

Strategic and competitive advantages of the agricultural sector in Querétaro, Mexico

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ABSTRACT

Objective: To characterize agricultural production in the state of Querétaro, Mexico, during 2018 in order to provide information that can facilitate business decision-making and lay out public and private strategies for the development of high-value projects in agrifood production.

Design/Methodology/Approach: The analysis was conducted through bibliometric exploration and collection of statistical data, available on different public-access agrifood statistics information platforms.

Results: The municipalities of Pedro Escobedo, Colón, San Juan del Río, and El Marqués established grain, vegetable, foraging grass, and rose crops through private sector productive projects with an agribusiness perspective, using available knowledge, technological innovation, and market intelligence.

Study Limitations/Implications: A lack of information to allow establishing the current agricultural vocation of the state of Querétaro.

Findings/Conclusions: Based on the perspectives of specialized markets at the national and international level, Querétaro possesses diverse strategic and competitive advantages for the establishment of high-impact agricultural projects.

Keywords: Agribusiness, competitiveness, innovation, sustainability, transfer of knowledge.

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INTRODUCTION

In Mexico, agricultural production is of great importance due to the incessant urbanization process, international trade, and demographic changes (Orozco-Hernández *et al.*, 2017). Added to this, the agricultural sector can endure some of the most changes in a specific time, either due to market factors or to natural phenomena that can destabilize supply and demand, and therefore prices. The agricultural sector is one of the most important for socioeconomic development; additionally, it represents a strategic axis for national food security and a supply source for multiple national agroindustries. In Mexico, agricultural production has been promoted in certain states like Jalisco, Guanajuato, Michoacán, Sinaloa, and Veracruz (SIAP, 2020), which have appropriate agroclimatic conditions, water availability for irrigation, soil quality, farm labor technification, and commercialization strategies that give added value, among other factors.

Agriculture in the state of Querétaro is currently in the midst of a transition, developing and implementing new technologies and innovation in its agro-industrial processes while promoting specialized alternative crops with commercial potential, such as: roses (*Rosa* spp.), asparagus (*Asparagus officinalis* L.), berries, grasses, and vegetables, among others, for national and international supply; in addition to the traditional vocation for crops like maize (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), chili pepper (*Capsicum annuum* L.), and red tomato (*Solanum lycopersicum*). In the same way, various agronomic practices have been adopted that allow for a more efficient use of natural resources to increase productivity, quality, and to contribute with this to the decrease of greenhouse gases, causal factors of global warming and climate change. Within the technological innovations that rural farmers have adopted, the following stand out: rainwater capture, rational use of water and soil, energy generation using solar panels, implementation of protected agriculture, biological control methods, production of supplies for vegetable nutrition, etc. (Caicedo-López *et al.*, 2021; Quevedo-Martínez *et al.*, 2019).

The Autonomous University of Querétaro has implemented different research projects that have allowed it to connect with rural production societies, civil associations and *ejidatarios* or communal landowners, focused on the transfer of knowledge and technology for basic and alternative crops, resulting in the production of different agrifood products (Vasco Leal *et al.*, 2020; Cuellar-Núñez *et al.*, 2018; Gaytán-Martínez *et al.*, 2017). However, efforts between different actors are required, including from the academic sector, government, and private sector to generate technological capacities in farmers; likewise, to incentivize interest from younger generations in farm work, which will allow the development of agribusiness groups interested in formulating and proposing solutions to their basic needs. These groups will generate productive and social intervention projects referring to the management and agro-industrial use of primary materials obtained from their production units, which will impact local, national, and international production. Considering the above, this study characterized the agricultural sector in Querétaro in 2018 with the purpose of facilitating business decision making and suggesting public and private strategies for the development of high-value projects in agrifood production.

