Green Technologies and their Effects on Agribusiness Performance in Mexico

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Abstract

Agriculture is considered an essential activity, insofar as it guarantees the food satisfaction of present and future generations, which represents a growth opportunity for agribusiness, whose strategic activity is integrated by agriculture and the transformation of inputs into finished products. The objective of the research is to identify if the use of green technologies affects the performance of the agribusiness sector in Mexico. The research is mixed and correlational. The research results show that agribusiness uses green technologies that minimize its consumption of energy, water, waste and toxic emissions, which were shown to have significant effects on its performance. However, the industry shows a lag in other border technologies such as nanotechnology, biotechnology and bioinformatics, due the high investment that these technologies represent for the sector, whose main structure is characterized by the small and medium size enterprises (SMEs).

Keywords
Green Technologies, Sustainability, Agribusiness Sector.

1. Introduction
As of the 1990s, concern was raised over the deterioration of the environment and its planetary effects, associated with the environmental and food crisis facing humanity. Causes that have influenced the need to include sustainability in the economic model as a route to achieve sustainable development in which companies, society and government assume their commitment to caring for the environment (FAO, 2018).

One of the activities that has been affected by the environmental crisis is agriculture, due to the contamination of water by nitrates, the use of pesticides and fertilizers with chemical components, greenhouse gas emissions, soil erosion, loss of biodiversity, among others. The persistent and high levels of hunger and malnutrition, the increase in human activities on land capacity represent a challenge for agriculture, aggravated by the continued growth of the world's population (Kirchmann & Thorvaldsson, 2000). To meet the growing demand for food from the more than 9 billion people that will populate the planet in 2050 (FAO, 2018), it will be necessary to increase food production. The antipode is that around one third of the food produced is wasted worldwide throughout the supply chain, representing economic and environmental costs.

Under this context, agribusiness has business opportunities considering sustainability as a way to improve and make its processes more efficient through strategies based on technological change and innovation. Specifically, through the use of properly implemented green technologies, they will contribute to guaranteeing the satisfaction of the needs of future generations and will improve the organization's performance by reducing environmental deterioration and minimizing the consumption of natural resources. This paper is organized as follows; in the following section, the literature review is developed (Relationship between Agribusiness and Sustainable Development) and (Innovation as a Tool to Improve Performance in Agribusiness). Second, methodology is introduced. Third, Analysis and discussion are presented. Finally, the theoretical and applied contribution of this research is provided.

2. Literature Review

2.1 The Relationship between Agribusiness and Sustainable Development

Climate change is expected to affect developing countries to a greater extent; its effects such as high temperatures, changes in rainfall regime, sea level rise and natural disasters related to climate represent risks for agriculture, food and water supply. In this sense, solutions are sought to reduce poverty, hunger and livelihood of billions of people worldwide (World Bank, 2015).

According to a World Bank report (2018), called Shock Waves: Managing the Impacts of Climate Change on Poverty, it indicates that poor people have a high risk of suffering climate-related consequences, the loss of crops due to lower rainfall, increases in food prices after extreme weather events and a higher incidence of diseases after heat waves and floods. The models suggest that climate change could cause losses in global yields from crops, which could be as high as 5% before 2030 and 30% before 2080.

The previous problem raises the need to approach the agricultural sector from a sustainable perspective, that is, that the analysis of agriculture considers the social, economic and environmental aspects to guarantee the satisfaction of the needs of present and future generations. However, agriculture not only suffers from the effects of climate change, but is also responsible for 14% of global greenhouse gas emissions. But agriculture has the potential to be an important part of the solution, through the mitigation, reduction and elimination of a significant amount of global emissions. Around 70% of this mitigation potential could be carried out in developing countries (FAO, 2018).

In this context, a more productive and resilient agriculture will require better management of natural resources: land, water, soil, fertilizers, among others. The literature indicates that there are different expressions that incorporate sustainability in agriculture such as eco-agriculture, organic farming, organic biodynamics, among others (Clements & Shrestha, 2004); (Conway, 1997); (Cox, Picone, & Jackson, 2004); (McNeely & Scherr, 2003); (NRC, 2000); (Pretty, 1995).

Students of the subject report that there are perspectives of a constant growth in the demand for food and agricultural products, which represents an opportunity for agribusiness. It should be noted that this sector includes both the harvest and subsequent activities related to the transformation, preservation and preparation of agricultural production for intermediate or final consumption; Agribusiness is considered a mediating element between food production and the final consumer (Barrett, Barbier, & Reardon, 2001); (Spencer & Cranfield, 2013); (Wilkinson & Rocha, 2009).

