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Retrospective Study of Production and Commercialization of Sheep Wool from Mexico

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Abstract

The purpose of this chapter is to provide information on wool production from Mexico in a period from 1980 to 2019, addressing some of the problems faced by the wool market over time. An analysis of variables such as national production of wool, cost of kg of wool, import and export of wool was performed with the aim of having a complete picture of the situation in Mexico. Also, the production of Mexico was compared with that of other countries that occupy the first places in wool production and quality, to have a starting point and propose improvement scenarios for the production of Mexican wool production. Overall, wool production in Mexico cannot cover the national demand, having to resort to the import of this product. The use of native resources of the region, such as the “Chiapas sheep breed” allows the development and maintenance of traditional ancestral culture, such as the Tzotzil, and the manufacture of handicrafts typical of each of the regions of Mexico. However, the management of long-term programs through the inclusion of dual-purpose breeds, wool, and meat can be a viable alternative for the development of the wool industry in Mexico.

Keywords: sheep, fleeces, wool quality, fibers

1. Introduction

The sheep have been raised throughout history to obtain three products—meat, milk, and wool. The leather is traditionally used for the manufacturing of shoes, jackets, and gloves, competing with synthetic products and with a downward market in recent years [1]. In the case of Latin America, from 2000 to 2016, sheep and lamb production has shown a slight decrease from 82,603 to 77,915 heads [2]. Throughout the years, sheep that produce wool have been selected to produce mainly meat; however, the Mediterranean countries have also been in charge of potentiating sheep milk production [3]. Wool is an animal product that is used by the textile industry; Botha and Hunter [4] indicated that approximately 56% of global wool production

is used for clothing, 42% for home textiles (interior design), and 2% for industrial applications. It should be noted that natural fibers, such as wool, globally accounted for 3% of total fiber production in 2013, similar to coconut fiber. Wool is still an accessible product, in high demand and with excellent prices, depending on the type of wool, but the most important thing about this natural fiber is that it is biodegradable without having a negative impact on the environment [5, 6].

1.1 International situation of wool production

In the textile industry, wool has been replaced by synthetic fibers due to its quality, price, and diversity. As a consequence, the world's number of sheep and wool production declined [3]. The amount of wool production in the market had a decline of 11.7% from 1990 to 1996 due to the large quantities stored for years by the main world producers (Australia, New Zealand, and South Africa). These were put on the market, generating a sharp decrease in the price and causing a decrease in the income of wool producers [7]. In spite of this, in 2002 the price of wool increased due to lower global production, due to the decline of the sheep population worldwide, the decrease in the Australian sheep stock, the increase in fiber prices, and the decline in cotton production worldwide [8]. In summary, wool production decreased globally due to a fall in the sheep inventory, sacrificing the number of animals for meat marketing consumption; the production of superfine wool breeds was privileged, and only increased production was shown in the main producing countries, such as South Africa, Uruguay, and Mongolia, in the 2013–2014 period [9]. The rest of the countries globally have not shown an increase in the number of animals for wool production and wool marketing.

It is noteworthy mentioning that although wool production represents around 3% of the global fiber production, it represents an income of 8–9 trillion dollars per year, just below cotton that has 45 trillion dollars, and coconut fiber that has an income of 0.4 trillion dollars. Even though the production of coconut fiber is like that of wool, economically speaking, wool is more profitable than other natural fibers. One example of this is that clean wool can reach a price of \$ 7.3 USD/kg, followed by silk (\$ 4.4 USD/kg) and cotton (\$ 1.7 USD/kg) [10].

1.2 The production of sheep wool in Mexico

Currently, in Mexico, there is an inventory of sheep farming of approximately 8 million heads [11]. The sheep production is distributed in three regions—in the central region for meat production, there are wool breeds, such as Suffolk, Hampshire, Rambouillet, Dorset; hair-sheep (Katahdin, Dorper, and Pelibuey) in the south-southeast region is mainly based on hair-sheep breeds (Pelibuey, Black Belly, Katahdin, and Dorper); and in the northern region which used to be the main supplier of wool, it has recently introduced hair-sheep breeds (Pelibuey, Katahdin and Dorper) for meat production [12, 13].

