interaction, understood as the creation of skills and competencies to innovate, [40] determined by the capability for institutional change [6].

At the individual level, the capabilities to improve agricultural practices for farmers, to increase efficiency in the use of land and increase productivity [41], based on training and changes in the processes carried out by the farmer, are of special interest in the studies due to their influence on performance. A critical role at the individual level, is related to the intermediation of knowledge and specialized training, which are key factors for both individually and collectively, for the development of skills [42] that positively influence the performance of agricultural practices. In this context of personal and mutual capability development, there is consensus on the determining nature of the generation of links and networks, to boost research capability building initiatives [4].

3.2.2. Components of the AIS and performance

As a system, the AIS are composed of interrelated subsystems, whose individual functioning affects the overall performance. Although there are different denominations to identify these subsystems, they highlight nominations of areas such as: environmental, political-institutional, social-cultural, economic-productive, infrastructure, and Science Technology and Innovation.

In reference to the environmental subsystem of the AIS, sustainable alternatives associated with food security and economic development are sought [43-44] to attack problems associated with soils [45], such as desertification.

Within the social subsystem of the AIS, they highlight findings that show research strengthens the construction of social capital [46] and the abilities of the performers [47] and in this sense, it is identified the communities of practice [34] favor the individual and collective capabilities in the AIS.

In the STI subsystem, a two-way relationship between the strengthening of innovation and research capabilities is identified [4]. Due to its nature of collaborative networks, research alliances, the nature of the roles among researchers and stakeholders and the type of research strategies in the AIS [45] are determining factors in the performance of the research. In the technological infrastructure subsystem, a nascent tendency associated with the development of individual and collective capabilities for decision making is identified, based on access to "Big Data" on resources of "Cloud Computing" [27], as a critical issue for the improvement of farm decision making and the performance of the AIS.

Around the political-institutional dimension, it is identified that despite their influence on innovative performance, few agricultural policy reforms manage to incorporate the principles of AIS [48]. This is explained by the impossibility of the reforms, of incorporating the specific needs of the actors and of understanding the capabilities derived from each context.

3.2.3. Collaborative networks in AIS

The networks of collaboration and knowledge transfer in AIS are enhanced by tools such as innovation platforms [38], which contribute to improving the capability of stakeholders to better their performance within the supply chain, to add value to the client [27].

A crucial function within networks is innovation intermediation. According to [49-50], the functions that innovation intermediaries would have in an AIS, are: "(i) articulation of demand, (ii) institutional support, (iii) brokerage network, (iv) capability strengthening, (v) management of the innovation process, and (vi) meeting needs for knowledge intermediation and mobilization and dissemination of technology and knowledge from different sources ". The convergence of the issues of knowledge and innovation intermediation within the development of capacities in agricultural innovation systems, emerges as a promising area of research development, for the improvement of the performance of agricultural innovation.

The "creation of networks and interactive learning", promote the awareness on the change of policies of the institutions that participate in the development of innovation processes in AIS [51]. For this reason, it requires a certain type of coordination that can be mediated by actors that assume the role of "innovation intermediaries".

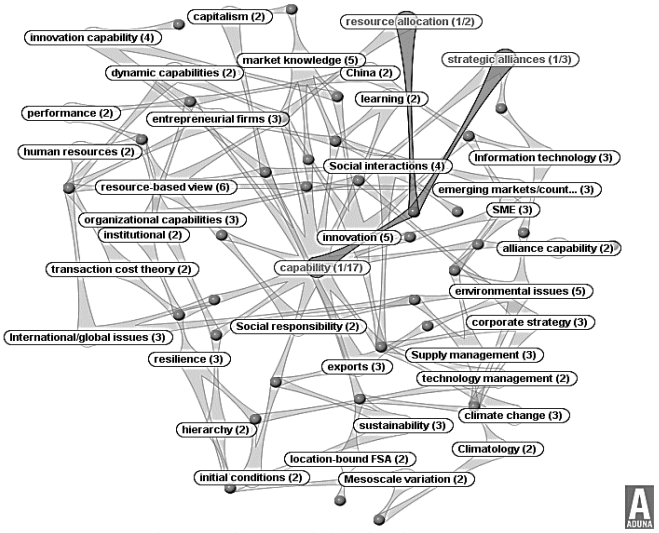

Figure 2. Keywords network in capability development.
Source: [2] The authors from Vantage Point.

