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Agrologistic chain redesign applied to the sheep meat sector in Hidalgo, Mexico

Rediseño de la cadena agrologística aplicado al sector carne de ovino en Hidalgo, México

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Abstract

For many years the livestock sector has been a fundamental part in the development of the food industry in Mexico, being an increasingly globalized market and with ever-changing consumption trends, forces the livestock industry in this case the sheep farming subsector of the state of Hidalgo, to develop new systems for its optimal improvement and continuous competitive growth. The objective of this document is to redesign the agrologistic chain of the sheep meat sector in the state of Hidalgo, through the location and configuration of multiple facilities, in order to determine the centroids by producing and consuming zones using the center of gravity model to identify the proposed installation of a classification center or feedlot and the TIF processing center, for the optimization of the transportation of this product, both in the supply of lamb and in the demand for the carcass in the regional market of the same state.

Sheep meat, Center of gravity, Hidalgo

Resumen

Durante muchos años el sector ganadero a formado parte fundamental en el desarrollo de la industria alimentaria en México, siendo un mercado cada vez más globalizado y con tendencias cada vez más cambiantes de consumo, obliga a la industria ganadera en este caso el subsector de la ovinocultura del estado de Hidalgo, a desarrollar nuevos sistemas para su mejora óptima y su continuo crecimiento competitivo. El presente documento tiene como objetivo rediseñar la cadena agrologística del sector ovino cárnico del estado de Hidalgo, a través de la ubicación y configuración de múltiples instalaciones, con lo que se quiere determinar los centroides por zonas productoras y consumidoras mediante el modelo de centro de gravedad para identificar la propuesta de instalación de un centro de clasificación o feedlot y el centro de procesamiento TIF, para la optimización del transporte de este producto, tanto en la oferta del cordero, como en la demanda del canal en mercado regional del mismo estado.

Carne de ovino, Centro de gravedad, Hidalgo

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Introduction

For many years the livestock sector has been a fundamental part in the development of the food industry in the world; And in Mexico, it is no exception, in an increasingly globalized market with increasingly changing consumption trends, it forces the livestock industry to develop new systems for optimal improvement and continuous competitive growth.

The sheep meat industry in Mexico and in particular in the state of Hidalgo, which occupies the second national place in production (SIAP, 2019), is deeply rooted in the customs of the population, since a large percentage of its consumption is only in traditional dishes, being mostly barbecue, which represents 95%, with a per capita consumption of 510 grams (Castelán, 2015).

This sector cannot depend to a great extent on the barbecue industry, this would be too risky, since barbecue production is based on the production of maguey stalks, an increasingly scarce input.

The agrologistics chain includes supply, storage, transformation and distribution activities, which are necessary to adapt the supply of livestock products to market demand, highlighting the link between these activities, through transportation.

Faced with the change in the environment, institutions are forced to take on the challenge of competing with the application of business networks, which causes continuous collaboration between them.

The distribution of the chain in the production of lamb is very complex and includes many intermediaries as well as at the national level, in the same way the flow can be as long or very short, as the case may be.

This reduces competitiveness, since as there are no adequate conditions for a lamb to be processed directly by a producer or marketer, this does not guarantee a safe product and much less with good quality characteristics.

That is why the need to propose the redesign of the agrologistics chain of the sector, because the existing TIF (Tipo Inspección Federal, Type Federal Inspection) center is only used in part, possibly due to its poor location and poor integration of the agrologistics chain that facilitates cargo supply operations alive, until the distribution of finished products.

The products offered by a company or industry serve as an input for another network before reaching the final consumer market; Therefore, for this to be accomplished, it is important that the supply chain is well integrated.

In accordance with the above, the present research aims to redesign the agrologistics chain of the meat sheep sector in the state of Hidalgo, Mexico, through the optimal location and configuration of multiple facilities, through the evaluation of supply and distribution geospatially.

It is intended to determine the centroids by producing and consuming area, to locate the supply and distribution centers with the highest concentration of supply and demand.

In the same way, it intends to establish the macro location of the collection center (feedlot), which will be fed by the supply network, this through the center of gravity model (considering the slaughterhouse and refrigerator with TIF certification).

Integrated logistics systems

It is irrevocable that collaboration and integration are essential factors for the success of modern supply chains and for their improvement methodologies, processes, standards and of course technological solutions have been created. Within a supply chain, collaboration has two dimensions within the company and between different organizations, but if there is no internal collaboration, external collaboration will never be possible. The integration of a logistics chain is unimaginable if none of the organizations that collaborate with it cannot align their processes internally.

The concept of collaboration is very important for the integration of modern logistics systems or supply chains, which adds value to products and processes, and of course competitiveness to the organization.

