

Characteristics of milk production in La Frailesca, Chiapas, Mexico

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Abstract:

Historically, the Frailesca region has been one of the main livestock farming areas of the state of Chiapas, so it can be assumed that the current structure of its dairy system is a good approximation of that of the state. This work aimed to characterize and analyze the production units that are part of the dairy system of the Frailesca region, with the intention of describing their structure in terms of size and type of production units. For this purpose, production parameters, production costs and profitability indicators were used. The main characteristics of the production units, in terms of their size and operating conditions by locality of origin, were determined in order to construct a typology of producers and to

make a contrast by locality. It was found that the productive structure of the region is based on small-scale units that constitute about 76.7 % of the total units of the sample, while medium-sized producers represent 14.6 % of the total and large ones only 8.7 %. Between these types of producers, there is a significant difference in terms of the size of the productive herd, yield, costs and profitability. In summary, the structure of the productive system of the Frailesca region, like other tropical dairy systems in the country, is made up of small-scale production units with characteristics of labor-intensive family units, low technological level and high supplementation costs.

Key words: Dairy production system, Profitability, Seasonality.

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Introduction

The state of Chiapas, along with other states in the southeast, is part of the states where the economic units of cattle farming follow an extensive-production, grazing and dual-purpose pattern^(1,2,3). Throughout its history as a milk-producing state, the state has advanced within the top ten positions in terms of its production volume, although with less significant increases than those that occurred in regions with family livestock farming (Jalisco) or intensive livestock farming (Coahuila)⁽⁴⁾.

In Chiapas, cattle farming is a relevant activity for the state's economy and has enormous relative importance in the primary sector. Since 2005, milk production has maintained a slight upward trend, which has placed the state as the ninth producer, even above states with higher levels of technification such as Hidalgo⁽⁴⁾; despite the fact that it had been one of the states where the lowest prices paid to the producer had been reported until 2010. However, from that same year, there was a turning point in the behavior of this variable, which marked a modification towards a growing trend in terms of the real income paid to the producer⁽⁴⁾.

Historically, the Frailesca region has been one of the main livestock farming areas in Chiapas. In 2018, Villaflores, La Concordia and Villa Corzo, three municipalities of La Frailesca, ranked among the main milk-producing municipalities of the state, along with Ocozocuatla, Tecpatan and Tapachula⁽⁴⁾. The region concentrates 10 % of the livestock

production units in the state and it is in milk production where it has the greatest relevance, given that 20 % of the units with dairy activity are located within its limits⁽⁵⁾. In La Frailesca, according to the latest livestock censuses, 85 % of the dairy herd is maintained under some type of grazing system and the remaining proportion under stabling⁽⁵⁾.

In the current configuration of the value chain, five main links can be distinguished: supply, production, collection, processing and commercialization⁽⁶⁾. The primary link has commercial linkages backwards with local and regional suppliers of inputs. Of these, those related to the supply of supplements for livestock feeding stand out for their importance, especially producers and marketers of poultry manure, grains and fodder⁽⁶⁾. The links that producers have “forward” in the chain are diverse and depend, among other things, on the type of production units and their spatial and technological situation. The main linkage of producers forward is carried out with a key link in processing: cheese production. A good part of milk production becomes a raw material for the local and regional cheese industry, both for the artisanal industry and for that with industrial processes⁽⁶⁾.

To deepen the analysis of the behavior of milk production systems, it is necessary to identify the characteristics of milk production units (MPU), which is done in this work through a cluster analysis as a way to obtain better explanations about the economic activity and as a resource for the design of better management strategies⁽⁷⁾. The production potential of MPUs in the country could increase if differentiated technological intervention policies and strategies were generated⁽⁸⁾. For this purpose, an effective characterization is necessary. Although different variables have been used for the typification of production units, the ones that provide the best results for the analysis of milk production systems are the size of the production unit and the level of production⁽⁹⁾. This method of analysis, at present, is one of the most used, as evidenced in recent case studies in Brazil, Colombia and Mexico⁽¹⁰⁻¹³⁾, because it allows finding more relationships between the variables studied. This is especially relevant because milk production is carried out in all agroecological regions of the country, which range from highly technified to those of subsistence⁽¹²⁾.

