Research result article

DESARROLLO GERENCIAL

ISSN Online: 2145-5147

Factors driving open innovation in SMEs in the fruit and vegetable sector

Factores que impulsan la innovación abierta en PyMes del sector hortofrutícola

Tulio Silva-Castellanos
Universidad del Valle, Cali, Colombia.

Abstract

Objective: This empirical study evaluates how depth, exploitation, entrepreneurial orientation, and absorption capacity contribute to the formation of the open innovation construct in the context of small-and medium-sized enterprises (SMEs) in the fruit and vegetable sector. **Method:** The study is based on a sample of 102 SMEs from the fruit and vegetable sector in the northern region of Valle del Cauca (Colombia) and employs multivariate analysis through structural equation modeling. **Results:** The findings confirm a positive relation between entrepreneurial orientation and exploitation with open innovation, with the former having a stronger relation. Depth has a nonsignificant negative effect on open innovation. A relation between absorptive capacity and open innovation cannot be verified. **Conclusions:** These findings suggest that exploitation and entrepreneurial orientation are antecedents of open innovation in SMEs. Therefore, the strategies of the National Agricultural Innovation System should be aimed at strengthening these capacities to improve the conditions of the fruit and vegetable sector in Colombia. In addition, the literature indicates a scarcity of studies in this area of research
Keywords: Entrepreneurial Orientation, Exploitation, Fruit and Vegetable, Open Innovation, SMEs
JEL Classification: O32

Resumen

Objetivo: El presente estudio empírico evalúa cómo la profundidad, la explotación, la orientación emprendedora y la capacidad de absorción afectan la innovación abierta en el contexto de las PyMes del sector hortofrutícola. **Método:** se desarrolló basado en una muestra de 102 PyMes del sector hortofrutícola del Norte del Valle del Cauca (Colombia) y un análisis multivariante por medio de la modelización de ecuaciones estructurales. **Resultados:** los hallazgos confirman que existe una relación positiva de la orientación emprendedora y la explotación con la innovación abierta, la primera tiene una relación más fuerte. La profundidad tuvo un efecto negativo no significativo sobre la innovación abierta. No se pudo comprobar una relación entre la capacidad de absorción y la innovación abierta. **Conclusiones:** Estos hallazgos sugieren que la explotación y la orientación emprendedora son antecedentes de la innovación abierta en las PyMes, por ende, las estrategias del Sistema Nacional de Innovación Agrícola, debe estar orientado a fortalecer estas capacidades para que mejoren las condiciones del sector hortofrutícola en Colombia. Además, en la literatura se evidencia una escasez de estudios frente al campo de investigación.
Palabras clave: Explotación; Hortofrutícola; Innovación abierta, PyMes; Orientación emprendedora.
Clasificación JEL: O32

Author of Correspondence

tulio.silva@correounivalle.edu.co

Received: 08-12-2021
Accepted: 11-09-2021
Published: 12-17-2021

How to cite this article (Apa):
Silva-Castellanos, T. (2021). Factors driving open innovation in SMEs in the fruit and vegetable sector. *Desarrollo Gerencial*, 13(2), 1-29. https://doi.org/10.17081/dege.13.2.5503

Introduction

In his analysis of the Great Depression, Schumpeter (1934) concluded that the most effective strategy for surviving an economic downturn is for companies to provide forward guidance, using projections and estimates as benchmarks. Subsequently, Drucker (1985) claimed that the survival rates of companies in the post-war period were likely higher for those that incorporated innovation into their development. Thus, innovation helps companies overcome financial downturns and become far stronger than competitors who choose to cut costs or focus on improving internal efficiencies.

These are some of the concepts that emphasize the imperative nature of innovation, which is currently of greater interest to small- and medium-sized enterprises (SMEs). SMEs understand that, although they may be accustomed to a contingency approach, situations may arise where improvisation is impossible, putting the organization at serious risk of extinction, as seen in the current scenario generated by the COVID-19 pandemic.

Chesbrough's (2020) analysis suggests that open innovation should be particularly encouraged in the light of the pandemic. Chesbrough (2003) originally introduced the term *open innovation* and suggested that companies in the 21st century are more likely to succeed if they create collaborative relations with other organizations when seeking to innovate. This is because open innovation provides access to new knowledge, allowing for the development of strategies better suited to responding to turbulent environmental conditions.

Open innovation is defined as *the use of intentional knowledge inputs and outputs to accelerate innovation and expand markets* (Chesbrough, 2003). The open innovation model seeks to leverage key organizational networks and stakeholders, such as suppliers, customers, public and private research centers, institutions, universities, and even competitors, to improve innovation capabilities and thus internal and external competitiveness. In other words, rather than relying solely on their own innovative capabilities, as in the case of closed innovation, companies should engage with a variety of external parties in the business environment.

However, most research on open innovation has focused on large enterprises (Chesbrough, 2003). There is little research evidence that open innovation exists in smaller organizations, and the research is still in its infancy, particularly in SMEs within the fruit and vegetable produce industry. Moreover, there is no empirical evidence on the factors that influence SMEs in the fruit and vegetable sector to access external complementary knowledge to innovate (Van de Vrande et al., 2009). Thus, to make an efficient use of this externally accessible knowledge for innovation purposes, SMEs must be aware of the factors that can

promote open innovation. Hung and Chiang (2010) and Najar and Dhaouadi (2020) identified various constructs that facilitate or contribute to SMEs' propensity for open innovation, including entrepreneurial orientation.

Furthermore, Benhayoun et al. (2020) and Fertő and Tóth (2016) argued that SMEs need to develop absorptive capacity to ensure the success of their innovation strategies. Additionally, Sun et al. (2020) highlighted that the knowledge exploitation capacity of SMEs impacts open innovation. Specifically, within the context of the fruit and vegetable sector, Zakić et al. (2017) concluded that exploitation indeed influences open innovation. Finally, Wang et al. (2020) determined that the depth of external knowledge significantly affects a company's ability to derive benefits from open innovation, supporting the hypothesis underlying this research. Given the above, and to further explore the proposed case, it is crucial to investigate whether the theories of entrepreneurial orientation, absorptive capacity, depth, exploration, and open innovation are applicable to Colombian SMEs in the fruit and vegetable sector.

Therefore, this study analyzes these issues within the context of Valle del Cauca to better understand their influence and determine how they can be strategically directed. Consequently, the first part of this article introduces the theoretical foundation on which the study is based. The method is then explained, followed by a brief discussion of the results. Finally, the article outlines the main contributions, limitations, and potential future research directions.

Theoretical Foundation

Open innovation in SMEs

Initially, open innovation was primarily associated with multinationals and high-tech companies (Chesbrough, 2003). However, there is evidence that open innovation is increasingly being adopted by SMEs (Lyu et al., 2020). Chesbrough and Crowther (2006) concluded that company size is not a determining factor in the implementation of open innovation.

Small businesses often lack the resources to develop and market new products, which encourages them to collaborate with other organizations (Van de Vrande et al., 2009). Grama-Vigouroux et al. (2020) highlighted that one of the obstacles SMEs face when implementing open innovation processes is the lack of financial and human resources, which limits their ability to scan and monitor their environment for external partners. Thus, SMEs must primarily rely on their informal networks to identify the innovation resources they lack.

Implementing open innovation is, therefore, a challenging task for SMEs. While large organizations can conduct parallel innovation experiments and launch internal and external innovation efforts simultaneously, SMEs must optimize their limited resources by being open to external sources of innovation.

According to Usman and Vanhaverbeke (2017), research on open innovation in SMEs focuses on general topics such as the adoption, benefits, and challenges of open innovation, the role of networks, sectoral patterns, and the influence of policy creation. However, as Usman and Vanhaverbeke (2017) stated, most of this research is qualitative, with few quantitative studies available.

