

## CHARACTERIZATION OF THE SUPPLY CHAIN FOR CATTLE PRODUCED IN THE NORTHERN ZONE OF VERACRUZ

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### ABSTRACT

Cattle production in Mexico is one of the main activities of the agriculture and livestock sector. The production, commercialization and fattening of steers that are sold for slaughtering represents an extended practice in rural communities, while changes in demographics and consumption habits in the population have an important demand for beef. The objective of this study was to characterize the links and identify the points of origin of production (cow-calf system), stockpiling, trading, fattening and sacrifice that make up the supply chain of cattle produced in the northern zone of the state of Veracruz, which supplies the demand for beef in the Metropolitan Area of the Mexican Valley. The methodology used was the design and application of semi-structured surveys with 180 young bull producers in 5 municipalities of the Huasteca Veracruzana region; 50 fatteners in the state of Hidalgo and in eastern State of Mexico; 2 Livestock Services Providers (*Prestadores de Servicios Ganaderos*, PSG); and 2 persons who introduce them to the slaughterhouses. A descriptive characterization of the supply chain was made with the information obtained. It was found that the main consumption center of meat obtained from the young bulls produced in the northern zone of Veracruz is Mexico City and State of Mexico; the animals produced in the Huasteca Veracruzana region are fattened in Hidalgo (Atotonilco el Grande, Ixmiquilpan and Metztlán) and the eastern zone of State of Mexico (Otumba, Tepetlaoxtoc and Texcoco), where they are fattened, slaughtered, dressed, packaged, distributed and sold at retail to the final consumer.

**Keywords:** beef cattle, fattening, productive process, stockpiling, trading.

### INTRODUCTION

The production of cattle is carried out in every region of the country, and although the large-scale farms in arid zones stand out, fattening centers have become important, both in tropical zones (Veracruz, Tabasco and Tamaulipas) and in temperate zones (Michoacán) (SAGARPA-SIAP, 2018).

The three main producing states of beef cattle in Mexico are Veracruz (with 1,125,113 heads), Jalisco (with 934,229 heads) and Chiapas (with 476,780 heads) (SADER-SIACON, 2021). On the other hand, the main producing states of beef on carcass in the country are Veracruz (274,419 t), Jalisco (249,920 t), San Luis Potosí (129,162 t), and Durango (115,004 t) (SADER-SIACON, 2021).

The main center of commercial destination and food consumption (including beef) is the Metropolitan Area of Mexican Valley (*Zona Metropolitana del Valle de México*, ZMVM), which includes Mexico City (CDMX), 59 metropolitan municipalities in State of Mexico, and one in the state of Hidalgo (OCDE, 2015). The ZMVM is the economic,

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financial, political and cultural center of the country, its extension covers 7,866 km<sup>2</sup>, and its population reaches slightly over 20 million people, concentrating 17% of the country's inhabitants; the region generates 32.5% of the GDP (OCDE, 2015). Because of the changes in demographics and consumption habits of the population, there is a high demand for food products, among them beef. Fattening of steers that are sold for slaughtering and the supply of beef demand in the ZMVM represent a widespread activity in the rural communities and the neighboring states the region (SADER-SIAP, 2021).

Veracruz is the most important state in the country in cattle production; the northern region of the state known as the Huasteca Veracruzana region, including the Huasteca Alta and the Huasteca Baja, is integrated by a total of 32 municipalities. Livestock producers that belong to this zone are organized in various local associations, which unionize in the Regional Livestock Union of Northern Veracruz. The predominant production system in this region is the double-purpose system (milk and meat); the milk is destined to auto-consumption and sometimes sold to intermediaries or directly to the final consumer. This region produces 124 million liters of milk, which represents 16.17% of the total state production, which is 777 million liters (SADER-SIACON, 2021).

In the Annual Assembly of the Regional Livestock Union of Northern Veracruz, which was celebrated on April 29<sup>th</sup>, 2022, as a result of the 2021 period closing, it was communicated that based on the number of breeding stock found, which was 1,039,668, and considering the reproductive indicators and the calving rate found in the Union in the zone, which was 52%, it was estimated that production of calves was 540,627 heads, while 10% of females were left for replacement and 5% mortality was contemplated, with which an offer of 459,532 heads destined to fattening was estimated.

