Abanico Agroforestal. January-December 2021; 3:1-18. http://dx.doi.org/10.37114/abaagrof/2021.1
Original Article. Received: 04/12/2020. Accepted: 14/01/2021. Published: 30/01/2021. Code:2020-15.

State of the art of mexican milk production

Estado del arte de la producción lechera mexicana

Martínez-Alba María[1] ID , Molina-Morejón Víctor[2] ID, García-Munguía Carlos[3] ID , Díaz-Carreto Emilio[4] ID, Vivanco-Florido Jesús[1] ID, Mata-Zamores Silvia*[1] ID

[1]Centro de Ciencias Económico Administrativas de la Universidad Autónoma de Aguascalientes, México. C.P. 20131. [2]Facultad de Contaduría y Administración en la Universidad Autónoma de Coahuila, México. C.P. 25710. [3]División de Ciencias de la Vida en la Universidad de Guanajuato, México. C.P. 36500. [4]Gerente de Suministros Lácteos en Nestlé México. C.P. 47425. [1*]Author for correspondencie Centro de Ciencias Económico Administrativas de la Universidad Autónoma de Aguascalientes, México. al139740@edu.uaa.mx. mtzalba@live.com.mx, vmolinaa2005@yahoo.com.mx, cagamu@hotmail.com, emilio.diaz@mx.nestle.com, doctorsalvatore@yahoo.com.mx

Abstract

In world milk production, Mexico ranks eighth (2017 - 2019), while in the purchase of powdered milk it holds first place with 11.2% of global imports (SIAP, 2019). Thus, the competitiveness of the dairy sector in Mexico depends on the continuous improvement of productivity in the long term. The objective of this study was to evaluate the current context of Mexican milk production, through a bibliographic review and by means of a Pearson correlation (P<0.01) of the quantitative variables: volume, heads of cattle, constant price, per capita consumption and imports of powdered milk. Observing that powdered milk imports maintain a high correlation with the volume variable (.883), it is understood that even though production remains high, it is not enough to supply the national demand.
Keywords: volume, yield, price, import, Mexico.

Resumen

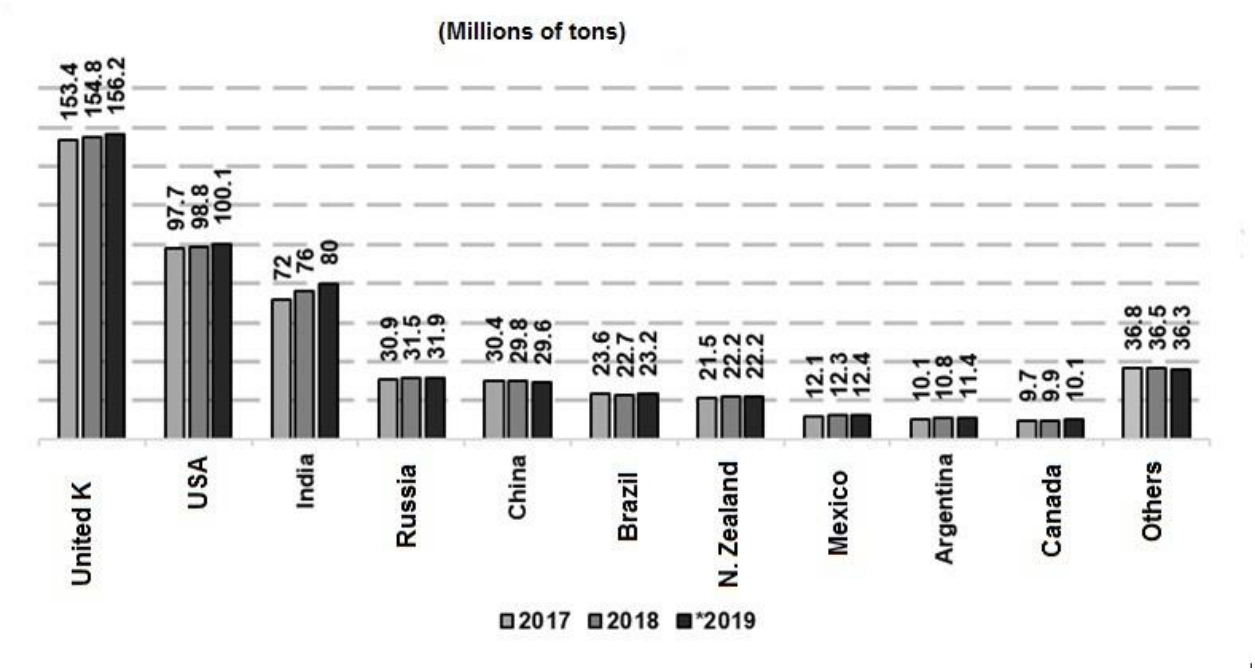
En la producción mundial lechera, México ocupó la octava posición (2017 – 2019), mientras que, en la compra de leche en polvo posee el primer lugar con el 11.2% de las importaciones globales (SIAP, 2019). Considerando así, que la competitividad del sector lechero en México depende de la mejora continua de la productividad a largo plazo. El objetivo del presente estudio fue evaluar el contexto actual de la producción lechera mexicana, a través de una revisión bibliográfica y por medio de una correlación de Pearson (P<0.01) de las variables cuantitativas: volumen, cabezas de ganado, precio constante, consumo per cápita e importaciones de leche en polvo. Observando que las importaciones de leche en polvo mantienen una alta correlación con la variable volumen (.883), entendiéndose así que a pesar de que la producción se mantenga al alza, no es suficiente para abastecer la demanda nacional.
Palabras clave: leche, volumen, precio, importación, México.