Oduro (2019) categorized the analysis of open innovation in SMEs into five key areas: the relation between the adoption of open innovation practices and company performance, factors hindering the adoption of open innovation, opportunities for improving organizational management through open innovation, the contribution of open innovation networks to the development of new products or service, and the relation between open innovation and the use of various forms of intellectual property rights, including inbound and outbound innovation.

Despite this, few studies have focused on the agricultural sector. Companies in this sector are increasingly seeking external sources of knowledge, indicating a growing interest in moving toward open innovation. These companies are now playing a key role in transforming the scientific landscape (Ahrolovich et al., 2020). The foundation for diversifying agricultural research is being laid through collaboration among agricultural research centers, key players in agricultural innovation systems, and open innovation management in agricultural SMEs.

According to Dranev et al. (2018), research in agriculture has often focused on thematic networks related to the distribution of agricultural segments in global value chains, the application of new industrial technologies across agricultural segments, the convergence of food production and the pharmaceutical industry, the popularity of multilevel innovation platforms in agricultural research for development, and agricultural innovation systems.

Carey et al. (2009) were among the first to study open innovation in the horticulture sector, finding that innovation is increasingly viewed as a co-creative process where key players along a value chain interact, collaborate, and coordinate their activities to generate new knowledge, technologies, and practices. Fertő and Tóth (2016) analyzed the innovation process in Hungary's agri-food sector using the open innovation concept.

Further supporting this perspective, Dranev et al. (2018) conducted an analysis of the scientific landscape and STI policies across different countries, shifting from a national to a more focused agricultural sector perspective. They concluded that agricultural productivity may be linked to the degree of research diversification. Other studies in the horticultural sector have focused on specific innovations, such as the genetic improvement of melons (Ahrolovich et al., 2020), blockchain (Borrero, 2019), and the Internet of Things, big data, and artificial intelligence (Misra et al., 2020).

As demonstrated, open innovation is not a static concept but rather a nuanced one that offers opportunities to enrich the concept, despite the complexities in configuring and understanding it, and even greater challenges in applying the theory. Therefore, it is essential to develop experiences in the appropriation and implementation of open innovation in the fruit and vegetable sector to meet existing needs. Despite the significant research attention the concept has received, few studies have examined the precursors to open innovation in SMEs.

Noteworthy among these are the findings of Fielke et al. (2018), who determined that entrepreneurial orientation influences how key players assign legitimacy to open innovation. Zakić et al. (2017) added that knowledge exploitation, whether internal or external, can drive open innovation. Fertő and Tóth (2016) examined the impact of open innovation and absorptive capacity on innovation performance. Frances and Fortuin (2009) considered its effect on open innovation in greater depth.

In light of this, this study proposes a formative measurement model that assumes depth, exploitation, entrepreneurial orientation, and absorptive capacity as causal indicators that form the construct of open innovation through linear combinations within the context of SMEs in the fruit and vegetable sector in northern Valle del Cauca.

Depth and open innovation in SMEs

To summarize the literature on the different forms of the open innovation model, Dahlander and Gann (2010) established a classification system based on the inbound or outbound orientation of the innovation process. According to their research, four types of openness can be identified: disclosure, acquisition, sale, and sourcing. Conceptually, disclosure refers to how internal resources are revealed to the external environment (Dahlander & Gann, 2010). Acquisition describes how companies market their inventions with other organizations. Sale involves acquiring inputs for the innovation process through the marketplace, such as through licensing and acquiring external expertise. Finally, sourcing refers to how companies use external sources of innovation.

The use of external sources of innovation has been linked in the literature to the concept of openness. (Laursen & Salter, 2006). A company's *openness* is characterized by two aspects: the number of external sources used (breadth) and the intensity with which these external sources are used (depth). This approach to opening up the innovation process is informal and does not necessarily require substantial capital expenditure; it is likely to be more successful among SMEs, (Van de Vrande et al., 2009).

Depth is defined as the extent to which companies draw on different external knowledge sources. It can be understood as the degree to which each partner cooperates (Laursen & Salter, 2006). Similarly, depth describes the intensity of the relationship with a limited set of external innovators when companies implement open innovation strategies in the innovation system (Lyu et al., 2020).

Intensive sourcing of ideas from a particular knowledge source requires companies to maintain strong and frequent contacts with that source (Chiang & Hung, 2010). As noted by Katila and Ahuja (2002), the more frequently a company uses knowledge, the more deeply it understands it. The relation facilitates knowledge transfer and helps SMEs innovate and adapt to change.

Although an in-depth search may involve a limited number of external sources of knowledge, this search may be particularly valuable, as organizations need to maintain ongoing interactions with their partners for each type of source (Laursen & Salter, 2006). From this perspective, it is essential to choose the most suitable institutions likely to generate reliable knowledge on an ongoing basis.

Depth is considered important for innovation in SMEs because it helps address the shortage of resources, skills, and knowledge while overcoming internal deficiencies. According to Ocasio (1997), SMEs need to focus their efforts and attention on a limited number of issues to achieve sustainable strategic performance. This means that they will struggle to maintain strong and frequent contacts with a large number of external sources for new ideas for innovation (Chiang & Hung, 2010). These arguments suggest that SMEs can only sustain strong and frequent contacts with a restricted and limited number of external sources.

Moreover, some researchers, such as Lu et al. (2020), indicated that over-reliance on external partners generates higher costs because maintaining strong bonds requires resources and attention. Furthermore, if a company relies too heavily on strong bonds, it may experience a decline in innovative performance. In line with the notion of the negative effects of excessive collaboration, authors such as Kobarg et al. (2019) acknowledged that depth is subject to the law of diminishing returns.

In addition, Laursen and Salter (2006) and Katila and Ahuja (2002) studied the relation between depth as a type of search and innovation, demonstrating the curvilinear causality of this variable. Laursen and Salter (2006) added that depth is positively correlated with innovative performance only up to a certain limit; beyond this tipping point, it can negatively impact innovation. The primary reasons for this include high costs associated with R&D and onerous contractual arrangements required to sustain long-term external relations.

Several studies have found different results regarding the relation between open innovation and depth in SMEs. Ferreras-Méndez et al. (2015) indicated no relation between depth and innovative and entrepreneurial performance, while Chiang and Hung (2010) observed depth-specific effects on incremental innovation performance.

More recently, studies such as those by Lyu et al. (2020) indicated that significant depth ensures accurate forecasting of a company's technological development in a rapidly changing environment. Capone and Innocenti (2020) claimed that depth, or the intensity of external network bonds, positively influences innovative performance. However, they agreed that after reaching a tipping point, this positive influence tends to decline, emphasizing the costs and challenges associated with open innovation practices.

A more comprehensive approach is presented by Wang et al. (2020), who posited that an ambidextrous knowledge strategy that addresses both the depth and breadth of external knowledge significantly influences a company's ability to reap the benefits of greater openness to external knowledge. Companies with greater depth enjoy a stronger positive relation at low to moderate levels of openness and a weaker negative relationship at high levels of openness.

Similarly, Kashosi et al. (2020) demonstrated that depth is directly and positively related to the innovation process in high-tech companies in developing countries, where reliance on external partners holds great importance, and companies tend to collaborate more with regular partners. Complementing this, Lu et al. (2020) investigated the relations between two types of open innovation strategies—breadth and depth—and the innovation performance of Chinese SMEs. Their results indicated that depth is positively related to the innovation performance of SMEs.

In the paper by Kobarg et al. (2019), it was observed that the incremental innovation performance of projects follows an inverted U-shaped relation with depth, but they did not find that depth influences radical innovation. However, Wang et al. (2019), in their study of high-tech companies in Taiwan, indicated that depth negatively affected innovation generation.