In general, cattle trade in Mexico begins with the producers of steers who breed young bulls to supply the production of weaning calves for fattening in systems with stables, semi-stables or grasslands, known as the cow-calf production system, according to Callejas-Juárez *et al.* (2014). Once the animals are weaned, they are stockpiled in the place of origin, and from there they are moved by the regional stockpilers to places where they will be fattened or else finished for their later slaughtering. The supply of calves to meat production systems implies one or more mobilizations from the breeding and grazing zones to the fattening places, which can be in different municipalities, states or countries. In each phase of the production process, the livestock increases its weight and value, and at the same time, the necessary activities and inputs for the care of animals increase, such as: a) workforce, b) infrastructure, c) inputs for feed, d) medications, e) technical assistance, f) logistic costs, and g) administrative expenditures for animal health regulation (medical exams, procedures, and transport guidelines). With the increase of these actions, the production costs in each of the links of the chain increase (SAGARPA-SIAP, 2018).

Mejía-Bautista *et al.* (2010) suggest that the characterization of the production units in the cow-calf system is important, particularly because studies that describe this production system in tropical regions are scarce. The interest in performing a study emerges from the quandary mentioned, which had the objective of characterizing the links and identifying

the points of origin of the production (cow-calf system), stockpiling, trade, fattening and slaughtering that make up the supply chain of the cattle produced in the northern zone of Veracruz and which satisfies the demand for beef in the Metropolitan Area of the Mexican Valley. The research hypothesis establishes that in the supply chain of cattle produced in the northern zone of Veracruz, the producers and fatteners of young bulls are the ones who present higher costs and risks, while the livestock stockpilers and traders take on fewer risks and obtain greater profits.

### METHODOLOGY

The study was designed as an exploratory, descriptive research that implied a process of collection and analysis of quantitative and qualitative data. The sample design of producers of young bulls was determined based on sampling for finite populations (Aguilar-Borjas, 2005); the following formula was used:

$$n = \frac{(p)(q)(N)(z^2)}{E^2(N-1) + z^2(p)(q)}$$

where  $N$  is the total population of young bull producers in the study region, 7,858 farmers;  $n$  is the size of the sample;  $p$  is the level of positive variability: 50%;  $q=100-p$ ;  $E$  is the maximum error allowed (7.3%);  $z$  is the level of confidence 95% ( $z$  of tables equal to 1.96).

Substituting values:

$$n = \frac{(0.5)(0.5)(7858)(1.96^2)}{0.073^2(7858-1) + 1.96^2(0.5)(0.5)} = 180 \text{ entrevistas}$$

A total of 180 questionnaires were applied with farmers in the general assemblies of the local livestock associations in the municipalities of Ozuluama (50), Tuxpan (35), Chicontepe (38), Chiconamel (17) and the local association of Mirador de Ozulama (40), held in the month of March, 2022. A convenience non-probabilistic sampling was used to collect information.

The questionnaire had six sections, which were the following: 1) general information of the producer; 2) infrastructure available for the grazing system; 3) characteristics of the farm; 4) management and breeding of calves; 5) workforce and service; and 6) commercial aspects in the sale of young bulls.

In addition, a survey was applied to 50 cattle fatteners in the municipalities of Atotonilco el Grande (16), Ixmiquilpan (4) and Metztlán (4) in the state of Hidalgo, and the municipalities of Texcoco (4), Tepetlaoxtoc (17) and Otumba (5) in State of Mexico; a convenience non-probabilistic sampling and key informants was used. The questionnaire had three large sections: a) general information about the livestock

producer, b) technological aspects and fattening technicians, and c) commercial aspects in the sale of finished livestock. The field work was carried out during the months of May and June, 2022.

To understand the way in which livestock was moved from the northern zone of Veracruz to the fattening zones, an interview was designed and applied to a stockpiler of fattening cattle located in the municipality of Naranjos, Veracruz, and two interviews were applied to Livestock Services Providers (*Prestadores de Servicios Ganaderos*, PSG) (independent traders or coyotes), both are in charge of stockpiling and trade of half-fattening young bulls, which have as destination the states of Hidalgo and State of Mexico.