In this sense, this work aimed to characterize the milk production systems in the main producing localities of the Frailesca region, through an analysis of the main production parameters of the MPUs and an analysis of the production costs and the benefit-cost ratio (profitability) for comparative purposes.

Material and methods

A convenience sampling was carried out in the main localities with milk production within the municipalities that make up the Frailesca region. Three of the municipalities with the highest dairy activity were considered: La Concordia, Villaflores and Villa Corzo. Of these municipalities, eight localities were selected in such a way that there was an adequate representation of the production systems linked to artisanal cheese making and, on the other hand, those most linked to the larger processing (industrial). The selected localities were Benito Juárez, La Concordia (municipal seat) and Las Toronjas in the municipality of La Concordia; San Pedro Buena Vista, Revolución Mexicana and Ricardo Flores Magón for the municipality of Villa Corzo; Calzada Larga and Los Ángeles in the municipality of Villaflores. In total, information was obtained from 104 MPUs (46 units from La Concordia, 22 from Villa Corzo and 36 from Villaflores).

In each locality, recognizable producers were detected and, later, through the snowball technique, other producers were found by reference of the previous ones. Through a structured questionnaire, information on technical-productive and economic variables regarding the characteristics of production, and the commercialization of milk produced in the different localities of the region, was obtained.

The economic variables were obtained at prices of the immediately preceding cycle, according to the producer's information. Most of the variable costs could be related to the monthly management of the herd, however, all were annualized in order to relate them to production and estimate the costs per cow and per liter. The calculation of the costs incorporated the sum of direct labor; costs of feeding, supplementation and medicines, costs for the purchase of feed for the herd (corn, fodder, silage, concentrate and poultry manure) and other direct costs related to the management of the herd (transport and freight, maintenance of meadows, payment of electricity, production of fodder, rent of paddocks and payment of professional services).

Unpaid labor was not taken into account because its inclusion was considered to underestimate the profitability of family MPUs. It is generally assumed that unpaid labor should be evaluated based on its opportunity cost in a hypothetical market. However, the labor of women, children or the elderly hardly has a reference market, in that sense, including its cost as an artificial opportunity cost implies incorporating a negative bias in the calculation of profitability. To calculate the profit of the production units from the sale of milk, seasonal changes in production and price variations throughout the year were taken into account, that is, the annual income was obtained as the sum of the monthly value of the

production. In this quantification, the seasonality of production and prices faced by each unit of production were considered.

The main characteristics of the production units, in terms of their size and operating conditions, were determined in order to construct a typology of producers and to make a contrast according to this characterization and their location by locality. The information obtained and the analyses constructed were cross-linked with information collected through focused interviews⁽¹⁴⁾ with key actors in the dairy system of the region and the state, in order to have elements to discuss and interpret.

With the information collected, a statistical analysis was carried out with the IBM SPSS® software. To contrast the characteristics of the different types of producers, a cluster analysis was carried out, in order to construct a typology based on the size of the production unit. Only the variable size was considered as a grouping factor, in order to have a better definition of the small, medium and large categories that are used by the official agencies related to the sector and in most investigations that seek to perform characterizations. For this purpose, the technique of grouping by furthest neighbors was used, since this method allows avoiding inconsistencies and undefinitions in the formation of groups⁽¹⁵⁾. Cluster analysis is a technique used to resolve group belonging and has been widely used in the characterization and classification of agricultural and livestock production systems^(16,17).

An analysis of variance was performed to delimit the existence of differences by size and location locality. To define the contrasts between the groups, a Scheffé test was used, given the characteristics of disparity in the size of the groups and the robustness of this method^(18,19,20). Both the design of the research and the analysis of the results and the interpretation of the information were carried out under the perspective of a single case study with multiple units of analysis⁽¹⁸⁾, understanding that it was the situation of the milk production system in La Frailesca, the main object of the work and, therefore, the case study of interest.

Results and discussion

According to the data obtained, about 65 % of the producers in the sample do not exceed herd sizes greater than 15 head of cattle in milking and 89 % do not reach 30 cows in milking. The average herd is 32.6 producing cows, a figure in which non-pregnant dry cows are also considered, while the average number of cows in milking is 16.37. This can be understood as the expression of a small-scale livestock farming where family labor^(13,21)

and low technological levels predominate. This type of productive structure is typical of the dual-purpose tropical livestock farming in southern, southeastern Mexico and Latin America^(11,22,23).