INTRODUCTION

In 2013, the World Organization for Animal Health (OIE) defined dairy production units as a commercial livestock production system whose purpose involves the breeding, reproduction and management of livestock for milk production; mentioning that the main systems established are integrated, intensive and extensive (OIE, 2013; Herrera *et al.,* 2011). In addition to considering that work in this sector has specific characteristics; since it is conditioned to physical effort in handling cattle, isolation, social separation and dependence on the natural environment (Main, 2002).

In 2018, the European Union ranked first in the production of bovine milk with a production of 154.8 million tons, which represented 30.6% of production worldwide (Figure 1). In addition to being observed that, in the same year, the United States of America was the second most important producer with a production of 98.8 million tons, representing 19.6% of world production (FIRA, 2019), and with an estimated 9.3 million head of cattle; it is considered as the country with the highest level of productivity, with 10.5 tons of milk per cow/year. Dairy Farming in the United States (DFUS) attributes its high productivity to good sanitary management and implementation of nutritious and balanced cattle diets, agronomically managed pastures, as well as facilities that ensure animal welfare (DFUS, 2020). Similarly, it can be observed (Figure 1) that countries such as Poland, United Kingdom, Germany, France and Holland manage to stand out, thanks to a dairy herd that exceeds four million head; with an approximate productivity of 6.6 tons of milk cow/year (FIRA, 2019).

During the same year (2018), India ranked third in world milk production, with 78 million tons (Figure 1); where this country includes dairy production units with up to five head of cattle and with little investment. Thus, India also has the largest bovine dairy herd, which is estimated at 58.5 million head; however, its productivity is the lowest among the main producers, with 1.3 tons of milk cow/year (FIRA, 2019; Hemme *et al.,* 2003). Comparing Mexico with the aforementioned countries and in the same production year, it is observed that it occupied the eighth position (Figure 1), with a contribution of 2.4% of total world production.



Source: FIRA with data from USDA, 2019.

Figure 1. Major international milk producers

Although dairy production internationally is achieved from different production systems; where countries such as Australia, New Zealand, Argentina and Uruguay register surpluses in their productivity due to the high availability of natural resources, which allows them to produce more and at lower cost (Santibáñez & Sánchez, 2009); in Mexico its production can be conditioned by the heterogeneity of animal production units (number of cattle, adoption of technology, reproduction, feeding, marketing, etc.) (Camacho *et al.,* 2017[a]; López *et al.,* 2014).