The 2008 World Forum on Agribusiness (WFA), organized by the UN, indicates that this sector represents up to 50% of the industrial sector in low-income countries. Similarly, he points out that the contribution of agribusiness to the total industry is 61% in agriculture-based countries, 42% in developing countries and 37% in urbanized developing countries.

It should be noted that from the year 2000, technological advances are observed at a general level, specifically, in information and communication technologies and, in the agribusiness sector, in primary production, for example, the application of biotechnology and sectors manufacturers as new processing methods (Da Silva, Backer, Shepherd, Chakib, & Miranda, 2013).

These technological advances have contributed to the creation of new unprecedented opportunities for agribusiness in terms of product and process innovations, vertical and horizontal links in supply chains, operation of distribution systems, among others. However, it also increases the fear that the sector may be left behind if they are not able to access these technologies in a timely and effective manner. As far as global agribusiness has a growth trend, as long as the primary activity that supplies this sector is supported, since the food crisis provides for an increase in the demand for food. Likewise, developing countries are in search of solutions to promote both agriculture and activities related to the transformation of agricultural-derived goods, so that future generations have the capacity to meet their needs.

2.2 Innovation as a Tool to Improve Performance in Agribusiness

Agribusiness requires innovations that allow it to make its production processes more efficient while protecting the environment, in order to obtain economic, social benefits and improve its processes and/or products through innovation. Escorsa and Valls (2003), define innovation as "an idea transformed into something sold or used". Meanwhile, Sherman Gee (1981) states that "innovation is the process in which, from an idea, invention or recognition of a need, a useful product, technique or service is developed until it is commercially accepted."

Shumpeter's theory tends to identify innovation as market experiments and to look for changes that cause a restructuring in productive sectors and in the market itself. In this sense, innovation is considered one of the aspects to consider in the strategies of any sector (Sutton, 1998). Other theories point out the importance of considering historical costs, that is, committed and unrecoverable resources to enter new markets or to create a competitive advantage by repositioning the value chain of production or products (Sutton, 1992).

While Tirole (1995), highlights the importance of positioning with respect to the competition and points out that innovation is required to defend its position in the market, as well as to obtain competitive advantages. Similarly, Rosenberg (1994), points out that the decision to innovate is resumed in a climate of uncertainty since the adoption of new products or processes, or the application of new marketing or organization methods that change according to the sectors, the cycle of product life, and other factors.

So innovation processes offer multiple opportunities and options to change the way agriculture is practiced, especially from an environmental and social inclusion perspective; By incorporating innovations that support sustainability, more and better food and agricultural products are generated with the same quantity and quality of resources. Innovation in agriculture allows the growing population to cope with the food crisis, by increasing agricultural production and, consequently, by the availability of food, and by improving the income of agricultural producers, which lead to hunger and poverty reduction. The literature indicates that there are new factors that modify the scenario of global agriculture and transform the needs of technological and organizational changes of agricultural producers. Among them, we can mention the change in the focus of agricultural holdings from production (quantitative approach) to the market (qualitative approach) and the increase in competition as a result of free markets and globalization (Cox S., 2002); (Joshi, 2003); (Sonnino & Ruane, 2008); (Szekely & Strebel, 2013).

So innovation becomes transcendental in agribusiness, since water scarcity will influence the use of irrigation and its methods, plant improvement, water recycling and reuse in food production and processing systems. Another environmental consideration that will influence the development of this sector is the wastes that are released from this activity. These aspects will increasingly guide production and food processing systems. The objective will be to develop and adopt production systems that are productive, sustainable and less harmful to the environment. However, in order to identify the appropriate area of the food supply chain and the appropriate technologies, it is necessary to have much more objective analysis data on the relevant life cycles ranging from agricultural exploitation to the final consumer (Foster, 2006). The technological development of the agribusiness sector will also be influenced by the current and future results of scientific and technological research and development and will depend on the resources and capabilities available to the sector.

In Mexico, according to the World Wildlife Fund (WWF) and the Mexican Institute for Competitiveness (IMC, in spanish), in its report “Cleantech Mexico 2018: Overview and recommendations to boost national eco-innovation”, he points out that there are reasons to promote innovation in green technologies in Mexico. This sector has been one of those that has had the highest growth rates in both developed and developing countries. Likewise, it has proven to significantly increase the productivity of various industries while reducing waste and greenhouse gases (IMCO, 2018).