ISSN-On line: 2414-8830

Model for locating multiple facilities in the supply chain

Nowadays, thanks to various technologies, especially refrigeration systems, they allow the integration of processes within the same plant, such as: slaughter, processing and storage, the last two susceptible to having a controlled temperature environment; therefore, in the present model two links in the chain, collection and processing, will be fragmented, seeking to strategically locate each of them.

In such a way that it is very important to adequately integrate the supply chain and thus reduce costs, taking into account as a starting point the location of the main consumption and production areas.

The Center of Gravity model as a good starting point for evaluating locations in the target area. This model allows to locate multiple facilities in a supply chain to later evaluate the flow of operations through the transport model. When a company with an existing network of facilities plans a new facility, there are two conditions:

1. The facilities operate independently

2. The facilities interact jointly, in such a way that the location of units with independent operation can be managed each one as a separate facility (Krajewski, Ritzman, Malhotra, 2015).

In other words, the center of operations will be attracted to the strongest concentration of supply or demand, as a magnet is attracted to a metal.

Methodology

This research will take as a regional market the state of Hidalgo and its different producing areas, taking as supply the production of lambs using the average weight in foot and its conversion to carcasses using the average weight of the carcass in the state, referring as demand, to the per capita consumption recorded.

For the design, as a first point an analysis of the closed internal market was carried out, in this case state, since it allows to have better control and accessibility in the production and consumption data, in this way a micro environment is created in which only it is competed, produced and bought in this geographical environment; therefore, exports and imports are omitted, imports of this meat are omitted, in order to measure this case of lamb meat, to measure the self-sufficiency or inefficiency of this product in the state of Hidalgo.

In this way, it will be possible to know the excess or deficit supply and demand, which will dictate the supply of this product or the surplus that can be used to create new products, without affecting traditional local consumption, which will allow the design of a model of network, supply and physical distribution in the supply chain.

Subsequently, a series of activities was followed, based on the Geographic Information Systems Methodology, to locate multiple facilities, as proposed by Krajewski et al., (2015). The application of this methodology recommends the geographic mapping of the study area, using satellite maps; allowing the investigation to show the localized points of the facilities.

According to Krajewski et. al (2015) “the x coordinate of the center of gravity, designated as x *, is found by multiplying each x coordinate of the points (length of the location or x coordinate in the mesh) by its load (li), adding these products (Σlixi), and then dividing by the sum of the charges (Σli). The y coordinate of the center of gravity (latitude or y coordinate on the mesh), denoted as y *, is found in the same way. The formulas are as follows ":

a) Length (x):

$$x^* = \frac{\sum_i l_i x_i}{\sum_i l_i}$$

b) Latitude (y):

$$y^* = \frac{\sum_i l_i y_i}{\sum_i l_i}$$

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The model designed was the physical supply and distribution model, based on the proposed methodologies, designed in such a way that it is capable of solving the existing gaps in the supply and distribution process, emphasizing transportation costs, including the configuration of facilities that allow to have a control of the entry of lambs and exit of finished products, which in turn create a transport plan, which allows estimating requirements, in addition to estimating the installed capacity of the necessary facilities in a certain period of time to be able to meet the demand.

Likewise, for the developed system to have an impact on the sector, it is recommended to take the model that is ideal for a more specific planning and to be able to execute these activities in the flow of operations in the supply chain of the livestock subsector of sheep farming to meat production.

In a practical way, the following points were a fundamental part for the development of the model:

1. As supply, the number of heads produced per region was taken, according to the average weight of the lambs, in the same way as demand, the number of carcasses obtained by annual per capita consumption for 2017 is taken using the average weight registered in it anus.

2. In this way, the number of trips or transport units to be used can be determined, respecting the parameters established by NOM-012-SCT-2-2014, on weights and dimensions in transport.

3. The existing TIF center has a macro location in the municipality of Cuautepec Hidalgo, with the coordinates: Longitude: -98.3267919 and Latitude: 20.0429636.

Results

For the analysis of this research, relevant and complete information was executed that was processed to obtain the expected results within the state closed market, these being:

Market: Hidalgo State

Supply: The amount of live lamb production per municipality, interpreted in head of cattle with the average weight.

Demand: The national annual per capita consumption of lamb meat, translated into lamb carcasses, with the average weight.

It was identified that, of a total of 84 municipalities in the state of Hidalgo, 65 are capable of supplying their demand by themselves, that is, they have a production surplus, which allows knowing that the state has sufficient capacity for consumption and autonomous production, and is a strategic area in the production of lamb. For a better grouping in the state of all municipalities, zones mentioned in table 1 were created according to the Agricultural and Fisheries Information System (SIAP).