Two interviews were designed and applied to introducers, who are in charge of purchasing fattened livestock which is moved to slaughterhouses to obtain the carcasses, entrails and skins.

Once the field information was gathered, it was captured and systematized in a database that was processed in a spreadsheet in the Excel software from Microsoft Office 2019, for the calculation and analysis of the response variables. The quantitative variables (number of animals, weight gain, production costs, and sale prices, among others) were analyzed with descriptive statistics. In addition, information was obtained through a bibliographic review and the analysis of official databases, such as those provided by the *Servicio de Información Agropecuaria y Pesquera* (SIAP), and *Sistema de Información Agroalimentaria de Consulta* (SIACON). In addition, information was obtained from government agencies such as *Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria* (SENASICA) and information supplied by the Regional Livestock Union from Northern Veracruz, the Regional Union from the state of Hidalgo, and the Social Development Direction of the H. Ayuntamiento in Atotonilco el Grande, Hidalgo, through the administration of the Livestock Tianguis of Atotonilco el Grande.

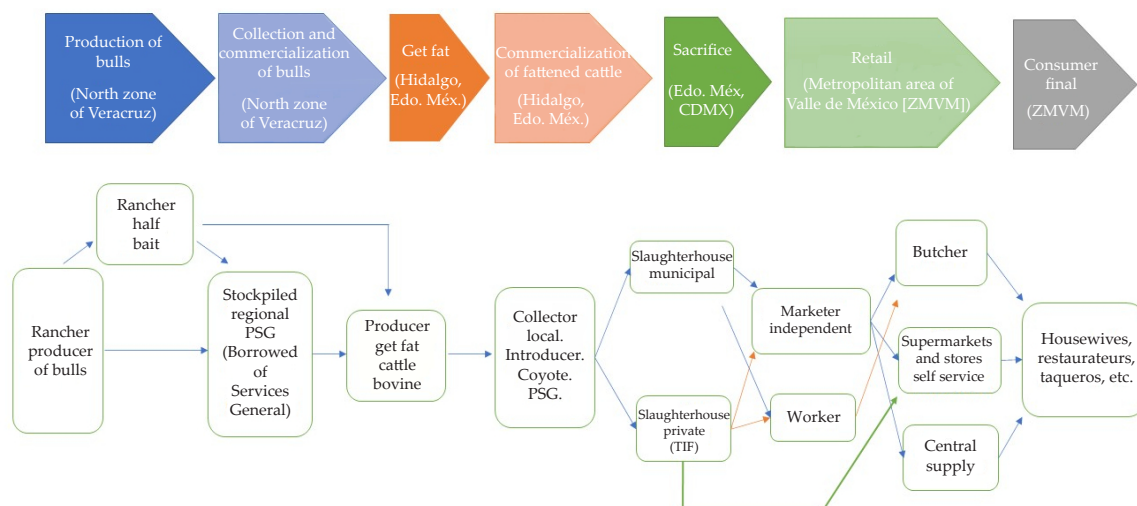
## RESULTS AND DISCUSSION

According to the information gathered in the field, the links that make up the chain were identified and outlined, which are presented in Figure 1.

### Production of young bulls

The first step identified within the supply chain of cattle was the production of young bulls, and the person who participates is the producer of breeding stock. It was found that 93% of the interview respondents were men and 7% women; this higher participation of the masculine gender within the livestock activity agrees with what was mentioned by Torres *et al.* (2016), who pointed out that the management of cattle in the tropical areas was carried out mainly by men.

The age range of livestock producers was between 29 and 82 years old, with an average age of 58 years; these data correspond to what was found by Méndez-Cortés *et al.* (2019), who made a categorization of producers in this same study zone. This average age also agrees with the range found by Cuevas-Reyes *et al.* (2016), who conducted their study with cattle



Source: prepared by the authors with information obtained in the field, 2022.

**Figure 1.** Supply flow of bovine livestock produced in the Northern Zone of Veracruz.

farmers in tropical systems in dry zones (Sinaloa, Mexico) and with studies by Granados-Rivera *et al.* (2018) and Juárez-Barrientos *et al.* (2015), who observed a similar age average in Tabasco and Veracruz, respectively.