In Mexico, wool production in 1996 showed a decrease of 13.5%, as in the rest of the world. In the following years, there was a recovery in production, increasing by approximately 26% (5042.18 tons in 2012) [14]. Recently, wool production in the country has been negatively affected by two factors, firstly, Mexico has prioritized the production of sheep for meat and, secondly, producers have stopped being interested in the production of sheep. As a consequence, wool production is only used for handcraft purposes in some states of Mexico [15]. Medrano [16] mentioned that by 1999, it was estimated that around 50,000 producers nationwide were engaged in sheep farming, and only 120,000 artisans worked with wool. In 2007, [17] it was reported that only 37% of the total heads of sheep were used for wool production. These data revealed the socioeconomic importance of sheep in Mexico.

For marketing purposes, wool fibers are classified based on—fine wool (Merino wool), medium wool, long wool, crossbred wool and carpet wool; secondly wool fibers are classified depending on the fiber length in Noels, strictly combing, French combing, clothing and carpet wool. Finally, wool fiber is classified on the age of sheep (Lamb's wool, Hogget Wool, Weather wool, Pulled Wool, Dead Wool, Cotty and Taglocks). This process is essential since there is great variability between sheep breeds, and even within the same breed, the different body regions of an animal, as well as the colors (being white color the most relevant for the textile industry because it is easier to dye) [18].

Mexico has coarse wools which, in some regions (the municipalities of “Temoaya” and “Guadalupe Yancuictlalpan,” in the state of Mexico and “With the Tzotzil community” region in the state of Chiapas, Oaxaca), continue to be used for handmade textiles manufacturing. The community of Guadalupe Yancuictlalpan, also known as “Gualupita,” located in the state of Mexico, is one of the few places where this activity is still carried out. In these regions, the product called “sarape” or “gaban,” “chamarro,” “jorongo,” which simulates a blanket with a hole in the center, to introduce the head, is still produced and is typical of the clothing of the people who work in the fields on cold nights of mountains and deserts. However, it has been negatively affected by the increase in production costs and the scarce promotion of its handicrafts [19]. Another example is the work carried out by the Tzotzil women located in the mountainous region of the state of Chiapas, whose purpose of raising sheep is an important subsistence strategy, since sheep are used for traditional garments for women wearing their black woolen skirts and their richly embroidered brown blouses, and they cover themselves with black shawls. Children's clothes, blankets, and bedspreads are woven to blend fleeces of different colors, to create an infinite number of gray and brown shades. These woolen clothes are quite heavy and a hairy finish is highly regarded; they are also waterproof and last a very long time—2 or 3 years of daily use and of course handicrafts (wool dolls, skirts, sweaters, bags, etc.) that are sold to tourists [20].

Therefore, the objective of the present study is to evaluate the production of wool in Mexico in a period from 1980 to 2016 and compare it with some producing countries and generate some scenarios about its possible commercial development.

2. Material and methods

The methodology consisted of a literature review, covering both scientific and technological documents and data from official sources from 1980 to 2019 regarding wool production in Mexico. Also, relevant information on the international market, such as costs, production, imports, and exports, was included.

The obtained data was analyzed as a retrospective and longitudinal study considering the following variables—number of animals, tons of wool produced, tons of wool imported, tons of wool exported, cost of kg of wool in US dollars, yield, and national per capita economic income. Then, a database was built, and three scenarios were proposed.

The first scenario is an overview of the national production of wool, considering the price of kg of wool and the number of animals reported by the Mexican state (INEGI) [17].

The second scenario is a picture of what would be the case if all sheep were sheared and all wool was commercialized, assuming that the sheep population was 100%, wool producer.

