



OVIS ARIES

SENIOR

Agricultural Class Monograph

Essential Question

How can the intensive production of lamb be commercially viable in
Valle del Cauca?

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Introduction

Ovis aries, also known as sheep, have existed for approximately 60 million years before common era (Czaplewski, 2016). This species used to be wild, maintaining themselves in groups. However, they were often indefensible to predators like wild dogs and wolves. Later on, ancient people started to domesticate this species, since it was a source of food, milk, and skin. Ancient people often used their skins and wool to make coats and other kinds of clothes, but they were primarily used as a source of food. Over time, sheep started to leave certain attributes behind like for example, genetic deficits caused by incest. This allowed new species and new attributes to be developed, like better kinds of wool, better efficiency in terms of milk and meat production. Some of these mutations and changes were caused because of the close care of humans (domestication), the climate and the geography. The close care of humans (domestication) made them become animals with more muscle and milk production. The climate allowed new kinds of wool to be developed. Allowing humans to have each day better skins and better wool for the protection from the cold. Getting close to the 21st century, sheep have become part of scientific studies and other discoveries. For example, in 1997, the experiments done to sheep Dolly, in the United Kingdom, were used for the first cloning made in animals. This scientific experiment was successful, although not in the way scientist wanted. This was due to the fact that the DNA was successfully cloned as well as the other factors it had. The diseases and other illnesses caused by the age were copied also from the original DNA, causing the cloned sheep to experience these in a young age (Center of Regenerative Medicine, n.d). To finish with, this species (including lamb) and its market has obtained lots of strength in the previous years all around the world. New markets have developed in Colombia, Ecuador, Brazil, and Mexico, increasing each day the lamb production as well as the consumption. Now, this

study first will focus on the species, the market, the proper management, and development of the lamb and meat business. Later on, the study will focus on analyzing the factors affecting this business, especially in the intensive and extensive production methods. Finally, this study will finish with the proposal of a business plan for Valle del Cauca, based on the intensive lamb methodology production.

Chapter 1: Ecology

1.1 Affinities

Sheep make part of the Animal Kingdom, where they can be cataloged as vertebrates and later on as hollow-horned ruminants. This categorization is due to the fact that they possess four stomachs, that function by feeding the bacteria they have inside these organs. They also have a process in which they decompose the grass by eating and re-chewing it. This process is done while resting, and when it's completed, they feed the bacteria in their stomachs with the remainings of this process (commonly called "chewing the cud"). On the other hand, they are also cataloged as mammals, having gestation periods of approximately 150 days (Shapiro, n.d). To finish with, this species has many kinds of breeds, including Katahdin, Dorper, Charollais, Santa Ines and many others, that vary on their different sizes, weights, and fiscal composition.

Taxonomy of *Ovis Aries* (Wilson, 2005):

- Domain: *Eukarya*
- Kingdom: *Animalia*
- Phylum: *Chordata*
- Class: *Mammalia*
- Order: *Artiodactyla*
- Family: *Bovidae*
- Subfamily: *Caprinae*
- Genus: *Ovis*
- Species: *Ovis Aries*

1.2 Fossil Record

Fossils from this species have only been found in Europe, Africa and Asia (*Figure 1.1*, below). Most of these were found in South Africa, but as well, fossils were found in Kenya, Algeria, and Libya. The time period estimated of these fossils is about 66 million years. Where these are located in the Phanerozoic era, and to be more precise in the Quaternary and Cenozoic era. The blue points in the map (*Figure 1.1*) reflect the fossils found from the Phanerozoic era, and the yellow reflect the ones found from the Cenozoic era. In addition, many of these fossils were found in caves, but as well they were found in coastal, eolian, fluvial-lacustrine places. On the other hand, the fossils found in Europe were located in the north and the south of the continent. Near the Netherlands and Italy, fossils were also found in caves. Looking at the displacement of sheep, a theory states that sheep come from the south of Africa that later migrated into Europe and Asia. However, there is a more precise theory, stating that *Ovis aries* had two main beginnings. One of them, in central part of Europe and the other in the south part of Africa, generating this species to have different characteristics (Czaplewski, 2016).



Figure 1.2: Location of Fossil Records. (Czaplewski, 2016)

1.3 Origin

Although is still uncertain, studies from their ancestors help to understand the different aspects of their origin. Their ancestors are mainly wild sheep, like Urial, Argali, Mouflon of Europe and Asia. The Mouflon of Europe is a descendant from the Mouflon of Asia, which was brought by humans into the Mediterranean region (Dohner, 2001). On the other hand, another theory states that the European Mouflon is a descendant of primitive sheep, that later spread and made other subspecies (Mungall & Sheffield, 1994). DNA studies support that ancestor of the species, *Ovis aries*, were first seen 60 million years before common era. These studies allow the theories to be more confident and precise when referring to the periods of evolution and their origin (Shapiro, n.d)

1.4 Present Distribution

In the present time, the distribution of sheep is worldwide, but significant populations are distributed at some specific locations. Countries like the United States, Canada, Mexico, Brazil, South Africa, United Kingdom, China, India, Australia and New Zealand poses high population concentration rates. However, Australia, New Zealand, and China are the countries with higher sheep population, having the possibility of exporting lamb to the United States, Europe, and middle east countries (Czaplewski, 2016). Sheep domestication has a large influence on its present worldwide distribution, as a result of its easy adaptability (International Lamb Profile, 4/12).