MATERIALS AND METHODS

The present analysis was limited to the state of Querétaro for the year 2018. The first methodological approach was carried out using bibliometric exploration for the study object's conceptualization. In the next phase, statistical data were collected from information sources such as the Agrifood and Fisheries Information System (*Sistema de Información Agroalimentaria y Pesquera-SIAP*, www.gob.mx/siap) and from the Informatic Program with Statistical Data on Agriculture, Livestock and Fisheries, called the Agrifood Information Query System (*Sistema de Información Agroalimentaria de Consulta*, SIACON). Then, using this information, traditional and alternative agricultural production was characterized in the state of Querétaro based on the importance represented by its economic value, production volume, and farmed surface area in different municipalities. The agricultural production value was expressed according to the Economic Information System (Peso/Dollar exchange rate) determined by BANXICO (2021) for May 24, 2021.

Finally, a series of productive and administrative premises are proposed, to consider for strengthening and consolidating; additionally, some strategic and competitive advantages offered by the agrifood sector in Querétaro are listed.

RESULTS AND DISCUSSION

Importance of agricultural production in the state of Querétaro

According to information obtained from SIAP (2019a), the value of agricultural production in Querétaro (except for 2014) showed a constant increase from the year 2010 to 2019, growing from \$116.5 to \$224.2 million US dollars (Figure 1).

It is expected that state agricultural production will continue to grow, considering that the fundamental objective of the guideline “Querétaro Próspero”, set forth by Querétaro’s State Development Plan 2016-2021 (2016), was to drive productivity and competitiveness in the agricultural, livestock and forestry sectors.

Agricultural production in the municipalities of the state of Querétaro

Agricultural production in the state of Querétaro can be found mainly in five municipalities (San Juan del Río, El Marqués, Pedro Escobedo, Amealco de Bonfil, and Colón), which represent 65.3% of the surface sown and receive the greatest production value for their agricultural activities (Table 1). For 2018, Querétaro reported a production value of approximately \$222 million USD and a farmed surface area of 149,409 hectares, according to the Agrifood Information Query System-SIACON (SIAP, 2019a).

Traditional agrifood production in Querétaro

According to the Querétaro Food Infographic (SIAP, 2019b), the state’s notable products and their contribution to the national agricultural volume are approximately 2,096,137 tons of products that provide regional food and fodder security to the country. Agricultural products notable for their economic value are maize (*Zea mays* L.) as grain and

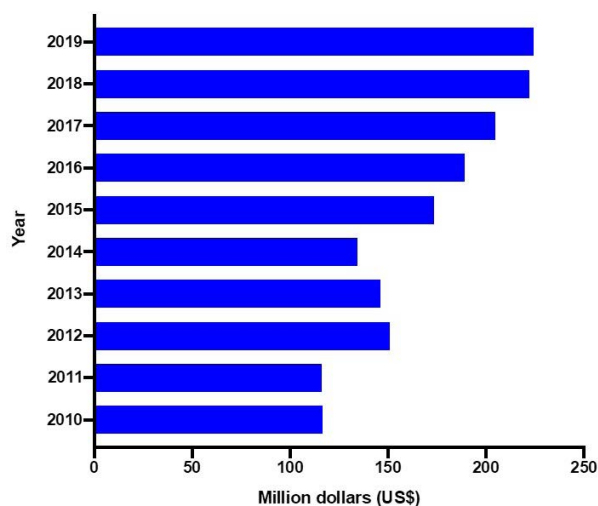


Figure 1. Agricultural production value in the state of Querétaro, México. Source: Prepared by the authors with data obtained from SIAP (2019a).

Table 1. Agricultural production in municipalities of the state of Querétaro (2018).