The third scenario is focused on recommending genetic improvement of sheep breeds to convert them into dual purpose and with this, not to neglect the meat

market, but in turn, increase profits for the producer and improve the country's wool market.

It is important mentioning that these scenarios are hypothetical and depend on certain variables, such as race, animal handling (all zootechnical aspects), price, wool production, and fleece quality (color, diameter, length, resistance, number and type of curls, and elasticity).

3. Results

3.1 Number of heads of sheep

According to the Mexican Agrifood Information System [21], the national inventory of sheep has shown an increase of 34% from 1980 to 2019 (6,482,200 and 8,708,246 respectively), considering the variations and economic changes that were experienced in the country (**Table 1**).

The variations discussed above can be observed when comparing the human population with the sheep population (**Figure 1**), showing that in 1980 for every 11 persons there was a sheep; for 1990, the number of sheep decreased by 9.8% compared to the previous year, and finally, for 2016, the number of animals increased as did the human population, giving a ratio of 14 persons per sheep. This confirms that sheep production has not had a great development through the years analyzed in this study. This is also in agreement with Ramírez [22], who reported an annual average growth rate of 0.85% between 1980 and 2016 for the sheep population.

3.2 Production of sheep wool in Mexico

In the case of wool production and market, it can be observed that the quantity of wool produced in the country has been drastically decreased. Compared with 1980 wool production, in 2016 that was decreased by 26%. Regarding wool imports, the year that showed more imported tons was in 1980 and in 2016, only 4854 tons were imported, representing 31% less compared to 1980. The opposite happened with exports since in 1980 there were no exports, but in 2010, 510 tons were exported (**Figure 2**).

The producer price has been reduced, presenting the best price (USD \$ 2.00/kg wool) in 1990. Subsequently, wool price has been decreasing by 87% from 1990 to 2019 (USD \$ 2.00/kg vs. \$ 0.26/kg, respectively). When considering the number of animals and total wool production, it can be seen that although the number of sheep heads has increased yearly, wool production does not grow at the same rate (**Table 1**). It confirms what was previously reported, where Mexican sheep production focuses

Year	Number of animals	Wool production (ton)	Wool price US\$/kg
1980	6.482.200	6554	1,47
1990	5.846.000	4517	2,00
2000	6.045.999	4176	0,587
2010	8.105.562	4683	0,282
2016	8.792.663	4854	0,27
2019	8.708.246	4015	0,26

Table 1.
Sheep population, wool production, and price of wool (US Dollar) in Mexico.

Figure 1.
Relationship of the human population in Mexico/number of total sheep from 1980 to 2010.

Figure 2.
Production (), import () and export () (tons/year) of wool in Mexico.

on meat, subtracting attention to wool production, which unlike the rest of the world seeks to obtain longer and finer fleeces. In Mexico, the use of crossbreeds gradually eliminated the wool of these and turn them into hair breeds (i.e., Pelibuey, Kathadin, and Blackbelly) [23].

States, such as Hidalgo, Oaxaca, Chiapas, Zacatecas, State of México, and Tlaxcala, are known for having a period of shearing of meat sheep that has given rise to their wool textile production. There are some wool groups in the country that have managed to survive. In mid-2010, associations, belonging to the cities of Guanajuato, Toluca, Tulancingo, and Chignahuapan, were organized to market and improve the value of national wool, through the selection and packing of wool from sheep meat breeds of various qualities to be exported to Uruguay [23].

3.2.1 Scenario 1

When considering the percentage that INEGI [17] published in 2007, we could assume that only 2, 999,058 sheep, 37% of the total population of the year 2010, was used for wool production, obtaining 4683 tons at a cost of USD \$ 0.28/kg (in 2007), leaving USD \$ 1, 311,240 of income for the total wool produced. When reviewing the FAO data [2], they indicated that imports of wool (dirty, clean, and waste) for

Mexico were 2099 tons at a cost of USD \$ 9,425,000 where the price per kg was USD \$ 4.49. It can also be noted that 42% of wool imports has a very poor quality, which was used for handmade textiles that were then exported (**Figure 3**) as a handcraft.