Recalling that, globally, milk and its derivatives are considered commodities (Vera, 2020), quoted in dollars and its price fluctuates in markets continuously (Doporto & Michelena, 2011). For this reason, some countries have opted to ensure milk production as a resource to supply domestic demand, while others have preferred imports (Sraïri *et al.,* 2013). It is important to remember that for some time now, dairy production has presented a profitability crisis due to low product prices and large investments in raw materials (Próspero *et al.,* 2013).

The Food and Agriculture Organization of the United Nations (FAO) together with the Organization for Economic Cooperation and Development (OECD), mention that in various parts of the world it has been proposed that between large and small dairy production units there are productivity gaps, understood as the profound differences between the average milk production obtained per cow in the herd, per hectare of arable

land, per wage worked or per year, among other variables (FAO *et al.,* 2012; Escudero *et al.,* 2012).

Such productivity gaps are reflected in economic profitability paths (Hanson *et al.,* 2013; Segura & Lozano, 2015), authors such as Aragon and Rubio (2005) define them as an indicator that quantifies the exchange relations of dairy production units with the market, reflecting the balance between investments such as labor and inputs (Jiménez *et al.,* 2014), with the price of products paid to the participant in the dairy production chain (Qüesta *et al.,* 2016), in which production units with large herds decrease their unit operating expenses by distributing the fixed costs of facilities, milking equipment and technical assistance services, in a very large production volume. It increases their profits and the economic possibilities of implementing improvements in the quality of the process (Hanson *et al.,* 2013; Segura & Lozano, 2015). However, in animal production units with a minimum number of head of cattle, there may be gaps in the scope of technical production potential and, therefore, in economic profitability and technological development (Bacco *et al.,* 2013).

Now, it is important to highlight that economic profitability is sensitive to the availability of agroecological resources (Mamián *et al.,* 2016), market distortions due to subsidies, hoarding, national and international control of dairy prices, inputs and milk substitutes (Escudero *et al.,* 2013; Hemme *et al.,* 2014).

In Mexico, the productivity of dairy farming as a primary activity, and its connections with the links of industrialization and marketing of fluid milk and its derivatives, is a relevant issue for the national economy (Núñez, 2016). Historically, there is a significant gap between national production and milk demand; this deficit to cover domestic demand is one of the reasons why the country has occupied the first place as an importer of powdered milk in the world (Loera & Banda, 2017; Salomón & Ramírez, 2018). That is why the Mexican dairy sector requires viable proposals and practical solutions that allow producers to participate successfully in national production, competing in the market, with an improvement in their income; but protecting biodiversity and its cultural richness (Garay *et al.,* 2011). In addition to emphasizing quality and administration, it is considered that these elements condition the transition of agricultural enterprises towards new forms of competitive organization (Arce & Martínez, 2007). Successful management of agricultural production units requires knowledge, organization, regulation and systemic action (Guevara *et al.,* 2004).

Thus, the objective of this study is to evaluate the current context of Mexican dairy production, from the perspectives of production and competitiveness of the last two decades, through the quantitative variables: volume, head of cattle, constant price, per capita consumption and imports of powdered milk.

MATERIAL AND METHODS

Sources of information: For this study, data for the variables volume, head of cattle, nominal price, per capita consumption and imports of powdered milk were obtained from the Agrifood and Fisheries Information System (SIAP), taking as a reference the data generated in 2000-2019 for the dairy cattle subsector.

Methodology used: A correlation analysis was carried out to examine the direction and strength of the association between the variables: volume, head of cattle, constant price, per capita consumption and imports of powdered milk. The sample estimator used to evaluate was Pearson's correlation coefficient (r) with the SPSS version 27 statistical program, and the interpretation of the results was carried out based on the criteria of Hinkle *et al.* (2003). Prior to the correlation analysis, milk prices per liter were deflated.

Milk price deflation: Refers to effect elimination of price changes (inflation or deflation) from a monetary value (García *et al.,* 2006). Converting a magnitude measured in nominal terms into another expressed in real terms.

$$P = \frac{Nominal\ price}{IP} * 100$$

Where:

P = actual prices

IP = Price index of base year 2010=100.