Municipality	Planted area (ha)	Production value (US\$)
Pedro Escobedo	18,575	61,043,880.84
Colón	15,344	38,039,704.11
San Juan del Río	24,190	29,319,041.87
El Marqués	21,329	27,727,707.33
Tequisquiapan	7,961	14,178,844.61
Amealco de Bonfil	18,149	13,524,708.13
Querétaro	10,234	10,233,343.40
Huimilpan	8,420	9,912,791.87
Ezequiel Montes	3,886	6,907,709.34
Corregidora	4,919	3,987,369.16
Arroyo Seco	1,528	2,124,748.39
Cadereyta	6,857.50	1,938,305.15
Jalpan de Serra	1,736	1,166,465.38
Peñamiller	1,149	894,072.06
Tolimán	1,284	480,726.65
San Joaquín	627.50	223,631.24
Pinal de Amoles	1,132	146,286.23
Landa de Matamoros	2,088	96,618.36
Total	149,409	221,945,954.11

Source: Own elaboration with data obtained from SIAP (2019a).

fodder, red tomato (*Solanum lycopersicum*), green chili pepper (*Capsicum annuum* L.), alfalfa (*Medicago sativa* L.), and beans (*Phaseolus vulgaris* L.) (Table 2).

Maize (*Zea mays* L.)

Maize (*Zea mays* L.) cultivation is important because of its cultural, social, economic, and daily dietary ties to the Mexican population, in addition to its widespread use as animal feed. The five principal municipalities where maize grain production is concentrated in Querétaro are: Pedro Escobedo (69 thousand t), San Juan del Río (40 thousand t), Amealco (39 thousand t), Colón (31 thousand t), and El Marqués (27 thousand t), out of a total of 256,752 tons that Querétaro registered for 2018. This contribution is low compared with that reported by SADER (2019) for the states of Sinaloa (5 million 818 thousand tons), Jalisco (3 million 800 thousand t), and Michoacán (1 million 993 thousand tons). The varieties or hybrids used for the cultivation of fodder maize in the state of Querétaro

Table 2. Traditional agricultural products produced in the state of Querétaro (2018). Source: Own elaboration with data obtained from SIAP (2019a).

	Maize (<i>Zea mays</i> L.)		Tomato (<i>Solanum lycopersicum</i>)	Green chili pepper (<i>Capsicum annuum</i> L.)	Alfalfa (<i>Medicago sativa</i> L.)	Common bean (<i>Phaseolus vulgaris</i> L.)
	Grain	Forage				
Value (million dollars US\$)	48.8	23.4	38.2	22.1	18.5	1.8
Volume (t)	256,752	752,423	105,500	36,282	553,442	4,678
Planted area (ha)	100,482	10,737	299	689.9	7,451	7,884

registered values of 752,432 tons, of which the municipality of El Marqués contributed 375 thousand tons, followed in order of importance by Pedro Escobedo (123 thousand t), San Juan del Río (70 thousand t), Colón (43 thousand t), and Querétaro (44 thousand t). Harvesting of this crop included the stalk, leaves, and ears and can be done when green for ensilage or when dry to obtain animal feed.

Red tomato (*Solanum lycopersicum*)

Growing red tomato (*Solanum lycopersicum*) has been very culturally important in the diet of Mexicans and it represents one of the crops with greatest economic significance, not only nationally but also for Querétaro, where a production value of approximately \$38.2 million USD was obtained in 2018. Among the main municipalities benefitted by this crop are Pedro Escobedo (16.4 million US dollars), Colón (15.2 million US dollars), and San Juan del Río (2.6 million US dollars). At the national level, there is an estimated annual consumption *per capita* of 13.8 kg, which makes this product essential for the basic food basket in Mexico. This product is destined, mainly, to be eaten fresh and the rest is intended for the transformation industry for making juices, pastes, puree, and preserves, among other products (Lares-Michel *et al.*, 2017).

Green chili pepper (*Capsicum annuum* L.)

Green chili pepper (*Capsicum annuum* L.) is one of the most important vegetable products in Mexico. During 2018, Querétaro had 689.9 hectares of surface sown with a production value of \$22 million USD. The municipalities where the highest economic income was obtained for this strategic production chain were: Colón (4.9 million US dollars), Querétaro (4.8 million US dollars), and Tequisquiapan (3.7 million US dollars). This product is directed, principally, towards fresh consumption and processing for a large variety of products, both edible (salsas, dehydrated, brined, pickled, etc.) and non-edible (pigments, essential oils, etc.).

Alfalfa (*Medicago sativa* L.)