A similar pattern was observed in the study by González-Moreno et al. (2019), who explored the influence of open innovation on the adoption of eco-innovation by food and beverage companies in Spain. By contrast, the researchers indicated that depth does not influence any type of radical eco-innovation.

In Colombia, Ramos Ruiz et al. (2018) conducted a study among SMEs in the agribusiness sector. The authors stated that these companies develop sporadic internal innovation processes and interact very little with external agents, indicating that the benefits of open innovation activities in this context are not being efficiently exploited.

The main source of innovation in agricultural SMEs in Colombia is customers (Ramos Ruiz et al., 2018). The same applies to informal contacts with competitors. They can learn from their successes and failures to develop their own strategies through incremental innovation. For these SMEs, knowledge acquisition capacity considerably impacts the depth of relations with external agents for their innovation.

Their findings revealed that companies can be categorized based on their external knowledge-seeking strategy, ranging from limited collaboration with traditional partners to broad and deep openness with a wide range of external sources. Considering the foregoing and following the model of Laursen and Salter (2006), the following hypothesis is formulated:

Hypothesis 1: Depth positively influences open innovation.

Exploitation and open innovation in SMEs

Agri-food companies can benefit from open innovation practices only if they implement knowledge management capabilities. Exploitation is an organizational learning activity that expands existing knowledge and skills, improves established production processes, and increases efficiency. Accordingly, exploitative innovation is based on existing knowledge and strengthens existing processes and skill structures (Jansen et al., 2006).

The ability to explore existing knowledge is key for collecting, systematizing, categorizing, disseminating, and exploiting knowledge that may be generated based on external sources. Without this ability, it may not be possible to generate relevant knowledge from external knowledge. Exploitation involves adapting to existing environmental requirements and enhancing the company's adaptation to future environmental changes to stabilize the market (Sun et al., 2020). Therefore, exploitation is deemed as the concept of incremental innovation.

Some studies have determined that SMEs use various means to pursue innovation exploitation compared with larger firms, as is the case with Evald et al. (2020), who described the notion of exploitation as outgoing open innovation. From the relational perspective, exploitation is referred to as a collaborative strategy in which producers must collaborate with existing partners in the search for external knowledge (Chesbrough & Prencipe, 2008). Exploitation activities are conducted for pooling competencies across organizations to generate synergies shared among partners.

Overemphasizing current competencies often leads to a *success trap*, i.e., organizational inertia that prevents companies from adjusting to the changing environment, thereby causing long-term underperformance. According to Chen and Liu (2018), the exploitation of innovation involves improving existing knowledge, gaining advantages, and achieving efficiency. Regarding existing knowledge, producers will be motivated to seek more local and relevant knowledge and use existing resources in specific areas, which are the basis for exploiting innovation. Accordingly, the probability of success increases for manufacturers committed to exploiting innovation.

Exploitation in the world of micro-entrepreneurs in the fruit and vegetable sector needs to be contextualized. In this regard, Cillo et al. (2019) conducted a study to analyze the relation between knowledge management capabilities and open innovation within agri-food companies. The researchers found that the ability to exploit knowledge is an enabler of open innovation strategies. Furthermore, Sun et al. (2020) observed a significant positive relation between open innovation and knowledge exploitation. In line with these approaches, the aim is to assess whether exploitation activities (Mom et al., 2007) constitute a precedent for open innovation. Therefore, the following hypothesis is proposed:

Hypothesis 2: Producer exploitation activities positively influence open innovation.

Entrepreneurial orientation and open innovation in SMEs

Miller and Friesen (1982) noted three aspects of entrepreneurial orientation: a company's strategy to engage in innovations, high-risk entrepreneurship, and proactive opportunity seeking. Risk-taking implies a willingness to commit significant resources to exploit opportunities or engage in business strategies in which the outcome may be highly uncertain. Proactivity reflects the entrepreneurial will to dominate competitors and take action in anticipation of future changes. Innovation refers to a company's tendency to engage in creative and innovative processes.

Entrepreneurial orientation involves the processes, practices, and decision-making activities that lead to the creation of a new venture. Companies with high entrepreneurial orientation are more likely to adopt proactive and entrepreneurial processes. Furthermore, managers are more responsive and compatible with external technologies. A high entrepreneurial orientation can help adjust management models to accommodate external technological opportunities and benefit more effectively from their innovation activities.

Entrepreneurial orientation is neither created nor imposed by management but rather reflects a strategic stance (Hung & Chiang, 2010). Entrepreneurial SMEs tend to act autonomously, innovate, take risks, and be proactive when faced with opportunities. By contrast, the management style of conservative companies is risk-averse, noninnovative, and reactive.

Entrepreneurial orientation may be reflected in an open corporate culture or influenced by new cooperative relations focused on the external openness of knowledge. Therefore, the acquisition of new knowledge will affect a company's management style, innovation attitude, or risk appetite through internal knowledge sharing or external cooperation to promote innovation.

One of the earliest studies in the literature on entrepreneurial orientation and open innovation is by Hung and Chiang (2010). The authors found that entrepreneurial orientation is positively related to firm performance. Their most significant finding is that a company needs to have a high level of entrepreneurship to benefit from open innovation, i.e., open innovation strategy works better in environments with a high level of entrepreneurship.

Other researchers have also indicated a positive relation between entrepreneurial orientation and open innovation. Wu et al. (2013) revealed that companies can improve their entrepreneurial orientation if their open innovation is higher. This finding is consistent with that of Cheng and Huizingh (2014), who stated that entrepreneurial orientation is associated with proactive and entrepreneurial processes and that this creates a fertile environment for open innovation.

In their study on SMEs, Freixanet et al. (2020) revealed that entrepreneurial orientation affects innovation performance through open innovation. Nobakht et al. (2021) indicated that entrepreneurial orientation is related to risk tolerance, so this attitude can help overcome some barriers in achieving open innovation. Wahyuni and Sara (2020) gathered information from SME textile manufacturers in Indonesia. Their results revealed that entrepreneurial orientation positively impacts business performance through knowledge competence and innovation, as it gives SMEs the opportunity to outperform competitors.

Sarsah et al. (2020) conducted their research with 357 SMEs in Ghana and succeeded in proving that entrepreneurial orientation significantly affects SMEs, as they can introduce radically new operational processes, new technologies, and product uses, which are key activities in radical innovation.

Kim and Ahn (2020) investigated 389 SMEs in Korea and proved that organizational characteristics, such as an open innovation-friendly environment, organizational flexibility, and entrepreneurial orientation, positively affect open innovation activities.

This finding suggests that SME managers should prioritize improving the performance captured by entrepreneurial orientation to enhance the performance of open innovation activities. Along these lines, Najar and Dhaouadi (2020) proved the importance of the manager's entrepreneurial orientation in promoting innovation environment and open innovation strategies.

Specifically, research related to entrepreneurial orientation and open innovation in SMEs in the fruit and vegetable sector has been scarce. One of the studies in the literature is that by Ginting (2015), who noted that agribusiness entrepreneurs should improve innovation capacity through entrepreneurial orientation to add value and explore the global market. SMEs should be highly entrepreneurially oriented, i.e., they should be willing to take risks, be proactive, be independent, and be able to compete aggressively.

Ginting (2015) argued that agribusiness innovation networks are social and informal, often underpinned by friendship. He suggested that by adopting an entrepreneurial orientation, these networks may exhibit a greater commitment to learning, a shared vision, and open-mindedness, leading to a higher degree of strategic renewal and the consolidation of formal innovation networks. In this context and based on the framework of Hung and Chiang (2010), it can be posited that the entrepreneurial orientation of managers in SMEs within the horticultural sector is positively related to open innovation. Therefore, the following hypothesis is proposed:

Hypothesis 3: Entrepreneurial orientation positively influences open innovation.