RESULTS AND DISCUSSION

The objective of this study was to determine and analyze the correlation between the quantitative variables: the results obtained show the mean and deviation of each of the variables (Table 1), as well as their correlation (Table 2). Next, each of the study variables is analyzed.

Table 1. Descriptive statistics

	Mean	Deviation	N
VOLUME	10650162.40	866038.473	20
CONSTANT PRICE	4.438000	1.8423572	20
PER CAPITA CONSUMPTION	118.385	6.5094	20
HEAD OF CATTLE	2335955.90	143903.375	20
MILK POWDER IMPORTATIONS	217100.00	70928.355	20

Source: Source: Author's own elaboration, 2020.

Table 2. Correlations

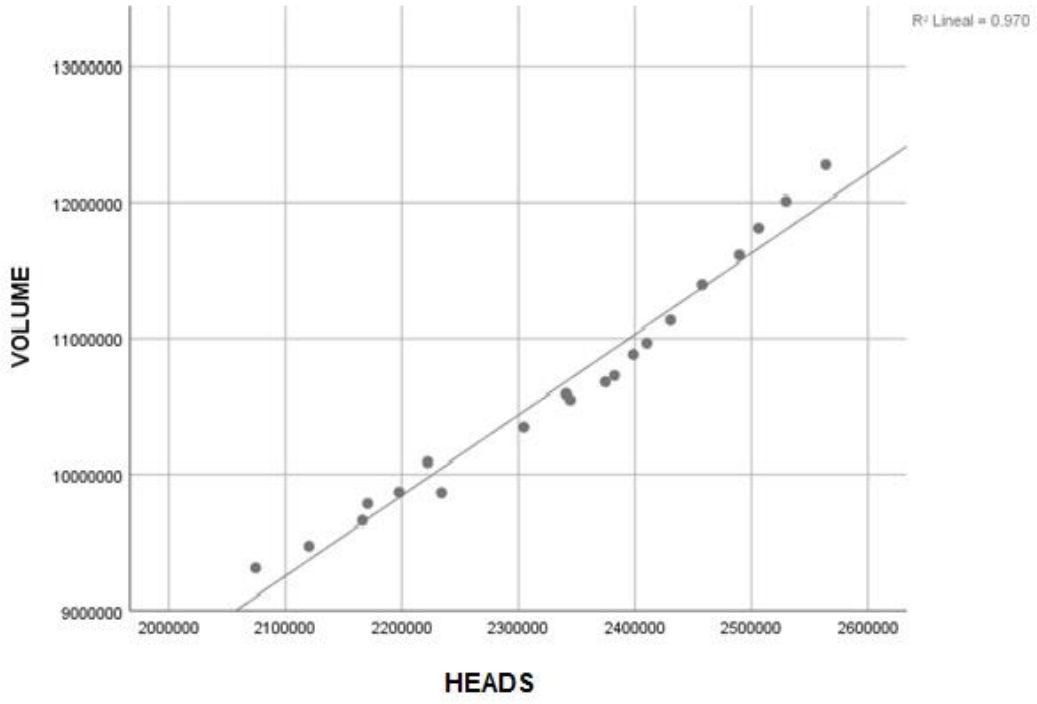
		VOLUME		CONSTANT PRICE	PER CAPITA CONSUMPTION	HEAD OF CATTLE	MILK POWDER IMPORTATION
VOLUME	Pearson correlation	1		.770**	-.269	.985**	.883**
	Sig. (bilateral)			.000	.252	.000	.000
	Sum of squares and vector products	1.425E+13		23337635,61	-28798567,3	2,332E+12	1,031E+12
	Covariance	7.500E+11		1228296.611	-1515714.067	1,227E+11	5,425E+10
	N	20		20	20	20	20
CONSTANT PRICE	Pearson correlation	.770**		1	-.414	.783**	.628**
	Sig. (bilateral)	.000			.069	.000	.003
	Sum of squares and vector products	23337635.61		64.491	-94.422	3946400.506	1559544.00
	Covariance	1228296.611		3.394	-4.970	207705.290	82081.263
	N	20		20	20	20	20
PER CÁPITA CONSUMPTION	Pearson correlation	-.269		-.414	1	-.345	-.071
	Sig. (bilateral)	.252		.069		.136	.765
	Sum of squares and vector products	-28798567.3		-94.422	805.066	-6143255.830	-626670.000
	Covariance	-1515714.067		-4.970	42.372	-323329.254	-32982.632
	N	20		20	20	20	20
HEAD OF CATTLE	Pearson correlation	.985**		.783**	-.345	1	.822**
	Sig. (bilateral)	.000		.000	.136		.000
	Sum of squares and vector products	2,332E+12		3946400.506	-6143255.830	3,935E+11	1,595E+11
	Covariance	1,227E+11		207705.290	-323329.254	2,971E+10	8394496905
	N	20		20	20	20	20
MILK POWDER IMPORTATION	Pearson correlation	.883**		.628**	-.071	.822**	1
	Sig. (bilateral)	.000		.003	.765	.000	
	Sum of squares and vector products	1,031E+12		1559533.000	-626670.000	1,595E+11	9,559E+10
	Covariance	5,425E+10		82081.263	-32982.632	8394496905	5030831579
	N	20		20	20	20	20