As a result of the conglomeration process carried out based on the number of producing heads existing in each farm, three conglomerates were defined. The first group is made up of the largest production units that have herds in a range between 75 to 90 producing cows. It is important to mention that this group of producers obtain the highest milk yields in the region, significantly higher than the average of the yields of the other two groups, which suggests that they have a better control of the production process or better conditions to carry it out. The second group of production units, considered of medium size, ranges from 44 to 66 producing cows and obtain average milk yields. And finally, the third group of small production units (the most numerous), which range from 6 to 42 producing cows and obtain the lowest milk yields (Table 1), however, statistically there is no difference between these last two groups.

Table 1: Herd characteristics by type of production unit (MPU)

Type of MPU	No. of MPU	Number of cows	Milking cows	Yield	Area (ha)	Stocking rate (cows/ha)
Small	80	23.3±9.1 ^a	11.9±5.7 ^a	6.8±3.6 ^a	24.6±19.0 ^a	1.52 ±1.47 ^a
Medium	15	52.3±7.8 ^b	25.2±11.5 ^b	8.0±4.7 ^a	51.4±43.7 ^b	1.50 ±0.83 ^a
Large	9	81.7±5.3 ^c	41.1±12.5 ^c	9.8±6.0 ^b	76.4±53.2 ^c	1.79 ±1.45 ^a

Yield= yield (L/cow/d).

^{abc} Shared superscript implies that there is no significant difference ($P<0.05$).

This classification gives a better idea of the productive structure of the region and corroborates that it is based on small-scale units that constitute about 76.7 % of the total units of the sample. For the sample obtained, medium-sized producers represent 14.6 % of the total and large producers only 8.7 %. Between these types of producers, there is a significant difference ($P<0.05$) in terms of the size of the producing herd and other parameters such as yield (not significant between small and medium-sized, but statistically different from the larger production units) and area measured in hectares (Table 1).

As for the area of the livestock production units, the size is very variable, so, farms ranging from 2 to 180 ha of paddocks can be found. However, the stocking rate is similar between small, medium and large production units. It is the small ones that present the maximum stocking rate values, a situation that can be explained by the lower availability of land and the fragmentation of the agricultural area in the region. These production units generally have a high dependence between the availability of pastures and the level of milk

production, in addition to a higher incidence of parasitic diseases and less access to the market⁽²⁴⁾.

The MPUs show a clear negative correlation between the available paddock area and the stocking rate to which it is subjected. That is, the smaller the paddock area available to the producer, the greater the stocking rate to which they subject that area. This fact is corroborated when analyzing the area of the ranches according to the locality in which they are located. As shown in Table 2, three of the localities with the smallest paddock area are also those with the highest number of animal units per hectare.

Table 2: Stocking rate of production units (MPU) by locality

Locality	Average area of MPU (ha)	Stocking rate (AU/Ha)	Yield (L/cow/d)
Calzada Larga	19.68±13.65 ^a	2.3±1.5 ^a	12.22±5.4 ^d
Las Toronjas	30.80±26.33 ^a	2.0±2.4 ^a	7.52±6.0 ^c
Revolución Mexicana	18.50±13.24 ^a	1.8±0.7 ^a	7.42±1.4 ^c
Benito Juárez	36.54±45.8 ^a	1.6±1.6 ^a	4.96±2.4 ^a
La Concordia	32.11±26.22 ^a	1.4±0.7 ^a	7.21±2.9 ^{bc}
Sn. Pedro Buenavista	42.27±41.53 ^a	1.3±1.0 ^a	6.79±1.0 ^{ab}
Los Ángeles	53.22±30.31 ^a	0.8±0.4 ^a	5.51±2.1 ^{ab}
Ricardo Flores Magón	38.60±26.95 ^a	0.7±0.5 ^a	5.32±1.5 ^{ab}