3.2.2 Scenario 2

If all the sheep that exist in Mexico were sheared, assuming that instead of 37% of the sheep population was 100% that which is used for wool production, we could say that the production in 2010 would have been 12,657 tons, with this figure would probably decrease considerably the amount of imported wool and increase the profit of the producer since, as mentioned above, not all imported wool is of good quality and producers who have dual-purpose animals would have a market for selling their wool. For this to take place, it is necessary to standardize the price to the producer per kg of wool and train them so that the shearing is annual and correct and then it could be possible for the producer to be interested in the market and obtain an extra income. Considering the previous points, if the payment of wool per kg was modified, it could be more attractive for the farmer producer. For example, New Zealand, where in the year 2010, the average price was USD \$ 2.27/ kg wool (8.1 more times than in Mexico), which increased the interest of farmers producers shearing their sheep annually to obtain approximately 2 kg–5 kg of wool [24] with a profit of USD \$ 4.54–USD \$ 11.35/kg sheep. In Mexico, this would make a big difference in the national market. This is hypothetical because not all sheep are wool-producing breeds, nor is all wool produced from sheep utilized. In fact, in Mexico, most wool is discarded and not sold by the farmers.

3.2.3 Scenario 3

The wool market should be attractive and consistent so that farmers stop seeing the wooly breeds as a “problem to shear” and become an opportunity and an extra income for the farmer.

In **Table 2**, in 2010, countries, such as Australia, New Zealand, and Uruguay, obtained a total annual income (wool production plus sheep meat production) of USD \$ 3,469,145.48; USD \$ 1,713,571.57; and USD \$ 240,303, respectively, in which, income from wool production, covered 42.7% in the case of Australia, 23.35% for New Zealand, and 49.24% of income in Uruguay. If we compare the results of these countries with those of Mexico, it can be noted that Mexico’s total income is not

Figure 3.
Import of wool (tons) in Mexico from 1980 to 2010 (defatted wool, fat wool, and waste wool).

Country	Number of animals	Meat production (ton)	US/kg meat	Income from meat production	Wool production (ton)	US/kg wool	Income from wool production
Australia	68.085.496	555.206,00	3,58	1.987.637,48	352.740,00	4,20	1.481.508,000
New Zealand	32.562.612	474.141,00	2,77	1.313.370,57	176.300,00	2,27	400.201,000
Uruguay	7.710.000	31.600,00	3,86	121.976,00	34.700,00	3,41	118.327,000
Mexico	8.105.562	54.966,00	3,64	200.076,24	4.683,00	0,28	1.311,240

Table 2.
Income from meat production (US Dollar) and wool production in different countries during 2010.

Countries	Number of animals	Wool production (ton)	% Fine wool (18–26 micron range)	% Fine wool (27–40 micron range)	Relation kg wool/sheep
Mexico	8.105.562	4.683	No information	No information	0.0006
Uruguay	7.710.000	34.700	35%	65%	0.0045
Australia	68.085.496	352.740	88–90%	12–10%	0.0052
China	134.021.218	272.000	70%	30%	0.0020
New Zealand	32.562.612	176.300	80–90%	20–10%	0.0054

Table 3.
Sheep population and wool production in different countries (2010).

Figure 4.
Proud Tzotzil women with their lambs (white/black).

very different from that of Uruguay. However, income from wool production only reaches 0.65% of the total income. If the wool production mentioned in scenario two had been obtained, and the price per kg was modified, taking as reference New Zealand (it is the country that showed the lowest price per kg of wool) we could reach a total income of USD \$ 228,807.63 where 12.55% of the total income would be for wool production. This would result in an increase in the income of both the country and the farmer producer. **Table 3** shows the percentages of the type of wool produced by the main producers worldwide. Australia, besides being the country that produces the most wool, also produces the largest amount of fine wool. In Mexico, there is no official information that indicates the percentage of fine wool produced in 2010, it can only be said that the amount is medium thickness, used to make handicrafts.