****Correlation is significant at the 0.01 level (bilateral). **Source**: Authors' own elaboration, 2020.

Volume - Heads of Cattle

Where data from the Agri-food and Fisheries Information Service (SIAP), mentions that the appreciation of world milk production for the year 2019 positioned the European Union as the main milk producer; while Mexico was in eighth place (SIAP, 2019). In contrast with the Food and Agriculture Organization of the United Nations (FAO) (2010), who considers that the countries with the highest milk losses are Russia, Mexico, China, Indonesia, Italy and Algeria; where Mexico is considered one of the countries with the lowest milk productivity per cow, only surpassed by India and Brazil.

Taking the aforementioned information as a reference and performing a correlation analysis of the variables volume and number of head of cattle over the last two decades in Mexico, the result is a high correlation (.985) between both variables (Figure 2).



Source: Authors' own elaboration, 2020

Figure 2. Simple dispersion with line adjustment of the variables Volume per Head of Cattle, 2000-2019 cycle

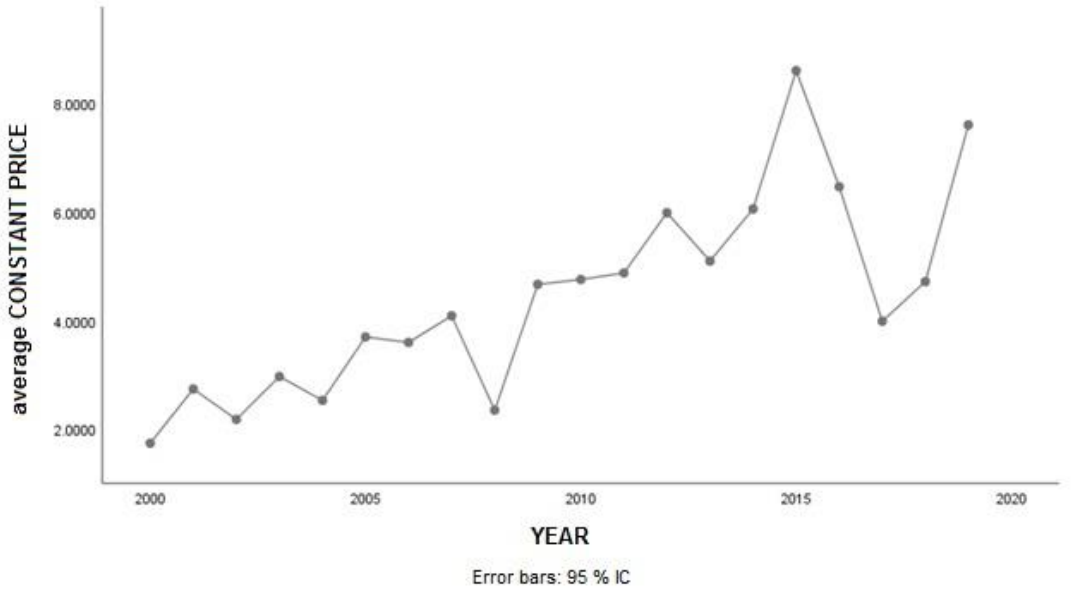
This is interpreted as a deficit in dairy productivity in Mexico, since ideally the number of cattle would be decreasing or otherwise permanent in recent years, meaning that the cattle have a good performance. Therefore, the profitability of Mexican dairy production units is questionable.

