

# Goat milk production in Guanajuato, Mexico: Coordination mechanisms established in the agri-food chain

Santos-Lavalle, Rodolfo<sup>1</sup>; Flores-Verduzco, Juan J.<sup>2</sup>; Olmos-Oropeza, Genaro<sup>3</sup>; Roldán-Suárez, Elizabeth<sup>4</sup>; Islas-Moreno, Asael<sup>2\*</sup>

<sup>1</sup> Universidad Para el Bienestar Benito Juárez García, Camino Presa de San Onofre # 21, Ayotlán, Jalisco, México, C. P. 47930.

<sup>2</sup> Centro de Investigaciones Económicas Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIESTAAM), Universidad Autónoma Chapingo (UACH). Carretera México-Texcoco km 38.5, Chapingo, Estado de México, México, C. P. 56230.

<sup>3</sup> Colegio de Postgraduados, Campus San Luis Potosí, Iturbide 73, Colonia Centro, Salinas de Hidalgo, San Luis Potosí, S. L. P., México, C. P. 78620.

<sup>4</sup> Universidad Politécnica de Texcoco, Carretera Federal Los Reyes-Texcoco km 14+200, San Miguel Coatlinchán, Estado de México, México, C. P. 56250.

\* Correspondence: aislas@ciestaam.edu.mx

**Citation:** Santos-Lavalle, R., Flores-Verduzco, J. J., Olmos-Oropeza, G., Roldán-Suárez, E., & Islas-Moreno, A. (2022). Goat milk production in Guanajuato, Mexico: Coordination mechanisms established in the agri-food chain. *Agro Productividad*. <https://doi.org/10.32854/agrop.v14i6.2120>

**Academic Editors:** Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

**Received:** September 06, 2021.

**Accepted:** May 19, 2022.

**Published on-line:** June 17, 2022.

*Agro Productividad*, 15(6). June. 2022. pp: 51-58.

This work is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International license.



## ABSTRACT

**Objective:** To characterize the goat producers according to the industrial destinations of the milk, in order to analyze the coordination mechanisms established in the agri-food chain.

**Design/Methodology/Approach:** A survey was applied to 122 randomly selected goat producers. Taking into account two industrial destinations, a socioeconomic, productive, and commercial comparison was carried out, through T-tests for independent means. In order to analyze the coordination mechanisms, the data were complemented interviewing owners of collection centers and businessmen who processed milk.

**Results:** The producers had small herds and a basic level of education. They used family workforce. The lack of organization in the sale limited their participation in the agri-food chain coordination.

Milk processing companies coordinate their efforts, organizing the collection, reaching trade agreements, setting prices, and establishing quality rules, usually through informal agreements.

**Limitations/Implications:** State intervention is necessary to regulate relations between the actors of the agri-food chain.

**Findings/Conclusions:** The informality of coordination mechanisms favors agribusiness and turns them into forms of domination that ensure their profitability.

**Keywords:** Goat producers, agri-food chain, goat cheese, *cajeta*.



## INTRODUCTION

The state of Guanajuato, Mexico, with a 42.3 million liters of goat milk production, ranks second in the country (SIAP, 2020). Producers carry out the activity mostly on a low scale; therefore, they diversify their income, working in agricultural production, as day laborers, and in small businesses (Iñiguez, 2013).

In addition, they are part of an agri-food chain; as suppliers, they are one of the links in different value networks. Their income depends on the decisions of companies whose economic power and position as articulating link enables them to coordinate this chain (Missohou *et al.*, 2004). This is the consequence of the oligopsony characteristics of Guanajuato's milk market, which is controlled by few companies. The power of this companies limits the value rate obtained by the producers (Escareño *et al.*, 2012; Oseguera *et al.*, 2014).

Very few producers have improved their insertion in the chain. Those who have chosen alternative methods engage in a different marketing channel: they sell their production to manufacturers of artisanal *cajeta* (a Mexican Candy traditionally made with goat milk and sugar; it has a liquid and thick consistency and is optionally seasoned with essences, spices, and liqueurs) or add value by processing it into cheese (Santos-Lavalle *et al.*, 2018). However, this has not happened with the bulk of goat producers.

Within the previous context, the objective of this work was to characterize the goat producers according to the main industrial destinations of milk in Guanajuato, in order to analyze the coordination mechanisms established in the agri-food chain.