Absorptive capacity and open innovation in SMEs

An essential part of the open innovation model is the effective integration of external or acquired knowledge and internal knowledge and routines, which depends on the absorptive capacity of an organization (Cohen & Levinthal, 1990). Absorptive capacity was initially refined by Cohen and Levinthal (1990) as a company's ability to recognize, identify, assimilate, transform, apply, and exploit new external information or knowledge.

Zahra and George (2002) broadened this theory by specifying four dimensions of a company's absorptive capacity: acquisition, assimilation, transformation, and exploitation. Acquisition reflects to an SME's ability to identify, explore, and access external knowledge. Assimilation refers to the analysis, interpretation, and integration of externally acquired knowledge with previous knowledge to assess its potential (Zahra & George, 2002), along with the communication skills needed to effectively disseminate new knowledge and extend learning throughout the company.

Application or exploitation represents the mechanisms that enable organizations to leverage existing skills and create new ones by incorporating acquired knowledge (Cohen & Levinthal, 1990). Therefore, application initially requires the internalization of new knowledge by combining it with an organization's previous knowledge to achieve a new integrative scheme (Cohen & Levinthal, 1990), i.e., transformation.

Cui et al. (2017) defined absorptive capacity as the ability to assimilate, acquire valuable external knowledge, transform this knowledge into a company's knowledge base, and exploit the new knowledge through innovation and apply new knowledge for business purposes (Cohen & Levinthal, 1990). Thus, the connection between open innovation and absorptive capacity is established.

The concept of absorptive capacity is nearly two decades old, and few studies have addressed its role in open innovation (Mubarak & Petraite, 2020). It is important to recognize that the results of open innovation can be unclear in case of a lack of absorptive capacity within organizations, even if the knowledge is acquired externally or created internally. Analogously, both sponges and sieves can *attract* liquids, but only sponges can retain them for later use (Mubarak & Petraite, 2020).

Flor et al. (2018) stated that some research works have revealed that the effectiveness of open innovation strategies can be increased by improving an SME's internal absorptive capacity processes. Thus, SMEs are increasingly becoming part of networks and systems that allow them to access valuable external knowledge from other players at the same time. Therefore, several authors have investigated the complementarity between absorptive capacity and effective management of external knowledge flows in open innovation systems.

In a study of Australian SMEs, Huang and Rice (2009) found that absorptive capacity negatively impacts short-term innovation performance. This result aligns with the finding of Cohen and Levinthal (1990) that absorptive capacity is *path-dependent* in nature. The authors indicated that it may take several years for innovation results to emerge from the investment in absorptive capacity. Spithoven et al. (2013) indicated that SMEs rely more on open innovation than large companies. Although large organizations engage in more open innovation activities, SMEs engage in all types of open innovation activities at significantly higher

intensities than large organizations. The authors further refuted the notion that large companies have greater absorptive capacity to acquire, assimilate, and integrate external knowledge. Najafi-Tavani et al. (2018) highlighted that in Iran's high- and medium-tech manufacturing industry, collaboration with external players per se does not guarantee an increase in these innovation capabilities. In fact, collaborative innovation networks enhance innovation capabilities only in the presence of absorptive capacity.

Benhayoun et al. (2020) proposed an operationalization of absorptive capacity adapted to the context of an SME embedded in collaborative innovation networks. The research highlighted that SMEs that pursue an open innovation strategy develop the absorptive capacity to achieve reciprocal and unidirectional learning. SMEs develop their capacity to acquire external knowledge to co-develop and commercialize an innovation with other players through their participation in collaborative innovation networks.

In summary, several scholars have argued that SMEs that can acquire new knowledge are better at capturing knowledge from external sources. Therefore, absorptive capacity may influence open innovation (Zahra & George 2002). Under these assumptions, the following hypothesis is proposed:

Hypothesis 4: Absorptive capacity positively influences open innovation.

Method

This study included data from SMEs in the fruit and vegetable sector located in the municipalities of northern Valle del Cauca, such as La Victoria (16%), La Unión (14%), Obando (10%), Toro (10%), and other municipalities (17%). Data were collected using a validated questionnaire based on a careful review of the literature. To avoid common methodological bias, the instrument was administered to SME owners and managers, the critical decision-makers in those companies.

To contact fruit and vegetable producers, it was necessary to collaborate with some members of the National Agricultural Innovation System (SNIA) (Aprocol, Asohofrucol, AGROSAVIA, ELIA, Cattleya, and Ministry of Agriculture and Rural Development). Aprocol and Asohofrucol conducted a pretest with 10 producers to validate the scales. Due to the COVID-19 pandemic, the questionnaire could not be administered in the field, so 90% of the companies completed it via telephone, and the rest did so online. In total, 152 companies participated in the study; however, 102 questionnaires were used.

Company size, company age, formalization, sales volume, and type of innovation performed were used as control variables. In addition, demographic data such as education, age, and gender were included. The results revealed that 76% of the producers were male. In terms of academic level, 38% of the population had a bachelor's degree, and 20% completed a primary education. Most farmers (33%) were aged between 42 and 52, and 30% were aged between 53 and 63.

Furthermore, 83.8% of SMEs belonged to an association, and 21% of the producers had a business license for their company. Regarding monthly sales, 70% sold less than 3 million pesos (41% had less than one million pesos, followed by 29% with sales between 1 and 3 million pesos). 82% of SMEs were more than 8 years old. More than half of the farmers had no regular employees, about 38% had between 1 and 3 hired employees. SMEs conducted activities related to open innovation, with 82.3% of them doing so in production processes. Finally, 88% of respondents were unaware of the SNIA, introduced by Law 1,876 of December 29, 2017.

None of these variables on the company and producer influenced the model or variables. Due to the context in which this study was conducted, a dichotomous control variable called *COVID-19 involvement* was used. This was because the pandemic could change producers' perception of open innovation. Studies by Benedek et al. (2020) on how COVID-19 has affected the agricultural sector, especially on issues of food safety, supply chains, and plantation labor shortages, were found in the literature.

The results indicated no impact of COVID-19 on any of the variables, but the questionnaire revealed that it affected 69% of the SMEs, with negative consequences, particularly in sales (45%) and income (39%), which were the most affected areas. This was linked to a significant decrease in customers (30%) and an increase in costs (28%). From the total sample, 11 were affected by transportation, marketing, logistics, a decrease in employees due to contagion, prices, and a decrease in work due to lack of mobility.

Results

PLS-SEM was employed to obtain the results because of its suitability for exploratory research, handling complexity, and effectiveness with small sample sizes (Hair et al., 2019). The first step in validating the model involved analyzing the reliability of each factor. The study introduced reflective constructs with factor loadings equal to or greater than 0.5, as proposed by Hair et al. (1998). Hair et al. (2019) noted that in exploratory studies within the social sciences, very weak factor loadings (< 0.7) have been observed. This finding suggests that if loadings fall between 0.4 and 0.7, the impact of the indicator should be analyzed before refining it, as it could affect the composite reliability of the construct.

Table 1. *Scale reliability análisis*

Scale reliability	Cronbach's alpha	rho_A	Composite Reliability Index	Variance average extracted (AVE)
Depth	0.84	0.77	0.85	0.46
Exploitation	0.76	0.80	0.84	0.51
Entrepreneurial Orientation	0.80	0.82	0.87	0.63
Absorption Capacity	0.91	0.91	0.93	0.65
Open innovation	0.71	0.75	0.81	0.46

Source: prepared by the author (2019).

The criteria of Fornell and Larcker (1981) and the heterotrait-monotrait ratio of correlation (HTMT) matrix were used to assess discriminant validity. According to Fornell and Larcker (1981), a construct has discriminant validity if its AVE is greater than the squared correlations between this construct and the others (Table 2).