It is important to consider that Mexico has a very varied dairy production from one region to another, as well as factors in the adoption of technologies, the agroecological and socioeconomic context, in addition to the climatic and cultural conditions of the communities (Camacho *et al.,* 2017[b]; SIAP, 2019). Where the success of agricultural production systems will depend on available resources, productivity and income, applied technology and product generated (Barrios & Olivera, 2013).

Constant price

SIAP reported in 2019 that the value of bovine milk production in Mexico during 2018 exceeded 71 billion pesos. With an average daily production of 32.9 million liters of milk. In addition to highlighting that milk production in Mexico is higher during the summer, due to the fact that the rainy season increases the availability of fodder (FIRA, 2019).

During the study, the current price was deflated taking 2010 as the base price, thus obtaining the constant price per liter of milk paid to the producer in the 2000-2019 cycle (Figure 3). A significant drop was observed in 2017, and then recovered in 2019.



Source: Authors' own elaboration, with data from SIAP (2020).

Figure 3. Simple error bars of average Constant Price per year (2000-2019)

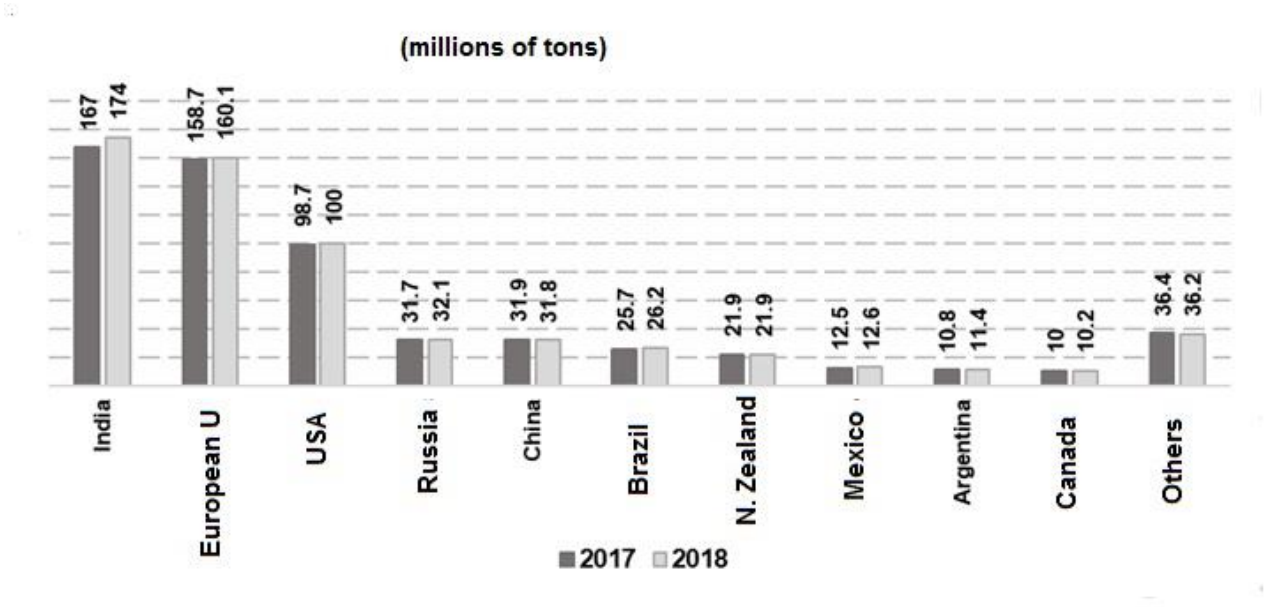
If It takes 2017 as a reference, it is important to consider that the increase in fuel and food prices was visible in the behavior of non-core inflation, which increase from 3.1% in 2016 to 12.6% in 2017, as a result of an acceleration in all its components: agricultural (9.8%), energy (17.7%) and government-authorized tariffs (8.4%) (Cordera *et al.,* 2017).