The highest proportion of farmers (67.8%) find in livestock production their main source of income, followed by commerce and the provision of veterinary medical services with 8.8% and 7.7%, respectively.

Regarding the degree of schooling of producers, the average was 10 years studied, amount that corresponds to finished secondary school, which represented 47.2%, and it was found that 28% had undergraduate university studies, higher than that reported by Méndez-Cortés *et al.* (2019), who mentioned that 22% of the producers had university studies.

On average, the seniority of farmers in the livestock activity was  $32 \pm 13.15$  years, which denotes that they are producers with experience and with possibilities to continue performing this activity. Regarding the type of land ownership, 65% is private property, 32% *ejidos*, and 3% rented, which have commodate or lease contracts for their use and exploitation.

The land that farmers have is 76.7 ha on average. All the farmers have basic infrastructure in their paddocks, which includes drinking troughs and feeding troughs. 93% of them use management sleeves in order to make animal management easy. The main types of grasses that are grown in the paddocks to feed the animals are brizantha (*Urochloa brizantha*) and estrella (*Cynodon plectostachyus*) with 35 and 28% of the land, respectively. All of the farmers (100%) made a fixed investment to maintain the grazing lands, since they are the main source of animal feeding. They also carried out techniques such as scraping, manual weeding, weeding with agrochemicals, and rotation of grazing for the recovery of the paddocks, in short intervals of time that range from 1 to 60 days. It was found that

the animals rotate every  $19 \pm 13$  days on average, with the aim of grasses recovering and growing again (Table 1).

Regarding the size of the cattle herd, it was found that farmers have on average 86 heads, of which 45 are wombs, four are studs and 38 young bulls. The surveyed farmers in this research can be catalogued as “conventional” producers according to the typology proposed by Méndez-Cortés *et al.* (2019), and they are characterized for being small-scale producers with low level of income, where their main economic activity is the sale of mid-aged or weaning calves.

In the study zone, the livestock activity begins with animal breeding, which can be conducted by two methods: a) natural service, which is implemented by 88.3% of the farmers, b) artificial insemination, with 3.3%, and c) in some cases the two methods are combined (8.4%). For the cases in which the animals are inseminated, 57% of the inseminations were carried out by the producers, 28.5% were carried out by specialist technicians, and 14.5% by the veterinarian.

Once the calves are born, they are identified individually by earring them, and then are registered to the National Individual Livestock Identification System (*Sistema Nacional de Identificación Individual de Ganado*, SINIIGA). All of the farmers (100%) carried out this activity, they paid for the earring and its placing. The calves at birth weigh on average 42 kg. The cattle breeds reported by the producers in the zone are mainly crosses of Swiss-Zebu (45%), Swiss-American (21%), Brahman (7%) and Swiss-European (6%). These results agree with those by Bautista-Martínez *et al.* (2020), who point out that crosses of European with Zebu breeds are used in the tropical regions of Mexico and the calves are destined to supply the national market, while pure European breeds are mostly used in the north of the country and the calves are for exports.

Calves are fed during eight months with a diet based on grazing conditions and milk in 77.2% of the cases, with balanced feed and milk in 9.4%, and the remaining 13.4% uses milk and other type of inputs to complete the animal’s diet (orange peel, agricultural byproducts, bread and cookie sweepings). After eight months, calves are weaned completely, reaching an average weight of  $181 \pm 2.4$  kg. Similarly, Bautista-Martínez *et al.* (2020) pointed out that in the tropical zones of the country, the weaning age of the calves is seven to eight months, reaching an average weight of 170 kg, which agrees with those

**Table 1.** Average cost per hectare for paddock maintenance.

Activity	Average cost per ha	Applications/Year per ha	Subtotal per ha
Weeding	\$1,209.0	2	\$2,418.0
Manual weeding	\$1,178.0	2	\$2,356.0
Agrochemical weeding	\$454.0	2	\$908.0
Tree pruning	\$200.0	2	\$400.0
Total cost per ha			\$6,082.0

Source: prepared by the authors with field information, 2022.

found in this study. Some farmers sell the young bulls at weaning. During the period when the field information was gathered, the average sale price of weaned young bulls was  $\$50.8 \pm 2.3$  pesos per kilo.