In addition, Table 3 presents the heterotrait-monotrait ratio of correlations (Henseler et al., 2016) to better assess discriminant validity. Discriminant validity exists if the HTMT value exceeds 0.90. Under both criteria, discriminant validity was met. Similarly, the model exhibited an acceptable fit by meeting the SRMR indicator, which is a goodness-of-fit measure for PLS-SEM to avoid model misspecification. Although Hu and Bentler (1999) stated that the SRMR should be 0.08, they suggested in a more conservative approach that a value of less than 0.10 or 0.08 is acceptable. The SRMR for this study was 0.10.

Table 2. *Fornell and Lacker criteria*

Test	Absorption	Exploitation	Open innovation	O. Entrepreneur	Depth
Absorption	0.81				
Exploitation	0.59	0.71			
Open innovation	0.40	0.46	0.68		
O. Entrepreneur	0.51	0.51	0.45	0.79	
Depth	-0.06	-0.04	-0.17	0.09	0.68

Source: Prepared by the author (2019).

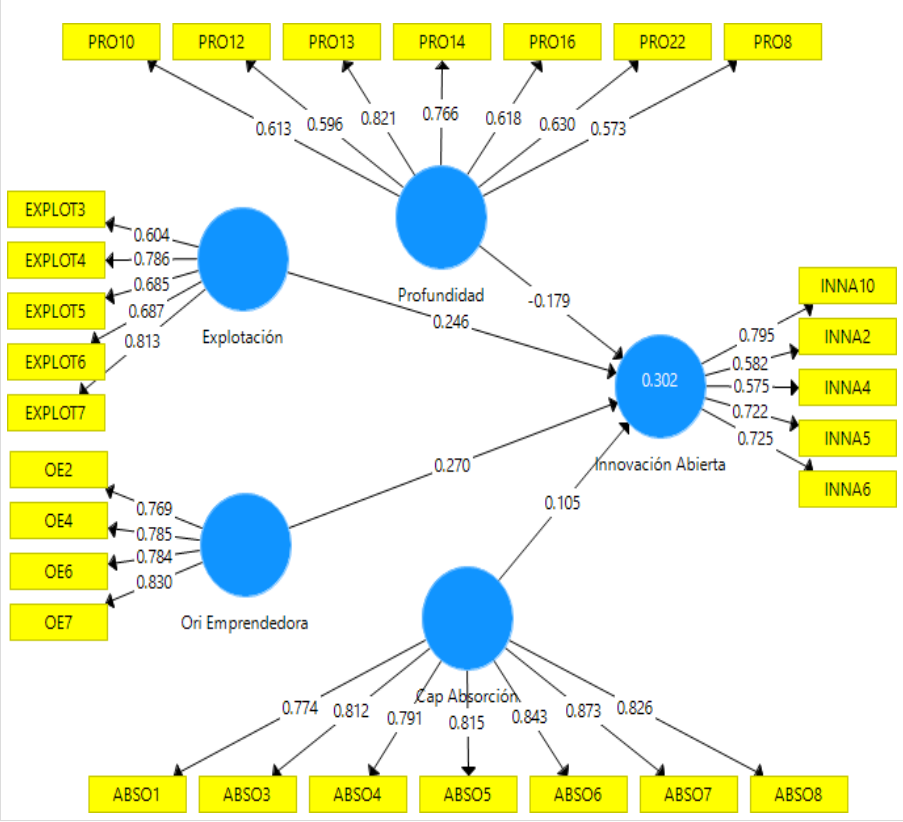
Table 3. *HTMT discriminant validity criteria*

	Absorption	Exploitation	Open innovation	O. Entrepreneur
Absorption				
Exploitation	0.68			
Innovation Open	0.49	0.60		
O. Entrepreneur	0.58	0.64	0.55	
Depth	0.17	0.15	0.23	0.19

Source: Prepared by the author (2019).

Once the validity and reliability of the reflective model had been demonstrated, the structural model was evaluated. The relations between variables were measured using the beta coefficient (β), which represents the strength of the relation. To determine the significance level, a t-test was performed using a bootstrapping process in SMART PLS.

Figure 1. *Model with t-values statistics*



Source: Prepared by the author (2019).

The following table presents the results obtained for the structural model.

Table 3. *Hypothesis testing*

Hypothesis	C/NC	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	2.5%	97.5%
Depth -> Innovation Open	NC	-0.179	-0.20	0.11	1.54	0.12	-0.38	0.13
Exploitation -> Innovation Open	C	0.246	0.26	0.10	2.37	0.01	0.06	0.47
O. Entrepreneur -> Open innovation	C	0.270	0.26	0.11	2.44	0.01	0.02	0.46
Absorption -> Open innovation	NC	0.105	0.10	0.11	0.97	0.40	-0.38	0.14

Note: *C = Confirmed; *NC = Not confirmed. Source: Prepared by the author (2019).

The correlation coefficient expresses the degree of linear dependence between two quantitative variables. The R2 was 0.302, indicating that the proposed model explains 30.2% of the phenomenon. At an exploratory level, this is considered valid, but it suggests the need for further study. The t and p values represent the level of significance for the hypothesis; in this case, a t value >1.96 and p value < 0.05 were considered significant, meaning that the hypothesis is acceptable.

In this study, positive and direct relations between the constructs of exploitation and entrepreneurial orientation toward open innovation, i.e., hypotheses 2 and 3, were tested. However, a positive relation between depth and open innovation could not be confirmed, so Hypothesis 1 was not supported. Furthermore, we did not observe a relation between absorptive capacity and open innovation because it was not statistically significant. Therefore, our empirical research did not support Hypothesis 4.

Discussions

The results obtained in the multivariate SEM confirmed that the factors positively influencing open innovation in SMEs in the fruits and vegetables sector were, in order, entrepreneurial orientation (t value of 2.44) and exploitation of innovation (t value of 2.37), both at a 5% significance level. In contrast, depth negatively affected open innovation, but the impact was not significant (t value of 1.54). The variable absorptive capacity (t value of 0.97) did not affect open innovation in SMEs in the fruit and vegetable sector.

Thus, Hypothesis 3 was supported, as entrepreneurial orientation was found to be a precedent of open innovation in SMEs in the fruit and vegetable sector. These results align with those of other researchers, such as Freixanet et al. (2020), who demonstrated that entrepreneurial orientation affects innovation

performance through open innovation. Similarly, Rakthai et al. (2019) observed that entrepreneurial orientation is positively related to network capability and the ability to innovate.

Entrepreneurial orientation is the tendency of an organization to adopt business processes and practices characterized by innovation, risk-taking, and proactivity. These dimensions reflect the willingness of SMEs in the fruit and vegetable sector to break away from established practices and venture into the unknown, particularly into open innovation. SMEs with a more open approach to innovation are exposed to various external technological opportunities, enabling them to complement their business model and create value.

According to Hung and Chiang (2010), companies with a high level of entrepreneurial orientation tend to constantly scan and monitor their environment to identify new opportunities that will strengthen their competitive position. As Ginting (2015) stated, agribusiness managers need to enhance their innovation capacity, which requires producers in the fruit and vegetable sector to exhibit strong entrepreneurial orientation—willingness to take risks, be proactive, innovative, independent, and compete assertively.

In addition, this research revealed that exploitation is a precedent of open innovation in horticultural SMEs, thus supporting Hypothesis 2. Zakić et al. (2017) indicated that exploitation influences open innovation. Cillo et al. (2019) demonstrated that the ability to exploit knowledge is an enabler of open innovation strategies within agri-food companies. The research revealed that exploitation influences open innovation because the fruit and vegetable sector orient its innovation strategy toward incremental process innovation.

According to the descriptive data, 82% of producers engaged in process innovation, focusing on updating methods and genetic improvements. Ramos Ruiz et al. (2018) and Ginting (2015) argued that firms in the agricultural sector rely on informal contacts with competitors and customers, engaging in incremental innovation by learning from the successes and failures of their peers and from customer feedback.