If a policy is achieved to encourage or subsidize support for genetic improvement and obtain animals with better production and quality of wool without neglecting the production of meat (main market in Mexico) could be reduced and probably eliminate the import of wool waste in Mexico.

In some Mexican states, there are wool breeds, such as Rambouillet to Australian Merino, Debouillet, and Lincoln, which have been crossed with breeds that have a good daily weight gain, such as the Columbia breed [25]. On the other hand, the Corriedale breed could be introduced to maintain quality and, like the previous

one, not neglect the production of meat. However, to achieve this, it is necessary for farmers to be trained and oriented so that there is a “regression” and their attention is focused on the breeds that have existed for many years in Mexico such as the Chiapas sheep breed (**Figure 4**) [26].

4. Discussion

4.1 Number of heads of sheep

Mexico has a great diversity of climates (temperate, humid, and dry), very rugged topographies (hills, mountains, desert, and rain forest), and different economic levels, which makes the production of sheep a favorable alternative (**Figure 1**).

Mexico has become more dependent on imports in program crops and meat/livestock between 1986 and 1998, where agricultural activities, such as corn, soybeans, wheat, cotton, rice, beef, pork, and poultry, have increased [21].

Sheep production in Mexico has undergone several changes over time and it is very evident that the growth has been slow. From 2010 until 2016, the number of heads has only increased by 8%, unlike the period of 2000–2010 in which there was a growth of 35%. This could be due to the production objective that each Mexican state has and that the majority of sheep producers are oriented to subsistence farms [15].

4.2 Production of sheep wool in Mexico

The national wool production shows a decrease through the years, being 1980 with the greater production unlike 2019 when the quantity of tons decreased up to 38%. Possibly this may be because sheep breeders have tended to replace the wool breeds with those that do not need to shear, leaving aside the wooly breeds and substituting them for breeds of hair (i.e., Kathadin, Pelibuey, and Blacbelly) or their crosses between these two, which is an advantage due to the low prices of wool and the lack of specialized labor [24].

It is important to mention that about 80% of the sheep registered with AMCO (Asociación Mexicana de Criadores de Ovinos) are of hair breeds and the rest of breeds. This proves the aforementioned [24], so there is an increasing decrease in wool breeds and a much bigger gap in specialized wool breeds, except for the native breed of Chiapas, where it is kept as a dual-purpose breed (meat and wool), for the production of clothing and handicrafts typical of the Tzotzil culture (**Figure 5**).

Another reason why wool production may be decreasing is the cost/benefit ratio of sheep producers, as the breeds are not specialized in wool production, the quality of the wool is very variable and its commercialization in certain areas is not profitable, including the shearing process.

The costs of shearing fluctuate between \$ 3.5 and \$ 4.5 USD per sheep and the shearers take all the wool as part of the profit and therefore, many farmers prefer to throw the wool sheared by themselves [27] than selling it. Finally, another factor is the intermediary or the lack of a direct marketing channel, which buys wool from sheep producers at very low costs, sometimes paying up to an average of USD \$ 0.10 per kilo of dirty wool, which is why they opt for had another alternative as a hair sheep breeds, and another factor that could affect the wool market is the issue of little diffusion and the loss of customers who have suffered wool crafts. The few localities that still have the habit of teaching and practicing the elaboration of handicrafts, increasingly tend to be less visited [19]. On the other hand, since the United States of North America is the main buyer of wool products (99% of the product), the market is affected when demand decreases, as it did in 2009 [28]. It is important

Figure 5.
Evaluation of wool by Tzotzil women on the live animal, to see that they are ready for shearing and to evaluate the quality of the wool, the women wearing their traditional clothing, long black woolen skirt, canvas on shoulders and braided hair.