The production of alfalfa (*Medicago sativa* L.) is tied to the dairy livestock sector in Querétaro. Feed for cows, goats, and sheep is the principal destination of this crop. The three main municipalities for production and commercialization for 2018 were: San Juan del Río, Tequisquiapan, and Colón, with a production value for that year of approximately 3.9, 3.4, and 3.3 million US dollars, respectively. The state production for that same year was 553,442 tons. According to information from SADER (2019), in Mexico this crop has the highest yields between the months of April and September, with a production volume of 33,711,846 tons, maintaining this average almost constantly from 2009 to 2018.

Beans (*Phaseolus vulgaris* L.)

Beans (*Phaseolus vulgaris* L.) are another crop of great importance in the daily diet of Mexicans and represents a source of protein, carbohydrates, vitamins, and minerals (Ramírez-Jiménez *et al.*, 2015). The annual *per capita* consumption in the country is around 9.9 kg (SAGARPA, 2016). Among the more appreciated varieties are the following cultivars:

Pinto, Bayo, and Flor de Mayo, which contribute higher nutritional quality and health benefits (Fernández-Valenciando and Sánchez-Chávez, 2017). For 2018, 7,884 hectares were farmed, distributed mainly in Cadereyta (2,591 ha), Colón (2,960 ha), and Ezequiel Montes (650 ha). This represented a state production value of approximately \$1.8 million USD for that year.

Agrifood production with high potential in the state of Querétaro

Alternative crops have recently been established in the state while in a productive reconversion phase, such as: asparagus (*Asparagus officinalis* L.), roses (*Rosa* spp.), barley (*Hordeum vulgare* L.), and triticale (× *Triticosecale* Wittmack), among others, which have increased in farmed surface area as a result of the economic interest for their commercialization in the national and international market (Table 3). It is worth noting that in the implementation and establishment of these crops, technological innovations and integral agricultural management with an agrobusiness perspective have been adopted, which has allowed for more economic certainty in these production chains.

Asparagus (*Asparagus officinalis* L.)

Asparagus production (*Asparagus officinalis* L.) is situated in the municipalities of Colón, Pedro Escobedo, and El Marqués with a surface sown of 1,079 hectares. With respect to the principal varieties available, the green variety has stood out for being the most consumed worldwide. It has a productive life of 10 to 15 years, after which it should be replaced with new asparagus seedlings to improve productivity. The edible part represents approximately 23% of the whole plant, and of the remaining 76%, 15% are roots (Zhang *et al.*, 2019).

Rose (*Rosa* sp.)

Rose (*Rosa* sp.) production is carried out in 128 hectares of the municipality of San Juan del Río, with a growing expansion in the adjoining area that is part of Pedro Escobedo. According to information from SADER (2019), the state of Querétaro is the third largest national producer, with an approximate annual production of 608,330 gross, after the state of Morelos (667,626 gross), and the State of Mexico (7,022,706 gross, each gross equivalent to 144 stems). The commercialization of production is carried out principally in the states of Guanajuato, San Luis Potosí, Hidalgo, and Nuevo León, with the size of the bud and stem standing out, as well as the diversity in colors and long shelf life.

Table 3. Alternative agricultural products in the state of Querétaro (2018) Source: Prepared by the authors with data obtained from SIAP (2019a).

	Asparagus (<i>Asparagus officinalis</i> L.)	Rose (<i>Rosa</i> spp.)	Barley (<i>Hordeum vulgare</i> L.)	Triticale (× <i>Triticosecale</i> Wittmack)
Value (million dollars US\$)	12.9	8.9	6.9	2.1
Volume (t)	6,592	608,330	28,749	73,365
Planted area (ha)	1,079	125.30	4,710	2,148

Barley (*Hordeum vulgare* L.)

Barley (*Hordeum vulgare* L.) cultivation is concentrated principally in the municipality of Pedro Escobedo. During the agricultural cycle spanning fall to winter, the production value represented approximately \$4.3 million USD, followed in order of importance by San Juan del Río (1.3 million US dollars), and Tequisquiapan (0.7 million US dollars). The state harvest of this crop is directed particularly toward covering national beer industry needs, with the most notable buyers being Grupo Model and Heineken México.