## MATERIALS AND METHODS

The research was conducted in Guanajuato, Mexico. The agri-food chain approach proposed by the Inter-American Institute for Cooperation on Agriculture (IICA) was used. This approach includes the set of actors and activities around a product in a given space (Herrera and Burgeois, 1996).

The field work was carried out from January to April 2019. The information was collected through semi-structured interviews with 122 goat milk producers, who were selected through a simple stratified sampling.

The sampling frame consisted of 408 producers who supplied goat milk to collection centers in five of the municipalities with the highest production in the state: 1) Santa Cruz de Juventino Rosas, 2) Apaseo El Grande, 3) Salvatierra, 4) Tarimoro, and 5) Valle de Santiago. At the same time, they supply the main agribusinesses that transform milk into gourmet cheeses or *cajeta*.

The variables related to the producers and their production system focused on socioeconomic, productive, and marketing aspects of milk. The analysis was focused on two groups of producers that are distinguished by the industrial destination of their product: cheese and *cajeta*.

Independent mean t-tests were performed to identify significant differences between the groups. A correlation matrix was carried out according to the Pearson coefficient to identify the variables with the greatest association with the industrial destination of the milk: experience of the producer, liters produced per goat, production system, sale price

per liter, price-setting body or individual, and potential penalization for low quality milk. Statistical tests were performed in the SPSS software.

Additionally, to understand the coordination mechanisms of the agri-food chain, interviews were conducted with owners of collection centers and with representatives of the main companies that processed goat milk.

## RESULTS AND DISCUSSION

### Producer profile and production system by industrial destination

The two industrial destinations of goat milk were the production of gourmet cheeses and the production of *cajeta*. The first destination included the largest companies, Interdeli, S. A. P. I de C. V. and Alimentos Carol, S. A. de C. V., operated in Queretaro. In the second, PROLECO S. P. R. de R. L. —supplier of Dulces Coronado, a subsidiary of Bimbo S. A. de C. V.— was found in Lagos de Moreno, Jalisco.

No significant statistical differences were found in the age and education of the producers; however, there was a difference between groups regarding the years of experience ( $p < 0.05$ ). Producers who sold their milk to the cheese industry were less experienced and were the most numerous; it can be surmised that they found this activity more attractive.

Regardless of the industrial destination, there were no differences in the number of workers and the type of workforce, which were mainly family-based. Escareño *et al.* (2011) pointed out that family members are an important source of workforce.

No differences were found in the number of milking goats; however, there were differences in milk production per goat ( $p < 0.05$ ), although milk production was inversely related to the industrial destination ( $r = -0.351$ ). On average, the group that sold to the candy industry produced 0.46 liters less milk (Table 1).

The producers in this group were the most experienced; however, more years in the activity do not mean higher productivity. In contrast, Salinas *et al.* (2015) consider experience as an intangible value and a factor related to productivity: goat farmers with more experience obtained 23.4% more milk.

**Table 1.** Comparison of variables per industrial destination group of goat milk in Guanajuato, Mexico.

Variable	Production destination	
	Candy industry (n=22)	Cheese industry (n=100)
Producer age (years)	51.22 ± 14.69 a	49.36 ± 15.26 a
Schooling (years)	6.40 ± 3.28 a	5.9 ± 3.84 a
Experience (years)	23.59 ± 15.84 a	15.14 ± 13.94 b
Number of workers	1.86 ± 0.77 a	2.25 ± 1.08 a
Number of family members involved	1.86 ± 0.77 a	2.15 ± 1.08 a
Number of milking goats	16.41 ± 8.82 a	20.12 ± 22.17 a
Producción por cabra (litros/día)	1.71 ± 0.79 a	2.17 ± 0.77 b
Precio pagado al productor (\$/litro)	5.80 ± 0.32 a	6.55 ± 0.34 b

Means with different letters in each row indicate differences between groups ( $p < 0.05$ ).

The average production per goat (1.7 liters of milk) observed in the first group surpasses the results of Escareño *et al.* (2011), who reported 1.5 liters per goat in low-intensity and grazing-dependent systems.

In this study, the difference in production was attributed to the feeding system. In this regard, an inverse relationship was found with the destination industry ( $-0.340$ ); that is to say, the stabling system was associated with the group that supplied the cheese industry, while the extensive pasture grazing system was related to the cajeta industry.

Most of the producers who sold to the cheese industry kept the goats in stable conditions (63%); this system was associated with the number of milkings ( $r=0.322$ ). In this group, the implementation of two milkings per day was higher (31 *vs.* 10%). Both situations favored a higher production of milk per goat.