to note that wool is not a highly processed material, as it is only cut from the sheep, cleaned, and spun, having the characteristics of being reusable, recyclable, and biodegradable. In addition, the animals do not need complex feeding, with good grazing management and supplementation at certain times of the year is enough for the sheep to produce wool [6], so it is of utmost importance to maintain the tradition of the production of handmade fabrics as a heritage, as it also helps to improve the economy of the different regions (i.e., Region Gualupita, Temoaya in the state of Mexico, Peña de Bernal in Queretaro, Region Tzotzil in Chiapas, etc.), besides being one of the factors that maintain the genetic diversity of sheep in Mexico [29].

4.2.1 Scenario 1

When comparing Mexico with wool-producing countries, it could be mentioned that, despite having a greater number of sheep, Mexico does not produce the same in wool; such as Uruguay, which in 2010 had 95% of heads of sheep that Mexico has and obtained a production 7.4 times greater than Mexico (**Table 3**). In the case of Australia, which is considered one of the main wool-producing countries, we can notice a big difference referring to the number of sheep, as well as wool production. On the one hand, Mexico only has 11.9% of sheep that Australia has and the production of wool in Mexico reaches 1.32% of the total of the Australian country. Another clear example is New Zealand, which in 2010 had a wool production 37.64 times more than Mexico with a sheep population four times more than Mexico [30].

4.2.2 Scenario 2

Mexico produces mainly coarse wool, since as mentioned, the crossing of the wool breeds with wool to have a greater production of meat, 95% of the national inventory is made up of native Criollo sheep, and only the remaining 5% belong to specialized breeds for wool or meat production, which has caused the quality of the wool to decrease considerably, however, this cannot be considered as a disadvantage since it is mentioned that thick wool (which is above 30 micron) is showing a growing trend worldwide, in greater demand than fine wool, which is being used in the manufacture of fabrics, carpets, blankets, among another uses [6, 12, 13], so it

can be a solution so that the production of wool in Mexico does not disappear, since it's a developing market, some countries are not meeting their internal demands and Mexico could export this product instead of considering it a waste.

Another wool-producing country is Italy, which is not one of the main producers, however with its 6.3 million head of sheep, it produces 14,000 tons (from 1.2 to 1.3 kg of wool per sheep, depending on the breed), but only 5% of the production finds a commercial point of sale, so it presents a market very similar to that of Mexico, in addition to mainly producing coarse wool, if this wool is not transformed it represents a waste with additional cost [31]. So, Mexico could learn from the strategies that have been carried out in Italy and other countries, with the management and marketing of its wool, which it allows. Obtain added value and make it more attractive for producers to carry out the shearing in a more orderly manner and find a market that favors all sectors. Nowadays the Italian wool presents projects financed by private companies which try to support the local sheep producers, promoting the wool of autochthonous crosses, which is being destined to the production of handicrafts, handmade textiles, and the application of ecological constructions, based on the technological properties of local wool such as high insulating power, high water repellency, and high resistance to compression [32]. The financing of private organizations could be a solution for sheep Mexican wool farmers as well. However, governments are currently not supporting domestic producers and the outlook is very disappointing because 80% of the national sheep flock belongs to producers with low economic resources and low technological levels [13].

4.2.3 Scenario 3

Considering scenario 3, banks [33] discussed the evolution of the Australian lamb industry during the period of 1980–2003. The industry was negatively affected during the 80s and early 90s by the low prices of wool received by farmers and began a slow recovery in the late 90s. However, since 2000, the industry has experienced exceptional growth, where several sheep meat industry development programs helped in this recovery (e.g., Trim Lamb Campaign, Fresh Australian Range Lamb, and Lamplan). In this sense, the crossing was proposed to maintain the production of wool and meat, which was not considered in Mexico.