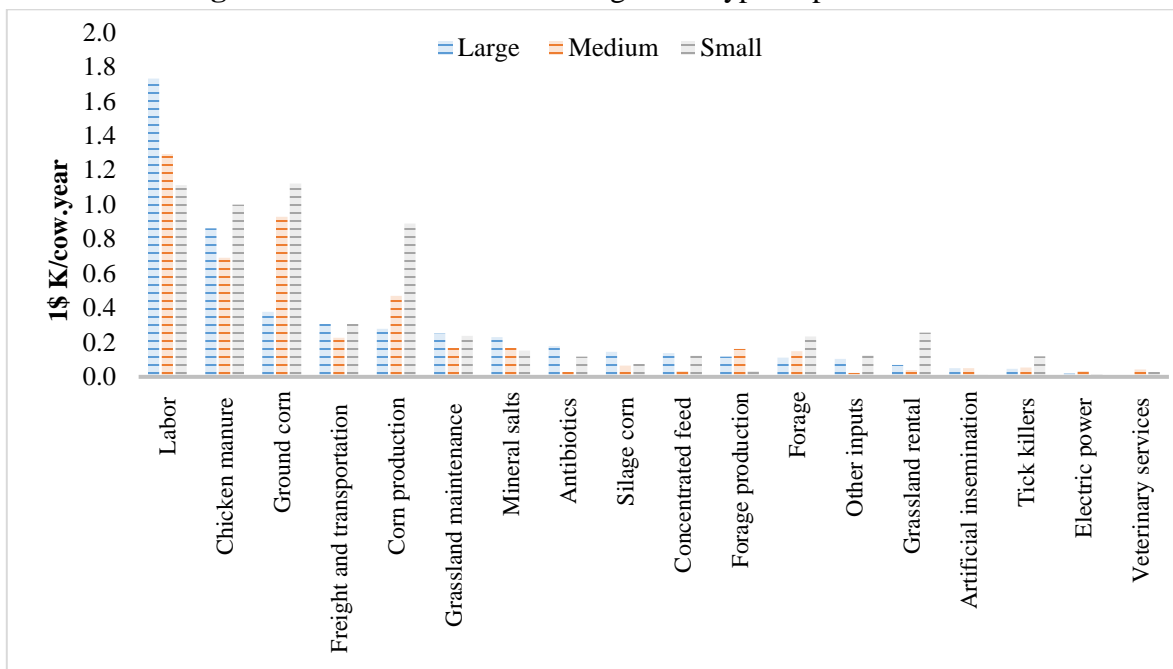
^{abcd} Shared superscript implies that there is no significant difference ($P<0.05$).

In the case of the locality of Calzada Larga, the units could be classified as more intensive and specialized, hence their smaller paddock area and their higher milking yields are natural, a feature that has already been described for milk producers in central Chiapas⁽²⁵⁾ and in Colombia where a higher production per animal and yield per hectare are obtained⁽¹¹⁾. These systems usually have more advanced technology, genetic improvement and a balanced food supply⁽²⁴⁾.

Due to the extensive characteristics of the dairy system of La Frailesca, a low cost of production in the primary link would be expected, compared to the costs of the specialized and family production systems of the center and north of the country⁽²⁶⁾. However, proportionally higher costs related to feeding the herd can be found, due to the orientation of recent years towards supplementation during milking. According to the data obtained from the fieldwork, feeding costs represent more than 60 % of the total costs, a proportion higher than the 50 % reported for the family backyard systems of the center and south of the country^(27,28) but below the 70 % of the production units of the specialized systems. This proportion is above the costs reported for other dual-purpose systems, such as that of the state of Jalisco, which is at 38.9 %⁽²⁹⁾ and those of the state of Veracruz of 46 %⁽²¹⁾.

Of the general structure of the operating costs of the livestock production units, four concepts stand out for their high proportion with respect to the total: those of corn production, the purchase of ground corn, the payment of labor and the acquisition of poultry manure, the latter being the third in relevance. This value reflects the structural importance of the input and its enormous impact on the profitability of milk production due to the marked seasonality of prices in the face of food demand during the dry season (Figure 1). The specific weight of the poultry manure in the feeding of the herd can largely explain the recent findings of aflatoxins, both in fluid milk and in derivatives of the milk production chain of Chiapas^(30,31,32), since this input is frequently contaminated with these mycotoxins. Poultry manure is an input of relatively recent introduction, given that in the mid-nineties it was not a regular part of the processes of livestock farming⁽³³⁾, despite the fact that there was already a developed poultry culture in the region⁽⁶⁾.