Triticale (× *Triticosecale* Wittmack)

Production of green fodder triticale (× *Triticosecale* Wittmack) is carried out in the municipalities of Pedro Escobedo, El Marqués, and Colón by local dairy farmers to feed their animals, because of the high nutritional value that this cereal provides in protein, dietary fiber, and starch (Makowska *et al.*, 2020).

Geographic location of agricultural production in Querétaro

Figure 2 shows the main traditional agricultural products and with high potential, established by municipality, in the state of Querétaro.

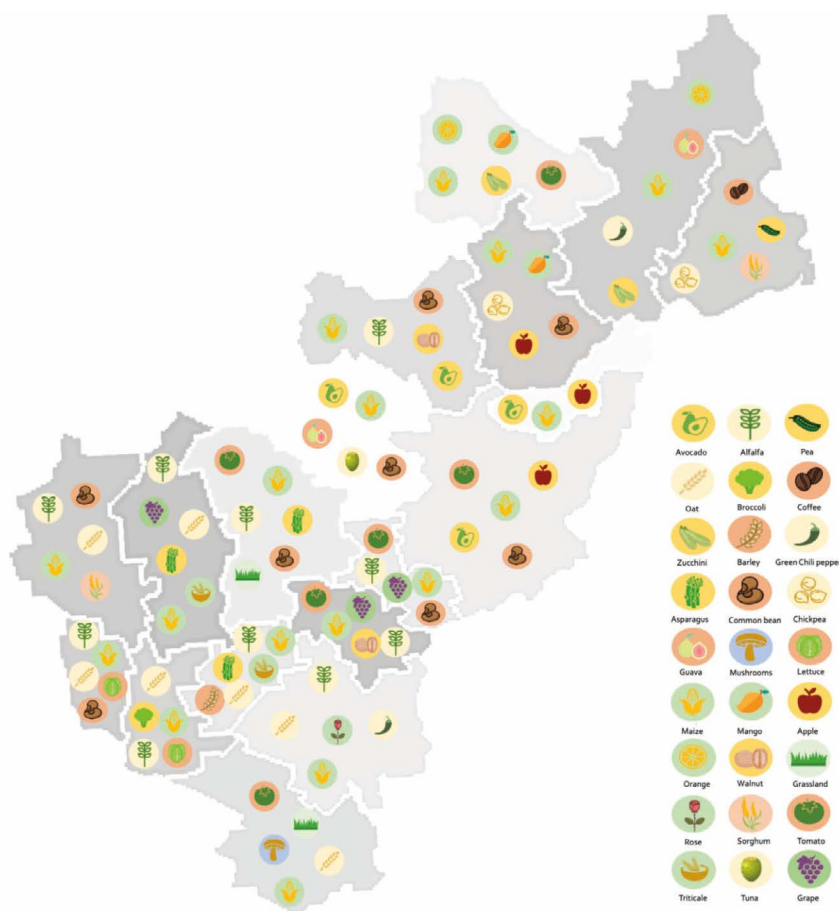


Figure 2. Main agricultural products by municipality in Querétaro, Mexico. Source: Prepared by the authors with data obtained from SEDEA (2020).

Important considerations for agrifood strengthening and consolidating in Querétaro

Although agrifood production in Querétaro is growing due to interest in highly profitable strategic crops and strengthened by national and foreign investment, the following premises should be considered in order to strengthen and consolidate this sector in all the productive initiatives mentioned, both in the municipalities with high potential and in those that must still implement innovation, technology, and business management (Table 4).

Table 4. Premises to consider for strengthening and consolidating of agrifood production in the state of Querétaro.