In Mexico, 95% of the consumption of sheep meat is as a typical food, in “Barbecue” (which consists of placing the meat in a hole in the ground, previously heated with firewood, and once the charcoal is bright red, the cuts of meat are introduced, placing a pot at the bottom, to contain the meat juice, and a grate so that it does not mix with the meat, this is covered with a few maguey stalks, and is left to cook for 12 hours, later it is uncovered and is ready for consumption) (**Figure 6**), which makes it difficult to have a quality standard of the produced carcass, since there is no distinction of cuts, and the only thing that is sought is the commercialization of animals weighing more than 40 kg [12, 13], regardless of breed, age, sex, body condition, or feeding system. After this period, Banks & Ross [34] showed that the genetic improvement in productivity and product quality increased by 4% per year at the end of the 1990s, generating a very competitive product (heavy lamb carcasses and lean, 18 kg–22 kg). This genetic success was associated with a positive combination of aggregate improvements throughout the sheep industry, which included better agricultural management, genetics, commercialization, and a consumer-centered industry. Continuous progress in the qualities of the carcass can be achieved by improving lean quality and increasing muscle [34], which in turn will result in more efficient production systems and higher meat yields. Gardner et al. [35] affirmed that the lamb industry can implement additional improvements through the strategic and intensive use of these genetic tools (i.e., artificial insemination or embryo transfer).

Figure 6.
Process of elaboration of “barbecue”, as a typical regional dish of Mexico.

In a genetic improvement program, it is important to monitor the genetic progress obtained to verify if the improvement objectives are achieved, or if adjustments are necessary. One way to analyze the genetic gains obtained is to visualize the average reproduction values of the different characters evaluated by generation, as well as to study the direction and speed of change in each trait [36]. In general, it is considered that annual genetic progress of approximately 2% would be the maximum to achieve within a closed population that concentrates on the selection of a single characteristic [36], in our case and with the genetic diversity should generate strategies that lead to the selection of meat-wool breeds, without neglecting the autochthonous breeds that maintain the production of artisanal wool in certain regions of Mexico. Tzotzil women and men wear spun wool clothing for ceremonial or everyday use in different colors (deep black coats and skirts, white ponchos, brown blouses, and gray blankets), which is a clear example of the selection made by the shepherdesses and indigenous craftswomen [20].

Another clear example of these systems of meat-wool crosses has been in Uruguay where the genetic program of Texel (terminal crossbreeding) uses quantitative and genomic selection. From this program, some preliminary estimates for carcass quality traits (hot carcass weight, French rack, leg weights, intramuscular fat, and carcass fat indicator) resulted in moderate to high heritability (h^2 , ranging

from 0.3 to 0.5) [36], without affecting wool production. When we look at the quality data of wool produced in Mexico and we want to compare it with other countries, but due to the lack of information it is not possible, but it can be said that the main wool production is from 27 to 40 micron. According to Perezgrovas and Castro [20], 36% of the income of indigenous communities in the southern region of Mexico (Oaxaca and Chiapas) comes from the realization of clothing and handicrafts. China in the present is one of the world's leading producers of wool, one of the reasons for the high production is the political and economic importance that ethnic minorities give to wool production since it is their main source of income [37]. Mexico not only has to give importance to wool production, wool quality, producers management training (as China does) but also must consider the climate and feed resources available in each region.

5. Conclusion

Wool production in Mexico continues to be deficient and therefore cannot meet domestic demand, having to resort to wool imports. It is necessary to consider that Mexico will not be able to completely cover the national demand since most of the commercial wool is of short and thick diameter, this is due to the great influence of meat breeds, such as Suffolk and Hampshire, which also have a great amount of black and brown fibers. The use of native resources of the region, such as the "Chiapas sheep breed" allows the development and maintenance of traditional ancestral culture, such as the Tzotzil, and the manufacture of handicrafts typical of each of the regions of Mexico; it is clear that Mexico will not improve its wool quality in the short term, however, the management of long-term programs through the inclusion of dual-purpose breeds, wool and meat can be a viable alternative for the development of the wool industry in Mexico, without affecting the production of sheep meat.

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