3.3. Content analysis of capability development

3.3.1. Bibliometric analysis of Capability development sample

The tendencies within the set of the body of knowledge of "capability development" show Pan SL, as the researcher with the largest number of articles (seven publications), secondly George G (five publications) and thirdly Chou TC with four. When it comes to countries with greater publication of the area, United States and Great Britain, add half of the articles (33 and 17% of publications). These articles belong to three major areas of knowledge: Business and Economics (53%), Engineering (18%) and Computer Science (8%).

Within the sample, the dominance of a particular journal is not evident, however, five publications gather 10% of articles: Journal of International Business Studies (10), Organization Science (10), Journal of Management Studies (8) and Strategic Management Journal (8). The trend in the number of publications per year remains increasing throughout the period of time, with the years of 2016 (59) and 2015 (42) being the peaks of publications within the capabilities development. The institutions with the highest number of publications are: University of Singapore (9), Imperial College of London (8), University of Taiwan (7), University of Padua and London Business School and Technological Institute of Massachusetts (6).

In order to identify characteristics and patterns associated with the advancement of capabilities, the frequency and proximity of keywords are examined through a cluster analysis with Vantage Point software, VP, (see Fig. 2). As the information source of the analysis, the metadata of the sample of articles is used, including titles and keywords exported from ISI Web of Science.

For statistical interpretation for key terms co-occurrence, categorization criteria are established: thus: i) high frequency, those terms that appear more than 10 times; ii) average frequency, those concepts that appear in the range of 4 to 9 times, and iii) frequency lowers, those notions that appear between 2 and 3 times.

Word sets are identified as follows: i) high frequency (transcribed literal in English): capability; ii) average frequency: resource-based view, market knowledge, innovation, environmental issues, social interactions, innovation capability; and iii) low frequency: strategic alliances, entrepreneurial firms, information technology, emerging markets, organizational capabilities, SME, international / global issues, corporate strategy, supply management, exports, resilience, climate change, sustainability, mesoscale variation, initial conditions, location -bound FSA, hierarchy, climatology, technology management, social responsibility, alliance capability, transaction cost theory, institutional, learning, human resources, performance, China, dynamic capabilities, capitalism, resource allocation.

Although the emergence of the concept capability is natural given its inclusion in the search equation, the concept capability for innovation stands out, within the category of average frequency. The term "Resource Based View" refers to the theory that dominates studies in the area of capability development [52]. This finding confirms the determining character of innovation capability, as the axis of the development and innovative performance for AIS.

Additionally, the environmental aspects stand out within the category of low frequency words. The low frequency terms reveal the recent interest in critical areas such as climate change and resilience in AIS, within a context of climate change. As a measure to perform the research approach within the sample of capability development, one mapping is constructed, in Table 3.

The predominant research focus on the sample is the qualitative one and the most frequent method is the case study. This finding validates the conception of the approach of agricultural innovation systems, as of an emerging nature. In addition, mixed methods represent the second most frequent research approach, strengthening the need to address this issue, through various methods, to facilitate their understanding. As a complementary analysis to the focus

Table 3.
Research approach on the AIS sample.

Approach	Method	Frequency (%)
Qualitative (54%)	Case study+	20%
	Literature Review	34%
Quantitative (6%)	Sample	2%
	Mathematical modeling	4%
Mixed (40%)	Longitudinal study +Statistic sample	40%
	Total	100%

Source: The Authors.

Table 4
Units of analysis identified in the CD sample.

Analysis unitys description	Frequency (%)
Capabilities	32%
Development of capabilities	16%
Innovation and resources capability	10%
Dynamic capabilities	6%
Business	44%
Industry	18%
Business ecosystem	12%
Corporate innovation	6%
Family business	4%
Supply chain	2%
Social commerce	2%
Technologies	16%
Data base	12%
Technological outsourcing	2%
Adoption of ECR	2%
Environmental	8%
Atmospheric modeling	2%
Ecosystem processes	2%
Biological effects	2%
Sustainable development	2%

Source: The Authors.

analysis, a mapping of the units of analysis within the sample is implemented. Table 4 shows the summary of the findings of this test.

The most frequent study unit within the CD sample is the business area. Within this, an orientation towards the analysis is observed by differentiated groups such as ecosystems and supply chains. The emergence of capability development is observed as a tool for analyzing global problems such as sustainable development.

3.3.2. Capability development

The term capabilities is associated with skills and competencies at the individual and organizational levels, which in turn support the obtaining and maintenance of competitive advantages in the market [53]. In that sense, Prahalad and Hamel use the concept "basic competence" to deal with organizational capabilities [54]. Within some theoretical approaches, resources and capabilities are leveled, however, they cannot be considered as part of a resource, due to its dynamic and complex nature [54].