Figure 1: Cost structure according to the type of production unit



As shown in Figure 1, permanent labor represents the largest component of the cost structure, which corresponds to the characteristics of production units with a low technological component and intensive in the use of labor. This concept refers to the wages paid to the person responsible for milking and herd management, who is often part of the family structure of the production unit. Therefore, it is important to consider that this expenditure is usually an income within the extended family unit and becomes a strategy of households to value the labor force of young members and generate a job option. These values coincide with what has been found by other economic studies of milk production in the Mexican tropics regarding that food and labor are the two main components of costs⁽³⁴⁾.

On average, the cost of production per liter of milk is \$4.22, which implies that in the months that producers sell their production below this value, they are incurring losses, a situation that happens at least three months a year during the rainy season. However, the increase in prices during the dry season allows most of the units to operate with a positive profitability and an average benefit-cost ratio close to 3.1. This index shows that for each peso invested in the farm, that peso plus an additional \$2.1 is obtained, that is, the operating costs of the dairy unit are covered, and a surplus is obtained.

Differentiating costs according to the type of production unit, some important contrasts are perceived. Figure 1 shows that smaller producers are the ones who make more intensive use of the poultry manure in the feeding of their herds, as well as ground corn. This is consistent with other studies for the region, where it is recognized that the relationship of corn consumption by MPUs is in relation to the number of hectares of grazing available, hence the largest producers, in terms of the number of heads, are also those with the lowest consumption of poultry manure and corn, foods related to more intensive systems⁽²³⁾. Large and medium-sized producers, for their part, also use this resource, however, not in the same proportion.

In terms of labor, larger producers make more intensive use of this resource, which is clearly reflected in their cost structure. This labor force is predominantly external (75 %), unlike small and medium-sized productive units where the non-family labor is between 50 % and 25 %, respectively. With the above data it can be inferred that smaller MPUs are closer to the behavior of family-type production units, while larger ones have more specialized and business characteristics as mentioned by other authors^(12,24).

Figure 1 shows that small production is more fragile due to the lack of resources for the maintenance of the herds. It is understood that, given the insufficiency of resources due to the small area and quality of pastures, they must resort to a greater expense for the rent of paddocks and the acquisition of fodder than those made by larger producers. For example, the cost of renting additional paddocks spent by small producers is up to \$257 for each head of cattle, an amount that represents 3.7 times more than what is spent by large producers and 6.4 times more than medium-sized producers. These conditions explain the higher relative costs per head of producing cattle. While medium and large production units face costs of MXN\$ 4,371 and MXN\$ 4,967 annually per cow respectively, for small ones, each producing cow costs \$5,815.

As in other production systems, the smallest-scale producer faces the highest production costs, both in absolute and relative terms. This condition is reflected in both the total annual cost per cow and the cost per liter of milk produced. Although, in absolute terms, the milk yield per producing cow is very similar in the three strata, the smallest is the one that produces with the highest costs and, therefore, the one that receives the lowest profits from

the sale of their product. Higher unit costs per liter of milk also imply greater risk and uncertainty during the dry season. The threshold of the costs found is close to what was reported in other studies for the municipality of Villa Flores and the state capital⁽³⁵⁾.

While medium and large units can withstand price decreases below the range of \$3.50 without making losses, small ones begin to face them at the threshold of \$4.50, which means that they assume this deficit for at least five months of the year (Table 3). Even with these vicissitudes, the small production presents a favorable benefit-cost ratio of 1.7, which implies a profit of seventy cents for each peso invested in the operation of the unit. On the other hand, large and medium-sized farms have better yields, the latter standing out with a benefit-cost ratio of 2.6.

Table 3: Competitiveness indicators by type of production unit (MPU)

	Large MPU	Medium MPU	Small MPU
Liters-cow/day	9.8±6.0 ^a	8.0±4.7 ^b	6.8±3.6 ^c
Total cost, M\$	405.60±116.9 ^a	224.28±155.9 ^b	126.49±112.7 ^c
Cost/cow, M\$	4.97±1.4 ^a	4.37±3.2 ^a	5.81±6.4 ^a
Cost/liter, M\$	3.68±2.4 ^a	3.39±1.9 ^a	4.44±2.8 ^a
Total income, M\$	834.30±488.2 ^a	591.23±497.6 ^b	211.12±117.6 ^c
B/C ratio	2.1	2.6	1.7

^{abc} Shared superscript implies that there is no significant difference ($P<0.05$).