The farmers who do not sell their animals at weaning continue fattening them until reaching half-fattening, where the animals have an average weight of  $278 \pm 66$  kg, which is reached approximately at 16 months of age, with a diet based on grazing, mineral salts, and agricultural byproducts. Some farmers use other sources of food when herbage is scarce, such as orange peels, which is an abundant product in the region.

Once the half-fattening weight is reached, the animals are ready for sale; the average price for these animals during the period of March 2021 to March 2022 was  $\$52 \pm 1.2$  pesos per kilogram.

During the 16 months on average when calves reach half-fattening, the farmer performs several activities such as identification, growth, fattening and health care of the livestock herd. All these activities represent costs for the farmer (Table 2).

Other costs consist on payment for the workforce and payment of utilities such as water and electricity (Table 3).

As a requirement for the commercialization of young bulls, the producer must request the livestock Association to issue a zoosanitary certificate and the livestock mobilization guide. To issue these documents, the Association requests a medical exam is performed on the animals to rule whether they are healthy and free of brucellosis and tuberculosis, which generate a cost for the farmer (Table 4).

It was found that young bull producers sell in 69% of the cases to independent traders or PSG, in agreement with the Mexican Official Norm NOM-001-SAG/GAN-2015. The PSG are individuals or legal entities of public or private nature that develop activities associated to livestock production different from animal breeding and are registered in the National Livestock Registry (*Padrón Ganadero Nacional*, PGN). Those activities can be fattening, stockpiling, establishment of slaughterhouses, livestock introducers, among others (NOM-001-SAG/GAN, 2015). 22% of the farmers sell to other livestock fatteners

**Table 2.** Average cost per activity (management and animal health care activities).

Activity	Average cost per application	Number of applications	Subtotal
Deworming	\$ 39.0	2	\$ 78.0
Vaccination	\$ 54.5	2	\$ 109.0
Anti-tick baths	\$ 18.5	11	\$ 203.5
Vitamins	\$ 55.0	1	\$ 55.0
SINIGA earring	\$ 50.0	1	\$ 50.0
Earring placing	\$ 30.0	1	\$ 30.0
Insemination kid	\$ 330.0	1	\$ 330.0
Insemination	\$ 130.0	1	\$ 130.0
Total cost			\$ 985.5

Source: prepared by the authors with field information, 2022.

**Table 3.** Average fixed costs in farm maintenance.

Activity	Average cost	Annual payment	Subtotal
Workforce*	\$11,200.0	12	\$ 134,400.0
Water	\$240.0	6	\$ 1,440.0
Electricity	\$300.0	6	\$ 1,800.0
Total cost			\$ 137,540.0

\*On average the salary was \$1,400.0 per workday per week, and on average two workdays were paid per farm. Source: Prepared by the authors with field information, 2022.

**Table 4.** Average cost for livestock commercialization.

Activity	Average cost	Amount	Subtotal
Invoicing and guide	\$116.0	1	\$116.0
Extraction of blood sample	\$ 80.0	1	\$ 80.0
Zoosanitary certificate and analysis	\$ 800.0	1	\$ 800.0
Freight	\$ 190.0	1	\$ 190.0
Total cost			\$ 1,186.0

Source: prepared by the authors with field information, 2022.

and 9% sell to livestock stockpilers. On average, the farmers declared having two clients with whom they carry out their sales and have an average commercial history of 10 years with them, who are mainly from the municipalities of Atotonilco el Grande in the state of Hidalgo (25%), Ozuluama-Veracruz (15%) and Tuxpan-Veracruz (11%).

From the farmers interviewed, 41% declared knowing the place where the animals will be finally fattened, with the municipalities of Atotonilco el Grande, Hidalgo (30%), Otumba, Tepetlaoxtoc and Texcoco in State of Mexico (17%), Tuxpan in Veracruz (14%), Ixmiquilpan in Hidalgo (13%) being the main destinations, the rest sell to other states or destine their animals to exports. Only 24% of the livestock farmers interviewed declared knowing the place where meat from their livestock will be consumed, and among these destinations the ones that stand out are Mexico City (60%), followed by State of Mexico (29%), Tuxpan-Veracruz (7%), and the state of Hidalgo (4%).