Once the surplus and deficit producing municipalities were established, the available supply and demand were generated, excluding imports and exports, as well as production destined for industry, since this product does not have an industrialized development or is very poor.

The analysis shows that in a closed market for consumption and production, the state of Hidalgo has a production surplus of 5,756 tons of lamb meat equivalent to 274,095 carcasses of 21 kilograms, which can be used for the development of new products or take advantage of that surplus as an exportable supply.

Location of multiple facilities

To continue with the supply chain design process, the macro location of location of the physical supply facilities was followed:

a) Collection centers

b) Feedlot.

With the grouping of municipalities by zones in the state, it is possible to generate an accumulated supply of live lambs and the demand for channels that will later allow locating each of the facilities by zone.

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Supplying Zone	Sheep meat Offer (carcass)	Demand (carcass)
Huasteca	719	6,762
Sierra	7,558	5,147
Valle Tulancingo	44,504	10,226
Región Cebadera	137,971	21,951
Valle del Mezquital	137,160	19,530
Bajío Hidalguense	18,100	5,147
Total	**346,012**	**68,763**

Table 1 Sheep meat supplying zone, offer and demand by area
Source: Own elaboration with analyzed information

The allocation of the macro location of the installation for each zone is based on the highest density of supply and demand as the case may be in each municipality (collection centers and distribution centers), allowing the generation of a surplus in supply.

Once the offers have been generated, the collection centers are located by zone, that is, they were located in the municipalities with the highest supply for each zone, being as follows:

Zone	Municipality	Length	Latitude
Huasteca	Huejutla	-98.075164	20.460486
Sierra	Meztitlan	-98.763261	20.595519
Valle Tulancingo	Singuilucan	-98.5199	19.968077
Región Cebadera	Apan	-98.45407	19.711382
Valle del Mezquital	Ixmiquilpan	-99.217117	20.483141
Bajío Hidalguense	Tecozautla	-99.632332	20.532635

Table 2 Sheep collection centers
Source: Own elaboration with analyzed information

With the established demands, the distribution centers are located by zone, that is, they will be located in the municipalities with the highest demand for each region, being as follows:

Zone	Municipality	Length	Latitude
Huasteca	Huejutla	-98.075164	20.460486
Sierra	Tlanchinol	-98.657308	20.989473
Valle Tulancingo	Tulancingo	-98.3691	20.989473
Región Cebadera	Pachuca	-98.759131	20.101060
Valle del Mezquital	Tula	-99.339563	20.101060
Bajío Hidalguense	Huichapan	-99.650840	20.378667

Table 3 Channel distribution centers
Source: Own elaboration with analyzed information

Graphically, the collection centers (blue drop) and distribution (green drop) would be represented on a map as follows:

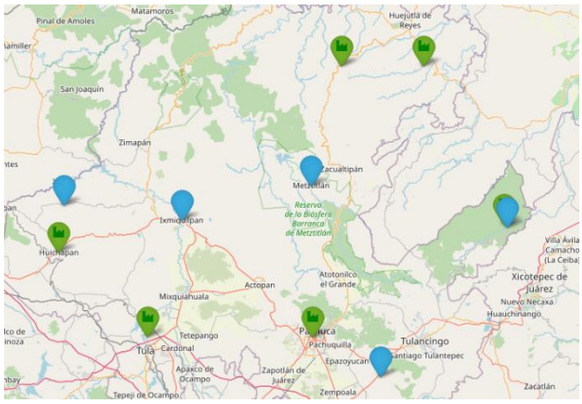

Figure 1 Mapping of distribution and collection centers
Source: Own elaboration with analyzed information

To assign the macro location for the new TIF center, the demand concentrations were used and the supply concentrations were used for the feedlot. With the center of gravity model, the exact point of the macro location of the classification center was determined, identifying the area in the municipality of Santiago Tlapacoya, as shown in Table 4.

Zone	Offer	Length	Latitude
Huasteca	719	-98.0751645	20.460486
Sierra	7,558	-98.7632619	20.5955194
Valle Tulancingo	44,504	-98.5199000	19.9680771
Región Cebadera	137,971	-98.4540700	19.711382
Valle del Mezquital	137,160	-99.2171174	20.4831412
Bajío	18,100	-99.6323321	20.5326359
SantiagoTlapacoya		**-98.8326134**	**20.1141553**

Table 4 Macro location of the sorting center or feedlot
Source: Own elaboration with analyzed information