In order to delimit and distinguish between capability and resource, next concepts has been considered: "Resources are inputs in the production process: they are the basic unit of analysis" and "a capability is the ability of a resource team, to perform some task or activity" [52], added to this definition of capability, [55] cite (Winter, 2003) who conceptualizes them as learned routines that organizations use to convert inputs and outputs, typically combining tangible and intangible resources.

In this sense, and understanding that the capabilities are factors that drive the future sustainability of the organizations, there exits the need to develop them, this is how [56] referring to the operative capabilities, which are essentials to generate processes such as manufacturing strategies. Added to this, the structure of the industrial sector where the organization is located, influences learning capabilities, innovation and performance [57], identifying learning as a primary source that intervenes positively in the development of capabilities.

To address capability development, it is necessary to formulate both strategies and policies [58] that promote them, both endogenously and exogenously, that is, internally in each organization and externally through relationships with other stakeholders in the favorable environment. In this regard, it is found that an innovative way of managing them within organizations is through outsourcing [59], as well as through the generation, modification and configuration of their existing routines and resources, factors that promote the achievement of its objectives [60] and improvement of its competitiveness.

Currently, the development of organizational capabilities focuses on issues such as innovation and service culture [40], giving way to the creation of collaborative work networks that lead to the generation of alliances, seen as a capability that reinforces the performance of the organization [41]. The development of capabilities is a process that is gradually generated and emerging in organizations [42].

To develop capabilities, organizations must consider aspects of the environment, among which there are those of social and environmental focus, which are technical and relational capabilities; the first ones influence the quality of the processes that are developed with a view to generating products and services, and the latter are aimed at creating links between the internal and / or external actors of the organization, in such a way that relations between them will be maintaining and strengthening, aspects that facilitate collaborative work [34].

Regarding the social factor that stands out in the relationships involved in the interaction of different actors in a group, it is necessary to avoid breaking into the social structure of the same, and should opt for the use of intergroup channels that facilitate the communication of its members [43], being the relational capability an essential element.

3.3.3. Identified capabilities that support AIS

Starting from recognizing that the capabilities result from a long-term investment planning process, focused on the basic competencies of the organization. This anticipated and focused investment approach is based on trajectory

dependencies that keep a company's capabilities growing cumulatively, which makes its learning trajectory especially difficult to imitate for the competition [61]. According to [62] organizational arrangements can profoundly affect the development of skills and cognition (or knowledge) that is an element that influences the research efforts undertaken in organizations.

In addition to the above, it is crucial to visualize the development of capabilities as an aspect important in adapting to change, in which the components of technology, marketing and management are of special value to generate expansion of organizations at the international level, as well as other capabilities such as: the generation of projects, political skills and skills for the formation of networks, as well as outsourcing processes. [46]

In environments where change is a key element and its adoption assumed as a capability [47], dynamic capabilities are identified [48], among which stand out organizational learning, reverse engineering and flexibility in manufacturing, the latter seen from practices associated with agriculture, such as production capabilities, which become necessary factors to be generated or reconfigured, in such a way as to guide organizations in the generation of emerging economies [49].

In addition, there are the technological capabilities, visualized as inputs that create a "synergistic effect on the performance" of organizations, which have special value [49].

In terms of technology, the change with respect to it influences the development of capabilities and in that sense the capability for evolution, the capability for transformation and the capability for substitution, represent ways to face these changes [50], highlighting the importance that implies the capability of evolution that is associated with incremental learning processes, which are based on the dynamic capabilities of an organization [51], thus allowing to adjust the technological change with a view to improving the competence through the ability of innovate.

However, it is found that innovation capabilities promote the development of technological capabilities, although they are influenced by the markets and policies promoted by the organization or even the region where they are developed, in addition to the cooperation work with other actors [52].

Another capability that becomes relevant within the context of emerging economies is the ability to undertake, since aspects such as competitiveness and environmental uncertainty, lead to the ability to adapt to changes in the environment, as well as; the appropriation of the organization's own routines (generated through experience), language and skills, which will generate organizational-level capabilities [47]. These same authors emphasize that the learning capability complements the capability of entrepreneurship, in the same way propose that the factors mentioned above, resources and experiences of organizations, are the drivers that conduct the development of capabilities.

Added to the above mentioned capabilities, and taking as a directing axis the AIS, other enabling capabilities have been found to generate results that favor their implementation in the regions, some of them are:

The capabilities of forecasting and replicating, to generate population subsistence, highlighted in the Bluelink marine project, in Australia [53], hint at the importance of incorporating into the AIS, actions aimed at adopting this type of capabilities in order to generate greater consistency in the objective of food security. Likewise, remote sensing capability contributes with models that impact ecosystems and climate [54]. In this regard, one could speak of strategy capability where flexibility and trust generated to interaction between actors in organizational synergy are essential factors [42] that drive their development.