In this sense, innovation serves as a tool for the performance of organizations due to the benefits obtained from the implementation of new technologies. It should be noted that the measurement of business performance is complex and necessary to determine the benefits obtained from the strategies and practices implemented, aside from the current situation of the companies as a starting point for the identification of opportunities for improvement and as a reference to evaluate future strategies. According to Gopalakrishnan (2000), the performance of an organization is defined based on different factors, including: a) efficiency, related to the inflows and outflows of resources; b) effectiveness, related to business growth and employee satisfaction; and finally, c) financial results, related to the return of assets, investment and profit growth.

Lee and Miller (1996) argue that performance depends on the company's objective and is reflected in profitability, related to operating income, which in turn is related to fixed assets and growth, which is linked to sales; the market segment and the development of new products, and the satisfaction of customers and employees. Thus innovation positively impacts the sustainability and performance of any sector (Damanpour, 2009); (Deshpande, Farley, & Webster, 1993); (Shumpeter, 1939), which is why innovation tends to be adopted as a means to obtain multiple benefits.

3. Methods

The studies that have been carried out on green technologies show the importance of incorporating them into the processes of production, commercialization, and distribution, since they are oriented both to reduce and avoid damages caused to the environment. Under this perspective, the agribusiness sector seeks to improve the efficiency of its production processes, so green technologies are a tool that will allow it to improve its economic, environmental and social performance (Bartlett & Trifilova, 2010); (Dao, Langella, & Carbo, 2011); (Leewuis, 2004) (Thangavel & Sridevi, 2015).

As for the characterization of the research, it is applied type, because according to Bunge (2008), the problem to be studied is always chosen with a definite final objective, and because it is linked to development, the resolution's main purpose is of immediate practical problems. In addition, it is a non-experimental investigation and for its period, it is transversal since the units of analysis are observed in a certain period of time (Ávila, 2006).

Due to its scope, it is a correlational investigation, since it seeks to determine the degree to which the variations in one or several factors are concomitant with the variation in one or other factors, which is determined statistically by means of correlation coefficients; in this case, innovation and its relationship with performance (Tamayo, 2003). It is of mixed type, since the investigation begins with a qualitative approach, to finalize the analysis with a quantitative approach.

4. Data Collection

For the field work, a questionnaire was designed that was applied to companies belonging to the agribusiness sector. To do this, the registry issued by the Ministry of Agriculture and Rural Development. (Secretaría de Agricultura y Desarrollo Rural (SADER) in Spanish), in which the total number of companies in the sector are registered.

5. Results and Discussion

For the analysis of the results, in the first instance the structure of the companies surveyed was identified, finding that 54% are small, 32% medium and only 14% are large. In the field work it was identified that around 50% of the companies have incorporated modifications not only to the product and the process but also in the commercialization and distribution of the same, considering physical aspects of the product such as packaging, labeling and design, as well as its publicity to highlight the environmental taxes that the product possesses and the way in which it is transferred to the consumer, through a less polluting transport, which has modified the forms of organization of the agribusiness. This demonstrates the importance that the agribusiness sector has given to environmental care and the incorporation of sustainability into its operations (Thangavel & Sridevi, 2015) (Dao, Langella, & Carbo, 2011) (Leewuis, 2004) (Bartlett & Trifilova, 2010).

As can be seen in Figure 1, 70% of the companies indicate that an important aspect of the agro-industrial process, where the greatest amount of pollution is generated, is the waste and waste derived from their activity, so they have placed special emphasis on implement the use of less polluting and more environmentally friendly technology at this stage of the process. It should be noted that there are still some companies belonging to this sector, which do not incorporate any type of innovation in sustainable matters, because they consider their products as 100% organic, so they do not want to invest in this type of technology, as they have the belief that will take away added value to your organic product.