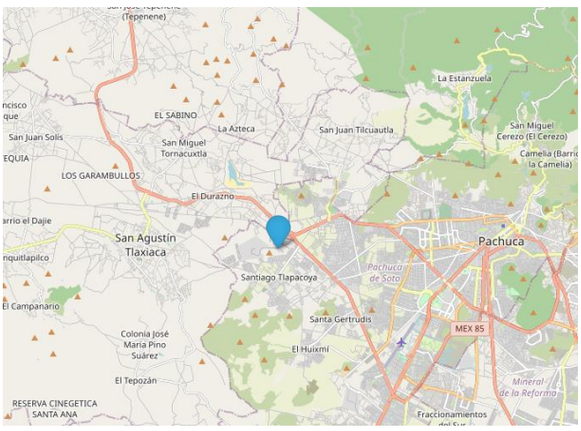

Figure 2 Exact location of the sorting center or feedlot
Source: Own elaboration with analyzed information

With the location of the classification center, the new TIF center is located, in order to generate the configuration of facilities that allows evaluating the supply flow and physical distribution, the location using the center of gravity method, is as follows:

ISSN-On line: 2414-8830

Zone	Demand	Length	Latitude
Huasteca	6762	-98.0751645	20.460486
Sierra	5147	-98.6573084	20.9894734
Valle Tulancingo	10226	-98.3691000	20.9894734
Región Cebadera	21951	-98.7591311	20.1010608
Valle del Mezquital	19530	-99.3395636	20.0535516
Bajío	5147	-99.6508401	20.3786677
Actopan		**-98.8578475**	**20.342312**

Table 5 Macro location of the new TIF center
Source: Own elaboration with analyzed information

When establishing the geographical location to the corresponding TIF center, it is necessary to mention that the center of gravity generated a preliminary location, which allowed it to be located in a reference point, the exact location shows a point in a mountainous region between Metztitlán and Actopan (blue drop); Therefore, it was determined to locate the macro location in the municipality of Actopan (green drop), for three simple reasons:

a) It is the main area at the state level in production and consumption of barbecue.

b) The proximity to federal communication channels.

c) It is a point closer to the main consumption centers such as Pachuca, Tula and Tulancingo.

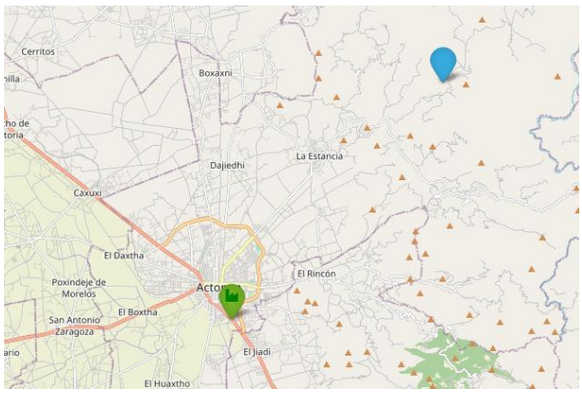

Figure 3 Proposed location of the new TIF center
Source: Own elaboration with analyzed information

Conclusions

The importance of the design of the supply chain has a high impact on improving the flow of supply and distribution, since the restructuring of the chain allows optimizing and systematizing the processes of a company and, therefore, makes it more productive.

Another important point to mention is that carrying out the design of the supply chain is a difficult task, since it is not only necessary to know in depth the market situation of the sector to which the supply chain will be designed, but also to have a high conceptual and abstraction capacity is required, so that the model includes all the fundamental elements to obtain the expected results.

The design is only the beginning in the process of improvement of the sector, it is still necessary to implement changes, once a system can be mathematically modeled that allows the entire chain to operate effectively and on the fly apply corrections since everything is perfectible, the system ideal does not exist.

From the analysis carried out, it was found that in the state it is mostly exceeded in its offer, which should look for options to carry out the distribution at the national level or, where appropriate, make the necessary openings to export, either in the channel or in specific cuts.

Main Findings:

– The configuration and location of the facilities is important for the efficiency in supply and distribution operations, which could guarantee a better service, an improvement in prices, thanks to the reduction of transport costs, through this having a better diversification of products.

– Checking the resulting data, it is important to say that this operations center is designed as a tool to reduce logistics costs and, of course, to facilitate the integration of state producers, thus partially encouraging social development.

– It is necessary to have a growth plan gradually, that is, this center must grow in installed capacity at the same time the production community is gradually integrated so as not to waste or saturate the fattening center (Feedlot), whose objective is to This is the homogenization and finishing of lambs.

– The purpose of strategically locating these facilities is to reduce distances and hours of transportation in the transport of lambs, which guarantees animal welfare that will result in a good quality of meat.

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– Thanks to the redesign of the supply chain, a production community could be generated, integrating horizontally and vertically this industry, and putting the Hidalgo sheep farming as a key activity in the development of the state.

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