In addition to the strategy capability, there are elements that support its development, such as; leadership, organizational culture, information technologies, long-term vision, community-networks [42], the environmental capabilities in the supply chains, which should be regulated by public policies [55].

The capability for integration among performers participating in an exchange of any nature (commercial, knowledge, etc.) involves the culture of both parties and the capability for learning, as well as communication and intermediaries [56], capability to manage innovation both in the market position and in the business model [57]. Innovation allows assimilation to change and, consequently, contributes to the sustainability of organizations, over time [57], in addition to this, risk and empowerment capabilities also influence this factor [58]. The capabilities of alliances between organizations, taking into account the experience and the routines thereof, which in turn will allow to evaluate the performance of the capabilities aforementioned [41].

4. Framework for CD in AIS

As a result of the content analysis of the 77 articles in the sample, the model reference framework for capability building in agricultural innovation systems emerges. The central point of this framework is the identified intersection between these two bodies of knowledge.

Both the CD and the AIS have been studied through linear approaches, however, currently, an increasing trend in the use of nonlinear approaches that are supported in the general theory of systems and in mixed research approaches is highlighted. Both bodies of knowledge address specific capabilities and converge around key points such as co-innovation, strategy, self-organization, adaptation, alliances and learning (see Fig. 3).

In reference to the AIS, three major areas can be differentiated in the mapped investigations: the networks, the agricultural innovation outputs and the capabilities associated with the performance of the system.

Making a parallel between the data resulting from the first part of this research work, and the results of capability development obtained in the second part, highlights the capabilities related to the performance of the AIS. The study of these capabilities is oriented towards the organizational level and its impact around the environmental, economic and productive dimensions, of STI, social and cultural, of regulation of policies and guidelines that adopt them as an input for the formulation of sustainability strategies and competitive advantage, as well as infrastructure focused on

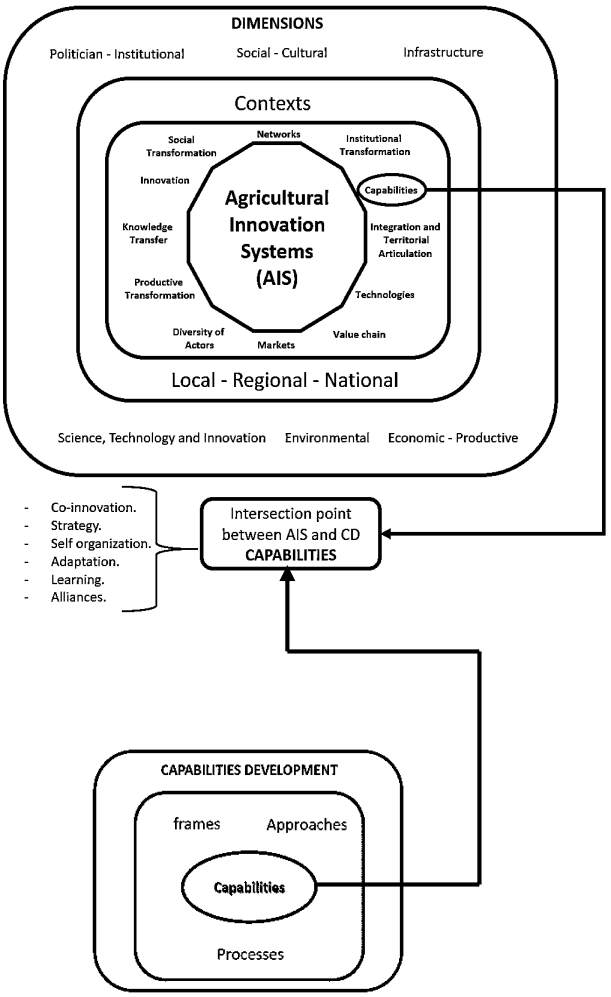

Figure 3. Capabilities in AIS.
Source: The Authors.

the use of ICT. However, the evolution of the system requires the development of new complementary capabilities and the strengthening of pre-existing ones.

Addressing the capabilities of a system based on interaction and interdependence, implies the appropriation of tools for networking, the effective generation of links between actors and collective actions, in a dynamic and complex environment. This capability for interaction enables learning based on new competences and skills that generate, as a result, an increase in the effectiveness of agricultural innovation within the AIS. The learning product of the interaction generates competences to innovate and is evident in new knowledge, practices and technologies transferred and appropriate by the actors of the AIS, and in certain cases, leads to the appropriation of resilience in the face of changes.