Producers in the fruit and vegetable sector are oriented toward exploiting innovation by expanding existing knowledge and skills, improving established production processes, and increasing efficiency (Jansen et al., 2006). These producers develop new products, services, designs, and processes based on already structured or developed frameworks. This exploitation process is conducted in collaboration with members of the SNIA, including Asohofrucol, AGROSAVIA, and SENA associations. As stated by Chesbrough and Prencipe (2008), exploitation involves a collaborative strategy where companies must work with existing partners in the search for external knowledge.

In the case of depth, the effect on open innovation was found to be insignificant, with a negative relation. Thus, it could not be established that depth benefits open innovation. These findings differ from those of Laursen and Salter (2006), who argued that greater depth enhances open innovation. This result is

understandable, as most SMEs report concerns in their innovation process, and undertaking open innovation likely depends on other factors (Triguero et al., 2018). Kashosi et al. (2020) demonstrated that depth is directly and positively related to the innovation process in a country, provided the environment fosters trust among external partners and the industry is high-tech.

Wang et al. (2019) indicated a negative effect of depth on innovation. According to the findings of Laursen and Salter (2006), companies with deep external knowledge acquisition do not use the specific knowledge resources and capabilities of external actors to innovate. Producers do not have extensive capacity to assimilate and integrate their existing knowledge and understand the knowledge possessed by external actors. The SMEs in the fruit and vegetable sector should begin with a low level of depth and gradually increase it in proportion to their investment in resources.

Conversely, Hypothesis 4 could not be tested because no significant relation was observed between absorptive capacity and open innovation. Spithoven et al. (2013) revealed that SMEs often lack the capacity to absorb external ideas and technologies, even when they have been initially identified and transferred. Before they can be effectively applied and approached, external ideas and technologies typically require prior knowledge, learning from experience, and significant modification.

For instance, most SMEs in the fruit and vegetable sector in Colombia do not have the resources and personnel with the necessary scientific training to understand, absorb, and apply the scientific discoveries and technologies developed in universities, research laboratories, or large companies. This limits their absorptive capacity. The research revealed that more than 70% of SMEs in the sector had revenues between 1 and 3 million pesos per month, which is a small amount to contemplate R&D activities. Furthermore, more than half of the producers (59%) of the SMEs did not have highly qualified workers that completed primary and secondary education levels. Thus, the processes of R&D and appropriation of external knowledge were affected.

It is not only about seeking and accessing external ideas and knowledge but also about being able to generate internally innovative results by combining external knowledge with the company's internal capabilities. Consequently, external knowledge does not benefit all companies equally, since a company's own resources and actions determine the extent to which it will be able to take advantage of it. It usually takes time and resources to transform routines into capabilities that incorporate absorptive capacity.

In addition, there is an implicit assumption that external knowledge is readily available for leveraging, but there is a limited understanding of the sourcing process needed to integrate it into the SME (Dahlander & Gann, 2010). The ability to exploit external knowledge is, therefore, a key element of innovative capabilities (Cohen & Levinthal, 1990). Despite its popularity, horticultural SMEs still struggle to manage open innovation appropriately (Vanhaverbeke et al., 2014).

Conversely, perhaps due to the informality of innovation networks in the fruit and vegetable sector (Ginting, 2015), SMEs are not in a position to scan and use external knowledge generated in collaborative innovation networks. A company with little capacity to absorb knowledge and technology will reduce its ability to learn from its partners, which may reduce its ability to innovate. A company's competitiveness is determined more by its external networks than by its size.

In summary, the research identified key factors influencing open innovation for developing competitive advantages in the fruit and vegetable sector in Valle de Cauca, Colombia. The aim was to generate public and managerial policy guidelines to improve competitiveness and sectoral growth through better integration with the productive sector. In addition, the study highlights the need for employing methodological strategies tailored to the specific characteristics of different sectors and regions, as part of a broader SNIA, as stated by Limas-Suárez (2020). Measures must be devised to improve the innovation capacity of companies to strengthen Colombia's position.

Despite the findings, the analysis provided here still offers many avenues for future research. There is a clear need to better understand open innovation in the sector, which should be addressed through quantitative studies and more empirical research in other regions of the country with a strong fruit and vegetable vocation, significant export activity, and large plantation areas. Cultural variables may also be included in the research model.

In this study, entrepreneurial orientation is treated as a unidimensional construct. Some researchers have argued that this variable actually derives from three dimensions: innovativeness, reactiveness, and risk-taking. Future studies may discuss how the three constructs independently affect the relation with open innovation. The dimensionality of entrepreneurial orientation is specific to developing countries. Future studies may explore the appropriate dimensionality of the variable for developing countries specifically.

Similarly, absorptive capacity has been validated as a single dimension. Future research could benefit from expanding the variable to include the dimensions proposed by Zahra and George (2002): acquisition, assimilation, transformation, and exploitation. This approach may provide insights into which dimension most significantly explains absorptive capacity in the fruit and vegetable sector. One of the most pressing issues is the study of intellectual property rights. Entrepreneurs in the horticulture industry often need to disclose their ideas well before securing intellectual property protection, which increases the risk of idea theft due to the necessity of making potentially valuable information public.

More research is needed to better understand how companies can successfully work with open innovation in a way that allows them to leverage their existing capabilities while simultaneously exploring fundamentally new competencies. In addition, it is necessary to deepen research on open innovation in SMEs and its relation with the propensity to export to get more clarity on what these relations are like in terms of how they are formalized and organized. It may also be important to study the type of innovation generated and the benefits companies get when engaging in open innovation activities (Thompson & Zang, 2020).

Conclusions

Finally, the results suggest that SME producers in the fruit and vegetable sector should focus on accessing and acquiring external knowledge to enrich their internal research activities. In addition, they serve as a reminder to managers that in their search for external knowledge, their actions should be guided by a sense of proactivity, risk-taking, and innovation. Once managers identify suitable external opportunities, they should actively integrate them into their company's business model to reap the benefits of their open innovation activities.

Open innovation, which involves merging external opportunities with the company's business model, helps producers find ways to effectively engage with valuable opportunities, preventing them from pursuing high-risk projects. Entrepreneurial orientation and open innovation are complementary strategic approaches that should be pursued simultaneously. Moreover, to facilitate open innovation, managers should organize their SMEs in ways that best suit entrepreneurial orientation; they should stay ahead of competitors by introducing new products or ideas.

SMEs in the fruit and vegetable sector should focus on exploiting knowledge, enabling them to achieve open innovation without requiring significant resources in innovation. Agribusiness SMEs in Colombia are characterized by limited R&D activity and the adoption of incremental innovations, which allows them to make improvements, introduce new technologies, and achieve results in the short term.

The data suggest that many SMEs benefit from their own initiatives and the knowledge acquired from producers. This allows them to adapt to existing environmental requirements and positions them to adapt to future environmental changes, thereby gaining market stability. Exploitation refers to the transfer of external knowledge, for example, through alliances or technology licenses. Therefore, those involved in the SNIA should work to transfer this technology, and manufacturers should implement strategies that help to appropriate it.

With regard to the results on depth, we suggest that producers in the fruit and vegetable sector should learn from external sources or partners; this is inevitable if SMEs want to acquire knowledge and develop their skills. It is often the case that SMEs have to go through a period of trial and error to learn how to obtain knowledge from an external source. It takes significant effort and time to develop an understanding of the rules, habits, and routines of various external knowledge channels.

One clear finding from the research is that many open innovation processes are not taking place in the fruit and vegetable sector because the impact of absorptive capacity on open innovation cannot be tested. When absorptive capacity is insufficient to encourage innovators to take risks, some companies may abandon the open innovation strategy and become more conservative and closed. The concept of open innovation emphasizes leveraging external knowledge. However, the presence of valuable external knowledge sources does not mean that the flow of new external ideas and knowledge into companies is automatic or easy.