The current structure of the bovine milk value chain in La Frailesca has a clear predominance of the processing link over the production link, a normal situation for the constitution of the structure of the country's dairy systems⁽³⁶⁾. This influence is reflected in a very important way in the level of prices paid to the producer and in their seasonality. In each locality and in general throughout the region, an oligopsony of few demanding buyers has formed, whose volume of processing (and therefore of purchase) gives them the possibility of significantly influencing the price of milk in each locality, because the dairy industry focuses on buying from the most specialized producers⁽¹¹⁾, possibly because they produce more milk and of higher quality and hygiene⁽²⁴⁾. It is evident that the system reflects the historical vertical integration of dairy systems in Mexico, of both intensive and family and tropical dairy systems⁽³⁶⁾.

Regarding the discrepancies between localities, the data showed significant differences in the yields obtained by livestock farms depending on their geographical location. In general, the locality of Calzada Larga stood out for having the highest milk yields of the entire sample of the Frailesca region (Table 2), which coincides with a significant difference in terms of supplementation with ground corn and poultry manure, as well as with the peculiarity that it is the only locality in which the practice of daily double milking is widespread.

In reinforcement of the idea of a relationship between supplementation and yield, the localities with the lowest milk production per head were also those with the lowest use of poultry manure. Clearly, the higher level of supplementation is related to higher yields and, therefore, higher costs. As in yields, the locality of Calzada Larga has the highest annual costs per head, the intensive characteristic of its production standing out, but also its greater dependence on the use of supplements and its vulnerability due to the variation of input prices.

For its part, at the other extreme is the locality of Los Ángeles, in the municipality of Villaflores, with the lowest costs per animal unit and with also low yields, although statistically similar to most of the localities, but below Calzada Larga. Undoubtedly, the management of the level of intensity is a critical factor that affects overall productivity⁽³⁷⁾; however, the producer decides what level of intensity to adopt, seeking to increase their profits and within the limitations of the resources available in the production unit⁽²⁴⁾.

As for the efficiency of the production units, their relationship with their low-cost system can be seen. As shown in Table 4, the localities with the lowest costs are also those with the highest relative profitability measured by their benefit-cost ratio (B/C). Of the B/C contrasts, it stands out that the farms with higher costs of supplementation are those that show less efficiency in the use of resources, however, their high yields result in higher incomes, generating the greatest absolute benefits. In other words, they are less efficient (since they have the lowest B/C ratios) but, thanks to their high production volumes, they generate the highest income for family units.

Table 4: Economic indicators of production units (MPU) by locality

Locality	Average income per MPU (MXN\$)	Average cost per MPU (MXN\$)	B/C ratio
Ricardo Flores Magón	138.49±57.4 ^a	50.64±61.7 ^a	5.72±5.1 ^a
Los Ángeles	248.77±99.9 ^{ab}	93.90±57.5 ^a	4.03±3.8 ^{ab}
Benito Juárez	247.98±398.5 ^{ab}	104.91±108.3 ^a	2.94±2.2 ^{ab}
Las Toronjas	201.23±160.2 ^a	87.26±81.6 ^a	3.07±2.0 ^{ab}
Sn. Pedro Buenavista	403.34±249.8 ^{ab}	198.56±160.4 ^{ab}	5.20±6.4 ^{ab}
La Concordia	357.74±223.3 ^{ab}	194.59±99.5 ^{ab}	1.97±0.9 ^{ab}
Calzada Larga	587.78±485 ^b	325.77±178.14 ^b	1.73±0.7 ^b
Revolución Mexicana	251.69±130.3 ^{ab}	199.80±87.9 ^{ab}	1.32±0.6 ^b

^{abcd} Shared superscript implies that there is no significant difference ($P < 0.05$).

Conclusions and implications

The structure of the production system of the Frailesca region is made up of small-scale production units with characteristics of family units, with intensive use of labor and low technological level. In the region, an oligopsony of few buyers has formed, which gives them the possibility of significantly influencing the price of milk. Milk production can be described as profitable in general, for both smaller and larger units. The difference between the MPUs is very marked depending on the locality. Those with more intensive production systems are more closely linked to larger processing industries. On the other hand, those of smaller dimensions are more linked to transformation systems of an artisanal nature.

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