The capabilities within AIS, are addressed individually and collectively. The increase of the capabilities of the farmers is of special interest for the appropriation and implementation of practices that increase the productivity. Due to its central role within AIS, it is affirmed that the change within the institutional subsystem increases the system's ability to innovate.

In this aspect, based on the definition of AIS, and its orientation backed by elements of value that seek local, regional and national development, in different dimensions, contexts and cultures that frame the work of agriculture, it is glimpsed, both through of the observation about the system and the synergy among the actors that are part of the agro ecosystem, as well as the experimental and analytical literature, that there are factors of special relevance on which these strategies should be generated.

These identified factors are: social transformation, innovation, knowledge transfer, productive transformation, diversity of actors, markets, value chain (or supply), technologies, integration and territorial articulation, transformation institutional, capabilities and networks. Highlighting as an asset of vital interest, the capabilities and their development, since it has been found that the complementarity of these with existing resources in an organization or interest group, are the engine that allows the generation of initiatives that drive the sectors.

These initiatives lead to the formation of communities of practice or networks of actors, which through collaborative work generate great achievements and innovative advances in their sectors, supporting emerging economies. Added to this, the ICT are visualized as tools that support these tasks, among which the innovation platforms stand out.

The context of the internal market of emerging economy countries limits the generation of value-added products, due to restrictions in consumption capability. The alternative of the international markets is limited by the conditions agreed in the Bilateral or Multilateral Treaties, in this way the access to markets of high added value for agricultural products, which should generate a driving effect on agricultural innovation. This strategy has been effective in some cases, such as the planting of salmon in Chile [63]. For this reason, the combination of policies, effective networking and individual and collective capabilities for research and innovation through new technologies, constitutes an alternative to build agricultural innovation results, based on the improvement of the system's capabilities and of individuals and organizations.

5. Conclusions

The structure of the keyword networks in the field of agricultural innovation systems research reveals a close relationship with network analysis, aimed at assessing the impact of policies and adoption of technologies, mainly at the farm level. The institutional dominance of this type of sectoral innovation system stands out for its strong relationship with the development of agricultural extension services or systems. A subsequent discussion could focus on the evaluation of the advantages and weaknesses of a public versus a private extension service in the context of emerging economy countries. Studies focusing on Agricultural Innovation Systems analysis by authors from "developing countries" do not reach significant levels of citation and visibility. In that sense, a potential area of study is the examination of the approaches implemented, in order to increase the impact of subsequent studies in the area.

The institutional dominance of this type of sectoral innovation system stands out for its strong relationship with the development of agricultural extension services or systems. A subsequent discussion could focus on the evaluation of the advantages and weaknesses of a public versus a private extension service in the context of emerging economy countries. In the same sense, the network of keywords in the field of capacity development research stands out for its close relationship with the institutional approach and capacities at the organizational level. Interactions or links, both individual and collective, are identified as determining, because they constitute the basic input for the development of innovation systems and constitute the structure of collaborative networks. Agricultural innovation focused on crops, taking farmers as a point of reference, dominates the panorama of the units of analysis of agricultural innovation systems. Due to the central role of universities in the intermediation of knowledge, as well as their natural orientation to the co-creation of knowledge and the development of co-innovation, it is identified as a necessity to approach this intermediary role, through tools such as the analysis of social networks.

Although the two fields of research show an increasing trend in the number of publications per year, the field of AIS is still in the exploratory phase, while the development of capabilities is consolidated, associated with the analysis based on the theoretical body of the theory of capabilities and resources and with a shift towards the dynamic capabilities approach. The identified trends product of the content analysis, show a convergence of the two AIS and CD topics, towards a new approach framed as: systemic, dynamic and complex, that responds to the gaps generated by the linear analysis approach of innovation.

The intersection between the AIS and the CD, focuses on the capabilities that enable the results of agricultural innovation, represented by the capabilities for networking: strategy, collaboration, learning, adaptation, self-organization and co-innovation. The main limitations of the review are the emerging nature of the systemic approach to address agricultural innovation and the lack of empirical studies, mainly within agricultural innovation systems.

Future areas of research include the performance analysis of collaborative networks and the impact of networking within agricultural innovation systems, at regional level, through the use of computer science techniques such as social network analysis, or the forecasting of indicators of the AIS, through of machine learning techniques as supervised and unsupervised learning.

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