Now, when performing the Pearson correlation analysis and taking Hinkle *et al.* (2003) as a reference for its interpretation, the per capita consumption variable obtained an absence of correlation (-.414) with the constant price. This indicates that, although consumption continues to rise, it does not influence the constant price paid to the producer. Meanwhile, a moderate correlation (.628) was obtained for the powdered milk imports variable. This coincides with Robledo (2018) and Cervantes & Cesín (2019), who preliminarily conclude that the price of milk paid to the producer in Mexico will continue to be low due to the increase in powdered milk imports, which displaces domestic production. In turn, authors such as Ramírez *et al.* (2010) and Davalos & Villegas (2005) mention that within the framework of the North American Free Trade Agreement (NAFTA) renegotiation, milk is one of the points of concern for Mexico, since the vulnerability of this market is directly related to prices. Besides considering that currently the term "sustainability" maintains an impact on the profitability of animal production units; since in a research conducted by Olivera *et al.* (2018) conclude that livestock producers do not know or dimension the transcendence for productivity and profitability that the application of economic, social and environmental tools would have; thus implying the term "sustainable development" (Girón, 2016). Demonstrating that productivity as the profitability of dairy production units, as well as the quality of life of producers, will be strengthened by the sustainability application (Zarate *et al.,* 2010).

Per capita consumption

FIRA's Directorate of Sectoral Economic Research and Evaluation, through its 2019 milk and dairy report, compiled relevant information from the national and international context of dairy production. It reports that according to data from the United States Department of Agriculture (USDA), in 2018 the world consumption of fluid milk reached an all-time high of 605.3 million tons. Where industrial use represents the highest consumption with 70% in the same year, either for value addition to liquid milk or for the production of dairy derivatives. Consumption of unprocessed fluid milk represented 29.2% of total consumption, while consumption for animal feed represented only 0.8% (FIRA, 2019).

Internationally India is the main consumer of fluid milk. Its demand in 2018 represented 26.7% of world production, attributed to population growth and the increase in income of the population. In turn, Mexico ranks eighth in fluid milk consumption; where its demand in the same year represented 2.04% of world production (FIRA, 2019) (Figure 4).



Source: FIRA with data from USDA, 2019.