### Stockpiling and trade of young bulls

The next step in the cattle production chain for meat is the stockpiling and trade of young bulls, which includes the purchase-sale and mobilization of half-fattening young bulls from the state of origin toward the points where they will be finally fattened, until reaching the slaughtering weight. In this step, the person who participates is the PSG, according to SAGARPA (2015), and these persons are fundamental for the beef production chain, since they get thin animals in the livestock producing zones of the country to transport them to the regions where they are fattened. The main benefit they obtain is the payment

of returns from commercial intermediation margins. In the livestock producing system, these persons are also known as “coyotes” or “livestock hoarders”. Two of them were interviewed, one originally from the municipality of Atotonilco el Grande, Hidalgo, and another from the municipality of Tepetlaoxtoc, State of Mexico, both with more than 15 years of experience. They reported that they are in charge of purchasing and stockpiling animals from the northern zone of Veracruz (mainly), San Luis Potosí, Aguascalientes and Hidalgo, and then those animals are moved for selling to the municipalities of Atotonilco el Grande, Ixmiquilpan and Metztlán in the state of Hidalgo, and to the municipalities of Tepetlaoxtoc, Texcoco and Otumba in State of Mexico. This agrees with what was mentioned by Bautista-Martínez *et al.* (2020), who establish that calves from the tropical areas of Mexico are sold in their majority to the central states in the country to be fattened. The PSG reported having contact with local producers who are in charge of concentrating and stockpiling animals from smaller farmers, and once they gather the sufficient amount of animals to fill a cage, which has the capacity to transport 65 to 70 animals whose live weights range from 380 to 400 kilograms, they contact the PSG and send them photographs and videos via WhatsApp of the animals stockpiled to carry out the sale. If the PSG likes the animals’ lot, because it fulfills the desired characteristics, a spoken agreement is established; then, the PSG goes to the ward place where the animals are located to make the purchase.

The traders pointed out that in order to purchase the young bulls, the farmer must comply with the following conditions: a) medical test in which the animals are ruled to be free of tuberculosis and brucellosis, and b) the livestock must have a mobilization guide (REMO), issued by the corresponding authority or in some cases, having a guide for the slaughter. The PSG requests from the local stockpiler that animals are kept fasting one night before being loaded into the cages, where they will be branded with the state mark where they are sold. The cost of transporting the animals to the place of destination (Hidalgo and State of Mexico) was approximately 18,000 to 20,000 pesos per cage; the cost for mobilization is covered by the fattener, and therefore, the PSG does not incur in transport costs for the animals.

Once the cattle arrives at the place of destination, it is weighed in the facilities of the local scale and delivered to the fattener. None of the traders hired any type of insurance for the animals, and if an animal dies during the freight from the original place to the final destination, this is discounted from the producer; if the animal dies in the freight from the facilities of the local scale to the pen where it will be finished, the responsibility for the loss of the animal will be the fattener’s, so that the profit of the PSG is not affected in any stage of the purchase-sale of the animals.

### **Fattening**

In the cattle fattening step, the person who participates is the fattener; according to SAGARPA (2015), the function that this agent performs consists in acquiring thin livestock (through regional suppliers or directly in the producing zones of the country) to

feed it with a variety of inputs (cereal grains, farm residues, agroindustrial byproducts, and pre-mixtures of vitamins and minerals), under confinement conditions, until they reach the weight for slaughtering (600 kg).

It was found that 100% of the fatteners interviewed were men, with an age range of 27 to 65 years, and on average 45 years old. Regarding education, it was found that on average they have studied  $11 \pm 4$  years. The seniority of the producers in the fattening activity was  $18 \pm 7$  years. Regarding land ownership, 98% declared having their fattening unit in private property, and only 2% within an *ejido*.

The cattle finishers interviewed had livestock herds of various sizes (number of animals), and it was found that there are farms that fatten from 35 to 600 heads and, on average, the producers fatten 145 young bulls per cycle.

The type of livestock that predominated in the finishing pens were whole male animals, of the type called by producers as “commercial”, which come mainly from the northern zone of the state of Veracruz (62%), Durango (16%) and Hidalgo (5%). The animals were primarily cross breeds, and none of the producers surveyed had any pure-breed specimens. Of the farmers, 40% keep Swiss-Zebu cross breed, 23% Charolesa, and 12% a Brahman-Charolesa cross breed. The purchasing price of the thin animals during the period of information gathering was on average  $55 \pm 1$  pesos per kg. The average purchase weight of the thin animals was  $357.4 \pm 28$  kilograms.