These results are logical, given the conditions of Guanajuato. Along with the traditional system of small herds in communal pastures, there is a stabling system production, while large-scale companies employ more innovations. The same thing happens in other parts of Mexico: the deterioration of the pastures makes it necessary to supplement the diet with grains, cut-and-carry forage, or through agricultural by-products (Wurzinger *et al.*, 2013; Salinas *et al.*, 2015), leading producers one step closer to complete stabling.

To contextualize, Ruiz-Zarate *et al.* (2012) report significantly higher milk yields (3.0 liters/days) in Saanen goats, under stabling conditions, than in this study. These results make it clear that there is a gap in the adoption of innovations.

Iñiguez (2013) argues that the production intensification processes increase if the production system interacts with the industry. Similar conclusions have been found in other countries (Ådnøy, 2014; Dubeuf *et al.*, 2018).

However, based on the prices, Dulces Coronado prefers to be supplied by producers with extensive grazing systems.

### **Coordination mechanisms**

Large-scale goat milk processing companies have managed to coordinate the agri-food chain through four lines of action: 1) the organization of the collection, 2) the achievement of commercial supply agreements, 3) the ability to set prices, and 4) the establishment of quality rules.

In a first approximation, these coordination mechanisms enable the integration of the links of the chain: *i.e.*, its structural development as a system. Additionally, they make it work to fulfill the essential purpose of generating food.

#### **1) The organization of the collection**

The agribusinesses had a supply system at their service. Although they did not own that service, they took part in its creation. Those services consist of strategically located collection centers with cold tanks; additionally, these centers are complemented by people who follow established collection routes.

Collection centers have developed over time as independent companies, in response to the arising demand and because some of them acquired equipment with the support of the government or leading companies. Most of them (19 out of 21) fulfill the function of

intermediaries between milk producers and processing companies, consolidating themselves as one more link. As a consequence of the lack of producer initiatives to organize the collection (with two exceptions), the position occupied by intermediaries is essential to capture small volumes from a large number of producers (Jaligot *et al.*, 2016) and to spread the policies of processing companies.

## 2) Commercial supply agreements

The processing companies needed to ensure the supply of milk, taking into account the following conditions: a price they were willing to pay; a volume that met their schedule; a certain quality level; and a guarantee of exclusivity. Therefore, supply agreements with collection centers were essential.

Overall, these agreements were established verbally (*i.e.*, they were informal). In practice, there was a tendency to maintain stable relations, to respect commitments to supply a single agribusiness, and to apply its price and quality policies.

Similarly, commercial transactions between the collection center and the producers were carried out informally. Exclusivity was also sought, and power was exercised to establish price and quality conditions; the producers accepted this situation in which they had no influence, because they are the most numerous, dispersed, and disorganized link (Iñiguez, 2013).

## 3) Price setting

An inverse relation was found between the destination industry and the price per liter of milk received by the producers ( $r = -0.539$ ) and differences between groups were observed ( $p < 0.05$ ). The cheese industry paid a better price for the milk it acquired; therefore, most producers-maintained relationships with these companies. Meanwhile, the lower price received by the group that supplied the candy industry was attributed to greater intermediation.

The price variation also depended on the organizational level of the producers; in two collection centers of organized producers obtained a higher sale price (15.3% higher) from Carol S. A. de C. V. Cooperation increases the power of negotiation with chain agents (Trienekens, 2011) and increases the value obtained (Sahlu and Goetsch, 2005).

However, in most of them, the lack of organization for the sale of milk was evident. Therefore, because of their dependency on intermediaries, many producers do not receive the full wealth they should (Ortiz *et al.*, 2008) and do not have enough power to negotiate prices.

This study did not only look into the price, but also pondered who establishes it. Eighty percent of the respondents mentioned that the price per liter of milk was decided by the buyer, 17% indicated that it was a mutual agreement with the buyer, and 3% considered that it was established by the market.

An inverse relationship ( $r = -0.308$ ) was identified between who defines the price and the industrial destination, with differences between groups ( $p < 0.05$ ). Most of those who destined the milk to the cheese industry agreed that the buyer (*i.e.*, the collection center) decided the price (86 vs. 59%).

Olhagaray and Espinosa (2007) reached a similar conclusion: the collectors determine the price of goat milk. That is to say, the producers identify the agent with whom they establish an immediate relationship as the buyer and do not mention the processing companies or any other intermediary that may be present in the chain.