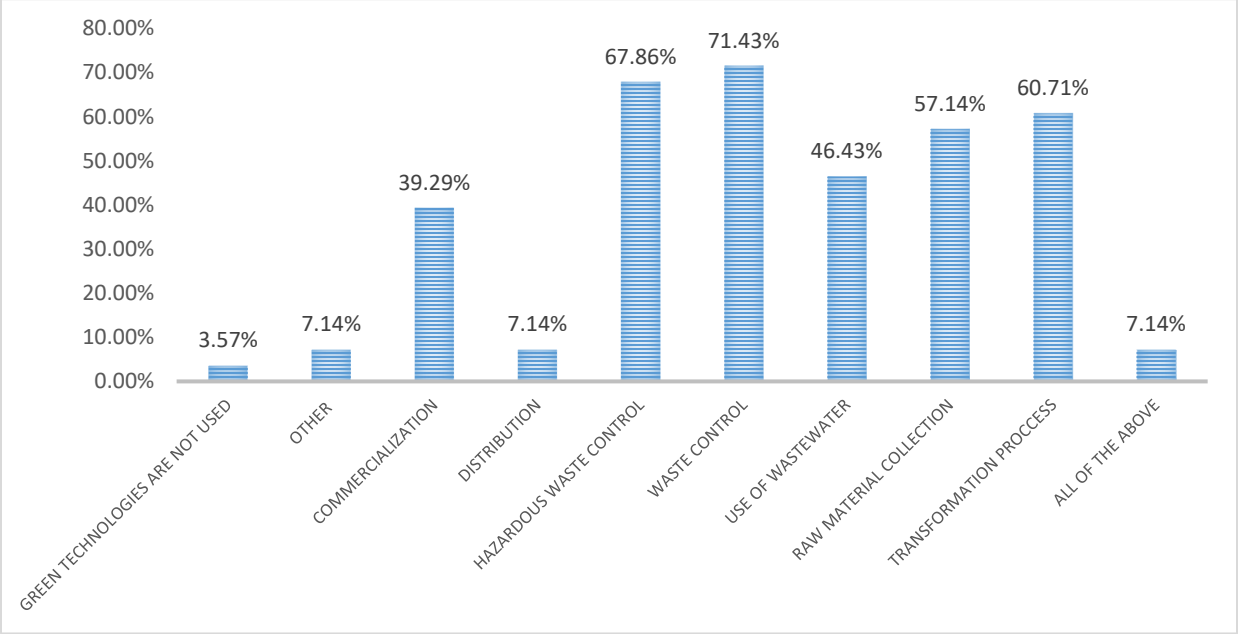

Figure 1. Stages of the process where green technologies are used

On the other hand, as shown in Figure 2, it was identified that despite promoting technologies to minimize waste from their activity, most of the companies that belong to this sector use technology that make them more They allow to minimize energy consumption, due to the increase in collection rates and the support granted by the Mexican government through programs and incentives, due to the promotion of this type of technology. While the technologies that companies incorporate less frequently, are biotechnology and information technologies. To a lesser extent, agribusiness is committed to investing in analytical and sensor technologies, robotics and automation, and nanotechnology.