According to Suárez-Dominguez (2011), the cattle must go through a reception phase when they reach the confinement place, which will allow the animal to recover the body-weight lost from transport. It is also to prevent and treat respiratory diseases of the recently disembarked animals, to get the animals ready for the production phase proper, and will allow recovery from the stress to which animals were subjected during transport. It was found that this phase is carried out by 100% of the farmers, the animals are received in the pen with abundant fresh and clean water, as well as oats straw or corn stubble; the fact that animals were subjected to during transport and body dehydration reflect in losses for the fattener. Based on information gathering in the field, it was calculated that on average, the young bulls reduce their total body weight in  $7.5 \pm 2.3$  %. After the arrival of the animals, the fatteners carry out a series of activities of reception and management of the herd, which represents a cost for the fattener (Table 5).

The young bulls for fattening are fed based on three types of diets: reception diet, growing diet, and finalization diet; each of these diets consists in a concentrated feed that each producer makes and which has been perfected with the passage of time and which is the one that has given best results. It was found that 68% of the producers supply a reception diet with an average cost of  $\$6,617.6 \pm \$739$  pesos/ton, and in this phase the animals consume on average  $8.62 \pm 2.66$  kg of food per day per head, and it has an average duration of  $21 \pm 13$  days. The growing diet is supplied by 84% of the producers, with an average cost of  $\$7,511.9 \pm \$865.9$  pesos per ton, and during this phase the animals consume approximately  $10.1 \pm 0.9$  kg per head per day. The finalization diet lasts on average  $90 \pm 37$  days and is implemented by 64% of the producers, with an average price

**Table 5.** Average cost by activity during cattle fattening.

Activity	Cost per animal
Livestock transport*	\$398 ( $\pm 74$ )
Reception activities	
Dehorning	\$28.5 ( $\pm 7$ )
Hormonal implant	\$77 ( $\pm 25$ )
Deworming	\$48 ( $\pm 17$ )
Vaccination	\$49 ( $\pm 13.6$ )
Application of antibiotics	\$30 ( $\pm 10.8$ )
Application of serums	\$15 ( $\pm 10$ )
<b>Total cost</b>	<b>\$ 645.5</b>

\*Cost of the freight from the place of origin to the fattening ranch.  
 Source: prepared by the authors with field information, 2022.

of \$7,546.8±\$652 pesos per ton, the animals consume on average 11.2±0.9 kg per day. For the feeding to be efficient, the producers point out that the success of the feeding plan they have is based on offering the recently made concentrated feed in sufficient amounts and abundant water. The feed is offered twice per day (morning and afternoon), with the aim of animals having feed available in the feeding trough every time they need to consume it. Other costs, in addition to the animal diet that fatteners must cover, are the payment of workforce and the payment of basic utilities in the farm, such as water and electricity (Table 6).

On average, the fattening cycle had a duration of 133±9 days, with a range from 120 days to 150 days, which agrees with the value published by SAGARPA (2015), which was 129±42 days per cycle. For the case of the producers surveyed, they obtain on average 2.8 fattening cycles per year.

The final product that the LPU (Livestock Production Units) obtain are finalized bulls, which reach an average weight of 600±40 kg; the average price for these animals for the period of March 2021 to March 2022 was \$56.2±0.9 pesos per kilogram.

It was found that 94% of the fatteners sell their fattened animals to intermediaries or coyotes, while the remaining 6% declared doing the slaughtering on their own independently. On average, the producers declared having 2 clients for the sale of their

**Table 6.** Average fixed costs for farm maintenance.

Variables	Average cost	Annual payments	Subtotal
Workforce*	\$14,576	12	\$ 174,912
Water	\$459	6	\$ 2,754
Electricity	\$359	6	\$ 2,154
<b>Total cost</b>			<b>\$ 179,820</b>

\*On average, the salary was \$1,822 per workday per week and on average, two workdays were paid per farm.  
 Source: prepared by the authors with field information, 2022.

animals with an average commercial seniority of 10 years, which come primarily from State of Mexico (71%), Mexico City (25%) and Tizayuca, Hidalgo (4%).