Furthermore, the study reveals a general need for the consolidation of SNIA for SMEs in the fruit and vegetable sector to be able to carry out open innovation processes. If they do not find themselves in an ecosystem that helps them overcome the asymmetries of information and the costs of research and development, then this process will not be successful. In conclusion, this research confirms that the shift to an open innovation paradigm allows companies in the fruit and vegetable sector to reduce their need for innovation-related capital investment, making business innovation more accessible to these companies.

References

Ahrolovich, R. N., Madiyarovich, S. S., & Urinbaevana, M. H. (2020). Melon and its Environmental Characteristics. *Journal of Critical Reviews, 7*(2), 480-490. DOI: 10.31838/jcr.07.02.91.

Benhayoun, L., Le Dain, M. A., Dominguez-Péry, C., & Lyons, A. C. (2020). SMEs embedded in collaborative innovation networks: How to measure their absorptive capacity?. Technological Forecasting and Social Change, 159, 120-196. DOI: 10.1016/j.techfore.2020.120196.

Benedek, Z., Balogh, P. G., Baráth, L., Fertő, I., Lajos, V., Orbán, É., ... & Nemes, G. (2020). The Kings of the Corona Crisis: The Impact of the outbreak of Covid-19 on Small-scale Producers in Hungary. *EuroChoices, 19*(3), 53-59. https://doi.org/10.1111/1746-692X.12292

Borrero, J. D. (2019). Sistema de trazabilidad de la cadena de suministro agroalimentario para cooperativas de frutas y hortalizas basado en la tecnología Blockchain. CIRIEC-España Rev. Econ. Pública Soc. y Coop, 71-94. DOI: 10.7203/CIRIEC-E.95.13123.

Capone, F., & Innocenti, N. (2020). Open innovation and network dynamics. An analysis of openness of co-patenting collaborations in Florence, Italy. Competitiveness Review: An International Business Journal. DOI: 10.1108/CR-10-2019-0101.

Carey, E. E., Jett, L., Lamont, W. J., Nennich, T. T., Orzolek, M. D., & Williams, K. A. (2009). Horticultural crop production in high tunnels in the United States: A snapshot. *HortTechnology, 19*(1), 37-43. DOI: 10.21273/HORTSCI.19.1.37.

Chen, Q., & Liu, Z. (2018). How does openness to innovation drive organizational ambidexterity? The mediating role of organizational learning goal orientation. *IEEE Transactions on Engineering Management, 66*(2), 156-169. DOI: 10.1109/TEM.2018.2834505.

Cheng, C. C., & Huizingh, E. K. (2014). When is open innovation beneficial? The role of strategic orientation. *Journal of product innovation management, 31*(6), 1235-1253. DOI: 10.1111/jpim.12148.

Chesbrough, H. (2020). To recover faster from Covid-19, open up: Managerial implications from an open innovation perspective. *Industrial Marketing Management*, 88, 410-413. DOI: 10.1111/jpim.12148.

Chesbrough, H. W., & Vanhaverbeke, W. (2018). Open innovation and Public Policy in the EU with Implications for SMEs. *Researching Open Innovation in SMEs*, 455-492. DOI: 10.1142/9789813230972_0015.

Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: early adopters of open innovation in other industries. *R&d Management, 36*(3), 229-236. DOI: 10.1111/j.1467-9310.2006.00428.x.

Chesbrough, H., & Prencipe, A. (2008). Networks of innovation and modularity: a dynamic perspective. *International Journal of Technology Management, 42*(4), 414-425. DOI: 10.1504/IJTM.2008.019383.

Chesbrough, H.W. (2003). The Era of Open Innovation. *Sloan Management Review, 44*(3), 35-41.

Chiang, Y. H., & Hung, K. P. (2010). Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. *R&d Management, 40*(3), 292-299. DOI: 10.1111/j.1467-9310.2010.00588.x.

Cillo, V., Rialti, R., Bertoldi, B., & Ciampi, F. (2019). Knowledge management and open innovation in agri-food crowdfunding. *British Food Journal*. DOI: 10.1108/BFJ-07-2018-0472.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation". Administrative Science Quarterly, Vol. 35 No. 1, pp. 128-152. DOI: 10.2307/2393553.

Cui, T., Wu, Y., & Tong, Y. (2017). Exploring ideation and implementation openness in open innovation projects: IT-enabled absorptive capacity perspective. *Information & Management.* DOI: 10.1016/j.im.2017.12.002.

Dahlander, L., & Gann, D. M. (2010). How open is innovation?. *Research policy, 39*(6), 699-709. DOI: 10.1016/j.respol.2010.01.013.

Dranev, Y., Kotsemir, M., & Syomin, B. (2018). Diversity of research publications: relation to agricultural productivity and possible implications for STI policy. *Scientometrics, 116*(3), 1565-1587. DOI: 10.1007/s11192-018-2799-2.

Drucker, P. F. (1985). Entrepreneurial strategies. *California Management Review* (pre-1986), 27(000002).

Evald, M. R., Clarke, A. H., & Boyd, B. (2020). An Open Innovation Project Typology of Exploration and Exploitation: Managerial Implications and Empirical Applications. *Journal of the Knowledge Economy*, 1-16. DOI: 10.1007/s13132-020-00642-4.

Ferreras-Méndez, J. L., Newell, S., Fernández-Mesa, A., & Alegre, J. (2015). Depth and breadth of external knowledge search and performance: The mediating role of absorptive capacity. *Industrial Marketing Management*, 47, 86-97. DOI: 10.1016/j.indmarman.2015.02.038.

Frances y Fortuin (2009). Innovation drivers and barriers in food processing. *British food journal, 111*(8), 839-851. DOI: 10.1108/00070700910980955.

Fertő, I., Molnar, A., & Toth, J. (2016). Borderless ideas-open innovation in the Hungarian food chain. *British Food Journal, 118*(6), 1494-1515. DOI: 10.1108/BFJ-10-2015-0399.

Fielke, S. J., Botha, N., Reid, J., Gray, D., Blackett, P., Park, N., & Williams, T. (2018). Lessons for co-innovation in agricultural innovation systems: a multiple case study analysis and a conceptual model. The Journal of Agricultural Education and Extension, 24(1), 9-27. DOI: 10.1080/1389224X.2017.1394885.

Fornell, C. nd Lacker, DF (1981). Structural equation models with unobservable variables and measurement error: Algebra and Statistics. *Journal of marketing research*, 382-388. DOI: 10.2307/3150980.

Freixanet, J., Braojos, J., Rialp-Criado, A., & Rialp-Criado, J. (2020). Does international entrepreneurial orientation foster innovation performance? The mediating role of social media and open innovation. *The International Journal of Entrepreneurship and Innovation*, 1465750320922320. DOI: 10.1177/1465750320922320.

Ginting, G. (2015). Open innovation model: empowering entrepreneurial orientation and utilizing network resources as determinant for internationalization performance of small medium agroindustry. *Agriculture and Agricultural Science Procedia*, 3, 56-61. DOI: 10.1016/j.aaspro.2015.01.013.

González-Moreno, Á., Triguero, Á., & Sáez-Martínez, F. J. (2019). Many or trusted partners for eco-innovation? The influence of breadth and depth of firms' knowledge network in the food sector. *Technological Forecasting and Social Change*, 147, 51-62. DOI: 10.1016/j.techfore.2019.06.011.