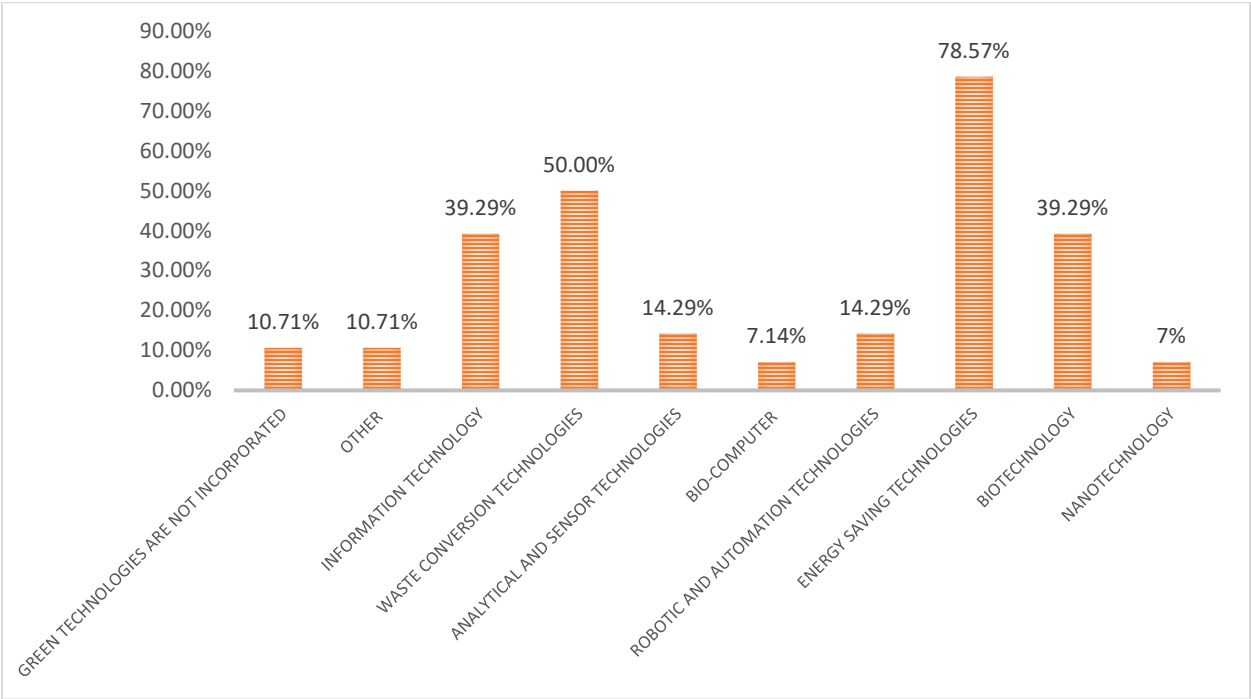

Figure 2. Green technologies incorporated in companies

By using green technologies, the agribusiness sector in Mexico has obtained a decrease in the consumption of water, energy, waste, and toxic emissions, which has allowed them to reduce production costs, have covered new markets, increased sales, profits and have decreased expenses and operating costs. However, it is considered that the consumption of raw materials has not been reduced. Other benefits that have been obtained from using green technology have mainly been obtaining an environmental certification which gives them the opportunity to compete in international markets, which increases their prestige and obtains greater brand recognition, as shown in Figure 3.

Figure 3. Economic benefits attributed to green technologies

The agribusiness sector has increased its profits, decreased its losses due to the use of green technologies and is heading towards a new market that has a growth trend. It should be noted that the agribusiness sector, by integrating two activities such as agriculture and the transformation of raw materials into finished products, has encouraged both the use of green technologies; for example in agriculture, the optimization of water, energy, planting and harvesting is sought; It also has several technological alternatives to correct damaged soil, improve fertilization, promote organic agriculture and the use of biocides, bioinformatics, nanotechnology and biotechnology. While, in transformation of raw materials to finished products, it seeks solutions to minimize its consumption of water, energy, reduce its toxic waste and the emission of toxic gases through various green technologies that have allowed it to improve its performance through a greater brand recognition, certification, prestige, minimization of costs, expenses, increased sales, greater efficiency and effectiveness in their production processes, among others.

After analyzing the behavior of innovation and performance, we proceeded to identify whether there is a relationship between both variables, either positively or negatively; to achieve this, Pearson's correlation technique (r) was used. In accordance with the above and as shown in Table 1, in most of the relationships between Innovation and Performance are between 0.4332 and 0.7679 being medium and considerable positive correlations, except for the improvement of key indicators, which has a correlation weak positive ($p > 0.05$).

Table 1. Matrix of correlations between Innovation and Performance

Correlations and p values for the Pearson test between Innovation and Performance	Incorporation of Innovations		Use of green technologies	
	r	P value	r	P value
Efficiency.	0.7679	0.000	0.4490	0.017
Effectiveness.	0.5555	0.002	0.4332	0.021
Improvement of indicators.	0.3138	0.104	0.2371	0.224
Benefits derived from the use of green technologies.	0.7214	0.000	0.6125	0.001
Financial results.	0.4803	0.010	0.4768	0.010

5. Conclusion

The demand for food and agricultural products is undergoing unprecedented changes due to climate change. Therefore, the development of the agribusiness sector is crucial to generate employment and income opportunities. It also contributes to improving the quality of agricultural products and their demand. The food crisis causes a growth in food demand and agricultural products with added value, in addition, the society has increased its awareness for environmental care. In addition, the barriers that the sector faces in order to obtain the inputs it requires, due to the difficulties inherent in the variety of climates and environmental effects on Mexican countryside.

To face the challenges, such as global positioning, infrastructure problems, difficult financial, business conditions and difficult access to infrastructure and human capital, Mexican agribusiness has chosen innovation as a tool to make its processes more efficient, and improve their products and marketing to the organization of the sector and involving the environmental care to compete in international markets. The promotion of agribusiness with a vision of environmental protection has led the incorporation of innovation as a tool to improve its performance, specifically through the use of green technologies as an option to improve its processes and using resources and capacities in a sustainable way.

It should be noted as a result of the research, that innovation, specifically the use of green technology in the agribusiness sector in Mexico, has a significant degree of relationship with the sector's performance. However, these results should be taken with caution since, the dimensions of analyzed variables, some relationships are weak because small and medium-sized and large companies were taken for the purpose of this investigation, so the results may vary because each size of company is different; In addition to that the resources and capabilities are also different. However, this sector requires promoting the use of more sophisticated green technology such as nanotechnology, biotechnology, bioinformatics and biocides since, according to the results of this research; most companies do not incorporate them due to the high costs that these technologies represent. Together, there are some companies belonging to this sector that do not incorporate any type of innovation, as they are considered traditional and due the resistance to change represented by the use of new technologies.

Acknowledgements

This work was financially supported by the Instituto Politécnico Nacional, México. The authors would like to thank this institution for their support and commitments to this research project. May thanks also to the referees for their valuable comments and suggestions to improve this research.

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