Figure 4. Main milk consuming countries

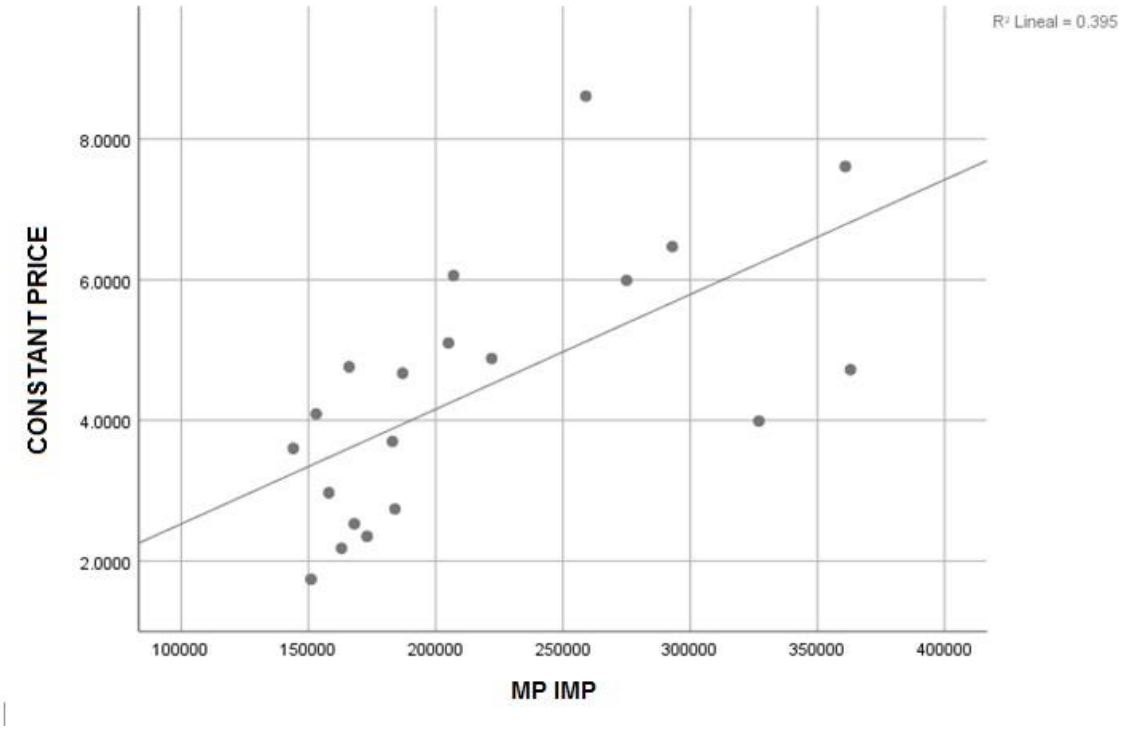
However, when performing the Pearson correlation analysis and taking Hinkle et al. (2003) as a reference for its interpretation, we obtained an absence of correlation between per capita consumption and the other variables. Thus concluding that imports of powdered milk into the country (-.071) do not influence the consumption of dairy products. Although it is important to mention that the behavior of per capita consumption in the last 10 years continues to rise (SIAP, 2019). For authors such as Montaño *et al.* (2012), mention that in northern Mexico consumers prefer whole fat milk, where the information provided by the producer will condition their consumption (Valencia *et al.,* 2015).

Imports of powdered milk

Although the Mexican dairy sector has favorable environmental conditions to be productive, imports of milk powder are currently on the rise. In this study, when performing the Pearson correlation analysis and taking Hinkle *et al.* (2003) as a reference for its interpretation, a high correlation was obtained between the average annual volumes (.883), coinciding with Engler & Nahuelhual (2003) who state that imported milk and domestic production behave as substitutes in consumption and in the industry. Similarly, the variable Number of cattle heads maintained a high correlation (.822), which is difficult to explain. It would be expected that the higher the number of head of cattle, the higher the productivity would also increase, and thus imports would

be expected to be lower. The per capita consumption variable showed an absence of correlation (-.071).

In turn, the constant price variable maintains a moderate correlation (.628), where authors such as Díaz *et al.* (2007) mention that "in the milk market, the industry exercises monopsony power over prices and to avoid a fall in domestic prices, imports must be curbed and controls must be exercised on the industry". Figure 5 shows a constant price growth and a tendency for powdered milk imports to grow, but it is presumed that there are other causes of dependence.



Source: Own elaboration, with data from SIAP (2020).

Figure 5. Simple dispersion with constant price line adjustment for powdered milk imports

Authors such as Espinoza *et al.* (2019), mention that if imports of milk powder and derivatives continue, the price of fresh milk in the national territory will continue to be affected, which, if we consider the variability in the constant price observed in Figure 5, can be attributed to a certain extent to imports of milk powder; thus coinciding with the aforementioned author. Powdered milk imported from the United States enters the

country at partially low prices, although it is important to note that imports only represent 21% of the milk market (Ramírez *et al.,* 2010). Thus making Mexico dependent on the external market by importing more powdered milk than the fresh milk it exports (Rodríguez & Armenta, 2018).

CONCLUSION

The current context of Mexican milk production was evaluated using data from the last two decades as a reference; through quantitative variables: volume, head of cattle, constant price, per capita consumption and imports of powdered milk. The background information shows that, over time, Mexico has not been able to improve its production and competitiveness in the international arena, despite the fact that the country has the ideal climatic conditions for milk production. In the correlation analysis carried out, it is concluded that powdered milk imports are highly correlated with the volume variable, which means that even though production continues to increase, it is not enough to supply domestic demand.

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