Premises	Results to obtain
To strengthen and consolidate the agro-industrial ecosystem of the state of Querétaro.	Growth of the municipal, state, and national economy.
To encourage knowledge and technology transfer to agricultural producers focus groups, through the development of theoretical and practical skills.	Producers with skills, abilities, and knowledge in productive, administrative, and financial topics.
To establish strategic links between several actors of the agri-food chains in the state of Querétaro.	Adoption of knowledge through basic science, applied research and technological innovations for value creation.
To implement technical support for the execution of productive projects.	Managed projects with business strategy.
To adopt adequate infrastructure, equipment, and machinery for agricultural production.	Increased productivity in productive economic units.
To generate agri-food products with high added value.	Opportunity to enter specialized market niches.
To promote the interest of young people in the agri-food sector.	Empowered youth with broad interest in the agri-food sector.
To make contract farming in agricultural activities.	Security and assurance in the marketing of agri-food products, getting fair prices as well.
Implement the use of agricultural insurance.	Reduction of the risk and productive uncertainty derived from environmental contingencies such as: drought, frost, fire, among others.
Increase hydro-agricultural infrastructure in productive economic units.	Efficient use of water.

Below are the main advantages of the agricultural sector in the state of Querétaro.

Table 5. Strategic and competitive advantages of the agricultural sector in the state of Querétaro.

Commercialization and market	Terrestrial connection with specialized markets such as Mexico City, Guadalajara, Monterrey, and access to the main markets of the country.
Logistics and Transportation	Querétaro Intercontinental Airport with ease of cargo handling.
	Freight transport and logistics with suitable mobile units to meet the needs of space, temperature, and controlled atmospheres.
Supply chain	Established companies as suppliers of commodities, machinery, equipment, tools, and specialized services for the updating and development of agro-industrial projects.
Business sector	Ease to articulate agro-industrial clusters with regional companies.
	Agricultural producers and investors interested in generating high value-added products and developing agribusiness.
	Specialized Agroindustrial parks: <ul style="list-style-type: none"> a. Agropark (Municipality of Colón) b. Florapark (Municipality of Amealco de Bonfil)
Research and link between academia, government, and the business sector	Universities, Institutions and Civil Associations providing teaching, research and links between the public and private sectors: <ul style="list-style-type: none"> Universidad Autónoma de Querétaro (UAQ) a. Colegio de Ingenieros Agrónomos Queretanos A.C (CIAQ) b. Unión Ganadera Regional de Querétaro (UGRQ) c. Centro Universitario CEICKOR d. Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) e. Centro de Tecnología Avanzada (CIATEQ) f. Centro de Enseñanza, Investigación y Extensión en Producción Animal en Altiplano (CEIEPAA - UNAM) g. Centro de Investigación en Ciencia Aplicada y Tecnología Avanzada (CICATA - IPN) h. Campo Agropecuario Experimental del Tecnológico de Monterrey (CAETEC - ITESM) i. Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP) j. Comité Estatal de Sanidad Vegetal de Querétaro A.C. (CESAVEQ) k. Private universities
Manpower	Availability of specialized labor in areas such as agricultural chemistry, horticulture, greenhouse and biosystem management, agriculture, agribusiness, and food science and technology, among others.
Support and financing programs	State and federal support for training and technical assistance. Development of agro-industrial projects in protected agriculture, technification and modernization of irrigation systems. Marketing incentives, among others.
	Access to financing by federal entities such as FND (Financiera Nacional Rural de Desarrollo Agropecuario, Rural, Forestal y Pesquero) and FIRA (Fideicomisos Instituidos en Relación con la Agricultura).
Security	Low levels of insecurity that encourage national and foreign investment.

CONCLUSIONS

In the state of Querétaro, the principal municipalities that produce both traditional and alternative crops are Pedro Escobedo, Colón, San Juan del Río, and El Marqués. These have implemented productive projects with a business perspective, considering the use of knowledge, technological innovations, and market intelligence. The state of Querétaro has strategic and competitive advantages that can position it in this sector, contributing to its rural development, food sovereignty, and growth. This study constitutes a preliminary description of agrifood production chains, so it would be important to complement it with other studies such as econometric, organizational, and technology management and innovation models, among others.

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