All of the producers (100%) declared knowing the place where the livestock will be slaughtered, with the private meat processor of Los Arcos, located in the municipality of Reyes la Paz, State of Mexico, being the most recurrent, with 77%, followed by private meat processors located in the municipality of Tepetlaoxtoc, State of Mexico, with 14%, and the municipal meat processor in Ecatepec, State of Mexico, with 8%.

Based on the information gathered in the field, the fattener producers mentioned that the main problems which they face are the high costs of inputs for the elaboration of diets, and this activity requires capitalization and modernization, being sensitive to the prices of grains, protein pastes, fodders, and agricultural stubbles, the same as the purchase-sale prices of the livestock. Another important factor that affects livestock fatteners is livestock theft, which is a generalized problem throughout the chain, and it happens during mobilization of the animals from pens to fattening centers, in the finishing centers, and in the transport of animals from fattening pens to the different slaughterhouses; this phenomenon places at risk the investment made by the producer in the livestock activity, as well as its economic stability and physical integrity.

### **Trade of fattened animals**

The next step in the chain is the trade of fattened animals and the person who plays this role is the introducer, who is in charge of purchasing fattened animals that are moved by them in cages to the slaughterhouses, where the animals are slaughtered to obtain meat on carcass, entrails and skins. Two interviews were made to introducers originally from Tepetlaoxtoc and Texcoco, State of Mexico.

The introducers declared having a broad portfolio of suppliers of fattened animals so that the purchase and the agreements in price are carried out by telephone, where they receive photographs and videos of the animals via WhatsApp, and because they have been purchasing from their suppliers for a long time, there is trust in doing it this way. Once the introducer completes the lot, they go to the farm where they will buy the fattened animals, which are loaded into cages and moved to the slaughterhouse.

In the slaughterhouse, the animals are slaughtered, bled, skinned and eviscerated, and this service has a cost of \$300 pesos per animal. The introducers declared that on average, animals have a yield of 63% of their live weight on carcass (the body of the animal without skin, head, entrails and legs), the price per kilogram of the meat on carcass (on the hook) was \$88 pesos. What is paid to the fattener is exclusively the weight of the meat on the hook. Meanwhile, the introducer takes as profit the price of the entrails, the head, the legs and the skin, which together had a price between \$2,200 and \$2,500 per animal.

Once they have the meat on carcass, there are two ways to sell it, the first one is done by the introducer, who transports the meat to workshops, markets and butcher's shops, where the meat is sold at an average price of \$94 pesos per kilogram. The second one is that other buyers go to the slaughterhouses, and they purchase fresh carcasses for their sale at retail.

The introducers declared knowing the destination where the meat will be sold at retail, with Mexico City standing out in 71%, in the city municipalities of Iztapalapa, Tláhuac, Coyoacán and Tlalpan, mainly; and State of Mexico, with the remaining 29% in the municipalities of Ecatepec, Texcoco, Tepetlaoxtoc, Los Reyes la Paz, Valle de Chalco, Ixtapaluca, Chimalhuacán and Ciudad Nezahualcoyotl, primarily.

## CONCLUSIONS

In the supply chain of cattle produced in the Huasteca Veracruzana region, the farmers are in charge of breeding young bulls; the Livestock Services Provider (PSG for its initials in Spanish) moves the animals to fattening centers, located primarily in the states of Hidalgo and State of Mexico (eastern zone), where they will be fattened by fatteners; once the animals are fattened, they are transported by introducers to the slaughterhouses, where they will be slaughtered and sold on carcass to independent traders, workshops, and butchers for their later sale at retail to the final consumer in the Metropolitan Area of the Mexican Valley.

The hypothesis of the research is proven, which establishes that the producers and fatteners of young bulls are the ones that have higher costs and risks, where feeding the animals is the concept that represents the highest costs within the activity of production and fattening, while livestock stockpilers and introducers are the ones that take on fewer risks, because they are not responsible for the lives of animals during the transport.

A connection between the livestock producer and the association is recommended, with the aim of managing and performing consolidated purchases of inputs, to reduce costs and increase the profit margin.

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