Some testimonies from owners of collection centers confirmed that agribusinesses set the prices for the collection centers and these, in turn, set prices for milk producers. The price remains constant throughout the year and is set without considering production costs, seasonality of supply, and industrial quality of goat milk, which is superior to cow milk (Dubeuf *et al.*, 2004).

#### 4) The quality of the milk

Processing companies establish quality criteria and an evaluation system as a requirement to buy milk from each supplier. Both the cheese and the cajeta industries consider acidity, adulteration with water, and the presence of antibiotics as quality parameters. Ninety-three of the interviewees were aware that it was an essential requirement and that they would not sell if they did not comply with it. Nevertheless, more than 60% said they had been penalized. The non-compliance penalization was associated with the industrial destination, and it had an inverse relationship ( $r = -0.335$ ). It was more frequent among producers that supplied cheese companies (93.8 *vs.* 85%); therefore, the *cajeta* industry seems less strict.

A large part of the producers lacks the conditions to meet the established quality requirements, given the limited technological inputs at their disposal (Iñiguez, 2013). For example, goats are milked by hand when they are still inside the stable (Escareño *et al.*, 2011), not in specific milking areas, and under unhygienic conditions (Gómez-Ruiz *et al.*, 2012). It could not be otherwise, given the lack of training and resources to invest in facilities and appropriate equipment.

The poor operation was not solely the responsibility of the producers; it was observed on the routes to the collection centers and even from there to the processing companies. In the first case, the collector carried out a superficial evaluation of the milk, but transportation did not include conservation management (Ortiz *et al.*, 2008), which probably led to the proliferation of bacteria (Olhagaray and Espinoza, 2007).

In addition, quality monitoring was interrupted in the collection centers, because they did not carry out daily samples per producer and not all of them had the required laboratory equipment (only two in the cheese agroindustry). Consequently, shipments were rejected in all of them, causing economic losses even to the producers, who sometimes were not paid for the milk.

The processing companies evaluated the milk in the collection center before each shipment, but failed to routinely carry out a microbiological count before they accepted or rejected the milk. The requirements are temperature below 3 °C; acidity of 14-15 °Dornic (microbiological contamination); fat between 2.1 and 2.9%; protein between 3.2 and 3.5%; and no water or antibiotics adulteration.

Therefore, informal agreements for the application of quality standards do not guarantee milk quality. On the one hand, it is doubtful that leading companies care about consumer health. On the other hand, the collection centers are not interested in equipping

themselves and do not follow quality evaluation routines. Finally, the producers do not have the conditions to comply with the required parameters.

Although prices do not promote milk differentiation based on its quality (Gómez-Ruiz *et al.*, 2012), there are opportunities for future progress, as long as appropriate regulations are applied with equity (Iñiguez, 2013).

## CONCLUSIONS

In the agrifood chain of goat milk in Guanajuato, Mexico, the processing industry companies generate the demand for milk and the policies for its operation. The coordination mechanisms that they establish allow them to control the rest of the actors, ensuring the profitability of the investments. The coordination of the chain with informal agreements is essentially beneficial for the companies that concentrate power. However, it is incapable of ensuring quality and favors the unequal distribution of wealth. We suggest changing to formalized agreements and contracts, as well as developing regulations, with the intervention of the chain's own agents and a determined participation of government entities.