Grama-Vigouroux, S., Saidi, S., Berthinier-Poncet, A., Vanhaverbeke, W., & Madanamoothoo, A. (2020). From closed to open: A comparative stakeholder approach for developing open innovation activities in SMEs. *Journal of Business Research*, 119, 230-244. DOI: 10.1016/j.jbusres.2019.08.016.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Castillo Apraiz, J., Cepeda Carrión, G., & Roldán, J. L. (2019). Manual de partial least squares structural equation modeling (pls-sem). *OmniaScience Scholar.* DOI: 10.3926/oss.37

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (1998). *Multivariate data analysis* (Vol. 5, No. 3, pp. 207-219). Upper Saddle River, NJ: Prentice hall.

Huang, F., & Rice, J. (2009). The role of absorptive capacity in facilitating" Open innovation" outcomes: A study of Australian SMEs in the manufacturing sector. *International Journal of Innovation Management, 13*(02), 201-220. DOI: 10.1142/S1363919609002261.

Hung, K. P., & Chiang, Y. H. (2010). Open innovation proclivity, entrepreneurial orientation, and perceived firm performance. *International Journal of Technology Management, 52*(3/4), 257-274. DOI: 10.1504/IJTM.2010.035976.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal, 6*(1), 1-55. doi.org/10.1080/10705519909540118

Limas-Suárez, S. (2020). El panorama actual de la innovación: un análisis en empresas colombianas altamente innovadoras. *Desarrollo Gerencial, 12*(2), 1-24. https://doi.org/10.17081/dege.12.2.3970

Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management science, 52*(11), 1661-1674. DOI: 10.1287/mnsc.1060.0576.

Kashosi, G. D., Wu, Y., Getele, G. K., Bianca, E. M., & Irakoze, E. (2020). The Role of Absorptive Capacity and Firm Openness Strategies on Innovation Performance. *Information Resources Management Journal (IRMJ), 33*(4), 1-16. DOI: 10.4018/IRMJ.2020100101.

Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and new product introduction. *Academy of management journal, 45*(6), 1183-1194. DOI: 10.2307/3069433.

Kim, N. K., & Ahn, J. M. (2020). What facilitates external knowledge utilisation in SMEs?–An optimal configuration between openness intensity and organisational moderators. *Industry and Innovation, 27*(3), 210-234. DOI: 10.1080/13662716.2019.1632694.

Kobarg, S., Stumpf-Wollersheim, J., & Welpe, I. M. (2019). More is not always better: Effects of collaboration breadth and depth on radical and incremental innovation performance at the project level. *Research Policy, 48*(1), 1-10. DOI: 10.1016/j.respol.2018.07.014.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. Strategic management journal, 27(2), 131-150. DOI: 10.1002/smj.507.

Lyu, Y., Zhu, Y., Han, S., He, B., & Bao, L. (2020). Open innovation and innovation" Radicalness"—the moderating effect of network embeddedness. *Technology in Society*, 62, 101292. DOI: 10.1016/j.techsoc.2020.101292.

Miller, D., & Friesen, P. H. (1982). Innovation in conservative and entrepreneurial firms: Two models of strategic momentum. *Strategic management journal, 3*(1), 1-25. DOI: 10.1002/smj.4250030102.

Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., & Martynenko, A. (2020). IoT, big data and artificial intelligence in agriculture and food industry. *IEEE Internet of Things Journal.* DOI: 10.1109/jiot.2020.2998584.

Mubarak, M. F., & Petraite, M. (2020). Industry 4.0 technologies, digital trust and technological orientation: What matters in open innovation?. *Technological Forecasting and Social Change*, 161, 120332. DOI: 10.1016/j.techfore.2020.120332.

Najafi-Tavani, S., Najafi-Tavani, Z., Naudé, P., Oghazi, P., & Zeynaloo, E. (2018). How collaborative innovation networks affect new product performance: Product innovation capability, process innovation capability, and absorptive capacity. *Industrial marketing management*, 73, 193-205. DOI: 10.1016/j.indmarman.2018.02.009.

Najar, T., & Dhaouadi, K. (2020). Chief Executive Officer's traits and open innovation in small and medium enterprises: the mediating role of innovation climate. *Journal of Small Business and Enterprise Development*. DOI: 10.1108/jsbed-04-2020-0109.

Nobakht, M., Hejazi, S. R., Akbari, M., & Sakhdari, K. (2021). Exploring the relationship between open innovation and organisational ambidexterity: the moderating effect of entrepreneurial orientation. *Innovation, 23*(1), 71-92. DOI: 10.1080/14479338.2020.1758566.

Ocasio, W. (1997). Towards an attention-based view of the firm. *Strategic management journal, 18*(S1), 187-206. DOI: 10.1002/(SICI)1097-0266(199707)18:1+<187::AID-SMJ936>3.0.CO;2-K.

Oduro, S. (2019). Examining open innovation practices in low-tech SMEs: insights from an emerging market. *Journal of Science and Technology Policy Management*. DOI: 10.1108/JSTPM-03-2019-0036.

Rakthai, T., Aujirapongpan, S., & Suanpong, K. (2019). Innovative capacity and the performance of businesses incubated in university incubator Units: Empirical study from universities in Thailand. *Journal of Open Innovation: Technology, Market, and Complexity, 5*(2), 33. DOI: 10.3390/joitmc5020033.

Ramos Ruiz, J. L., Polo Otero, J. L., Arrieta Barcasnegras, A. A., & Vélez Durán, L. F. (2018). Determinantes del grado de apertura de las pymes agroindustriales: una aplicación para el departamento del Atlántico. *Revista Desarrollo y Sociedad*, (80), 189-229. DOI: 10.13043/dys.80.6.

Sarsah, S. A., Tian, H., Dogbe, C. S. K., Bamfo, B. A., & Pomegbe, W. W. K. (2020). Effect of entrepreneurial orientation on radical innovation performance among manufacturing SMEs: the mediating role of absorptive capacity. *Journal of Strategy and Management*. DOI: 10.1108/JSMA-03-2020-0053.

Schumpeter, J. (1934). *The Theory of Economic Development*. Harvard University Press. Boston. MA.

Spithoven, A., Vanhaverbeke, W., & Roijakkers, N. (2013). Open innovation practices in SMEs and large enterprises. *Small business economics, 41*(3), 537-562. DOI: 10.1007/s11187-012-9453-9.

Sun, Y., Liu, J., & Ding, Y. (2020). Analysis of the relationship between open innovation, knowledge management capability and dual innovation. *Technology Analysis & Strategic Management, 32*(1), 15-28. DOI: 10.1080/09537325.2019.1632431.

Thompson, P., & Zang, W. (2020). The impact of foreign influence on exporting through open innovation. *Growth and Change, 51*(1), 256-277. DOI: 10.1111/grow.12349.

Triguero, A., Fernández, S., & Sáez-Martinez, F. J. (2018). Inbound open innovative strategies and eco-innovation in the Spanish food and beverage industry. *Sustainable Production and consumption*, 15, 49-64. DOI: 10.1016/j.spc.2018.04.002.

Usman, M., & Vanhaverbeke, W. (2017). How start-ups successfully organize and manage open innovation with large companies. *European Journal of Innovation Management*. DOI: 10.1108/EJIM-07-2016-0066.

Van de Vrande, V., De Jong, J. P., Vanhaverbeke, W., & De Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation, 29(*6-7), 423-437. DOI: 10.1016/j.technovation.2008.10.001.

Wahyuni, N. M., & Sara, I. M. (2020). The effect of entrepreneurial orientation variables on business performance in the SME industry context. *Journal of Workplace Learning*. DOI: 10.1108/JWL-03-2019-0033.

Wang, C., Chen, M. N., & Chang, C. H. (2019). The double-edged effect of knowledge search on innovation generations. *European Journal of Innovation Management*. DOI: 10.1108/EJIM-04-2018-0072.

Wang, C., Chin, T., & Lin, J. H. (2020). Openness and firm innovation performance: the moderating effect of ambidextrous knowledge search strategy. *Journal of Knowledge Management*. DOI: 10.1108/JKM-04-2019-0198.