## REFERENCES

- Ådnøy, T. (2014). The dairy goat industry in Norway: Challenges in a historical perspective. *Small Ruminant Research*, 122(1–3), 4-9. <https://doi.org/10.1016/j.smallrumres.2014.07.011>
- Burgeois, R., & Herrera, D. (1996). *Enfoque participativo para el desarrollo de la competitividad de los sistemas agroalimentarios*. 2ª ed.; CADIAC/IICA: San José, Costa Rica. 228 p.
- Dubeuf, J. P., Ruiz, M. F., & Mena, G. Y. (2018). Evolution of goat production systems in the Mediterranean basin: Between ecological intensification and ecologically intensive production systems. *Small Ruminant Research*, 163, 2-9.
- Dubeuf, J. P., Morand-Fehr, P., & Rubino, R. (2004). Situation, changes and future of goat industry around the world. *Small Ruminant Research*, 51(2), 165-173.
- Escareño, S. L., Salinas-González, H., Wurzinger, M., Iñiguez, L., Sölkner, J., & Meza-Herrera, C. (2012). Dairy goat production systems: status quo, perspectives, and challenges. *Tropical Animal Health and Production*, 45(1), 17-34. <https://doi.org/10.1007/s11250-012-0246-6>
- Escareño, S. L. M., Wurzinger, M., Pastor, L. F., Salinas, H., Sölkner, J., & Iñiguez, L. (2011). La cabra y los sistemas de producción caprina de los pequeños productores de la Comarca Lagunera, en el norte de México. *Revista Chapingo Serie Ciencias Forestales y del Ambiente*, 17(Especial), 235-246. <https://doi.org/10.5154/r.rchscfa.2010.10.087>
- Espinosa, O. V. E., Rivera, H. G., & García, H. L. A. (2008). Los canales y márgenes de comercialización de la leche cruda producida en sistema familiar (estudio de caso). *Veterinaria México*, 39(1), 1-16.
- Gómez-Ruiz, W. J., Pinos-Rodríguez, J. M., Aguirre-Rivera, J. R., & García-López, J. C. (2012). Analysis of a goat milk cheese industry in a desert rangeland of Mexico. *Pastoralism*, 2(5), 1-12. <https://doi.org/10.1186/2041-7136-2-5>
- Iñiguez, R. L. (2013). *La producción de rumiantes menores en las zonas áridas de latinoamérica*. Embrapa: Brasília, Brasil. 564 p.
- Jaligot, R., Wilson, D. C., Cheeseman, C. R., Shaker, B., & Stretz, J. (2016). Applying value chain analysis to informal sector recycling: A case study of the Zabaleen. *Resources, Conservation and Recycling*, 114(1), 80-91.
- Missohou, A., Diouf, L., Racine-Samba, S., & Wollny, C. B. A. (2004). Goat milk production and processing in the NIAYES in Senegal. *South African Journal of Animal Science*, 34(1), 151-154.
- Olhagaray, R. E. C. & Espinoza, A. J. J. (2007). Producción y comercialización de la leche de cabra en el GGAVATT-INIFAP “Juan E. García” en Lerdo, Durango México. *Revista Mexicana de Agronegocios*, 11(20), 308-313.
- Oseguera, M. D., Keilbach, B. M. N., van Der, Z. A., Sato, C., & Udo, H. (2014). ‘It is better to herd than to be herded: making a living with goats in the Bajío region, Mexico. *Pastoralism*, 4(9), 1-18. <https://doi.org/10.1186/s13570-014-0009-2>

- Ruiz-Zarate, F., Fuentes-Rodríguez, J. M., Aguirre-Villaseñor, L., López-Trujillo, R., & Alfaro-Aguilar, A. J. (2012). Productividad de cuatro explotaciones caprinas en Saltillo, Coahuila, México. *Agraria*, 9(2), 73-79.
- Sahlu, T., & Goetsch, A. L. (2005). A foresight on goat research. *Small Ruminant Research*, 60(1-2), 7-12.
- Salinas, G. H., Meza, H. C., Escareño, S. L., Echavarría, Ch. F., Maldonado, J. J., & Pastor, L. F. (2015). *Sistemas de producción caprinos carne-leche tendencias productivas en México y el mundo*. In: Enfermedades de las cabras, 1ª ed.; Díaz-Aparicio, E., Torotora-Pérez, J. L., Palomares-Reséndiz, E. G., & Gutiérrez-Hernández, J. L., Eds.; INIFAP: Distrito Federal, México. pp. 3-22.
- Santos-Lavalle, R., Flores-Verduzco, J. J., Cervantes-Escoto, F., Salas-González, J. M., & Sagarnaga-Villegas, L. M. (2018). Oportunidades para caprinocultores de Guanajuato, México, en la comercialización de queso fino. *Revista Mexicana de Ciencias Pecuarias*, 9(3), 601-613. <https://doi.org/10.22319/rmcp.v9i3.4500>
- SIAP. (2020). Leche de caprino. Avance de la producción pecuaria por estado. Servicio de Información Agroalimentaria y Pesquera. Recuperado el 16 de mayo de 2021, de SIAP: <https://www.gob.mx/siap/acciones-y-programas/produccion-pecuaria>
- Trienekens, J. H. (2011). Agricultural value chains in developing countries a framework for analysis. *International Food and Agribusiness Management Review*, 14(2), 51-82.
- Wurzinger, M., Escareño, L., Pastor, F., Salinas, H., Iñiguez, L., & Sölkner, J. (2013). Design and implementation of a community-based breeding program for dairy goats in Northern Mexico. *Tropical and Subtropical Agroecosystems*, 16(1), 289-296.