Chapter 2: Environmental Factors

2.1 Environmental Factors in distribution

Domestic sheep are very versatile and they can live in almost every part of the world. They are able to live in deserts, forest, savanna, and mountains. The maximum altitude sheep can survive is around 5,000 meters above the sea level and its due because of the lack of oxygen available. Sheep are capable of adapting in cold weathers, developing wool in order to preserve their body temperature. As well, in hot areas, sheep are capable of adapting, developing hair instead of wool, allowing them to maintain a stable body temperature (Hiendleder, Wassmuth, & Janke. n.d.).

Wild sheep have developed their bodies in order to survive in the remote areas of mountains, deserts, and forest. Although their rusticity (resistance and toughness), sheep domestication by humans have developed some other different traits. As a result, sheep have improved their quality, but maintaining as well the rusticity of wild sheep for certain climates. Sheep crossings and genetic modifications have permitted to obtain excellent quality sheep with an exceptional efficiency in the production of wool, milk, and meat. Maintaining at the same time their rusticity for specific climates, that pure breeds will have trouble of getting used to. (Hiendleder, Wassmuth, & Janke. n.d.)

2.2 Climate & Elevation

Sheep are characterized for living in all kinds of habitats as a result of their easy adaptation process. They can live from deserted areas to plateau environments located 5000 meters above sea level. The climate isn't a limitation for the distribution of sheep because they

adapt easily to the temperatures exposed, with the variation of their wool thickness and development. As well, food isn't a limitation factor, due to the fact that sheep are herbivores and can find food easily in any environment (Reavil, 2000).

2.3 Relations

Ovis aries have caused lots of pests in island habitats, like Hawaii and Santa Cruz islands. These pests were very destructive, damaging trees and the habitat of endemic birds (Scott et al. 1984). This species affects the habitats of herbivore animals because they eat almost every type of grass and plants. As a result, this species may cause serious damage to habitats, affecting the population of other herbivores and other animals related to herbivores. *Ovis aries* main source of food is any type of herbs like grass and flowers. On the other hand, their main predators are Wolves and Coyotes (A-Z Animals, 2008). Sheep also tend to have *Melophagus* obvious that is an external parasite that resides in the sheep's wool, where it sucks the blood of the sheep causing irritation (BioWeb, 2009) There are also internal parasites that are cataloged in two groups, bacteria, and worms. Bacteria makes part of the digestive system of sheep that sometimes can transform into parasites like *Fusobacterium Nectophore* that causes foot rot in sheep that then damages the soft tissue of the foot making the sheep limb fall off due to the pain (BioWeb, 2009)

Chapter 3: Biology

3.1 Chromosome Complement

The chromosome number reported varies from 33-60 (Berry, 1941) It all depends on the technique used and the kind of species it's being analyzed. *Ovis aries* chromosome complement has evolved over time, reducing from $2n=58$ to $2n=52$ (Bunch & Foote, 1977). This genetic reduction has been caused due to the selective fusions of their ancestors. The genetic swapping has made the inherited selections go towards a lower chromosome number. One ancestor of *Ovis aries* is the Mouflon, that has a chromosome number of $2n=54$. As a result of the crossings with the Mouflon, the chromosome number has fallen, compared with the Argali species, that has a chromosome number of $2n=56$. The hybrid newborns, as a result, have a chromosome number of $2n=55$. This is due because of the crossing of Ram ($2n=55$) and Ewe($2n=54$) [$(1/2(2n=55) + 1/2(2n=54))$] making it drop slightly over time. As a result, there is an alteration in the sex ratio (two female newborns per male newborn) that can be cataloged as a benefit in the population increase. As well, this alteration in the sex ratio will contribute to the shift of a lower diploid number, having in the future fewer chromosomes. (Bunch & Foote, 1977). This change might not have such a great impact, but if in the future the diploid number gets smaller, there would be fewer genes that cause debilitation in some aspects of the species.

3.2 Life Cycle

Sheep are cataloged as mammals, indicating that they feed their newborns with milk. As a result, newborns are automatically dependent from their mothers, making them learn how to walk immediately. They are always exploring new places and food resources where they learn to

become ruminants eating different kinds of vegetation (Reavill, 2000). Within the year, lamb becomes sheep having a life expectancy is of 6-11 years of age.

3.3 Reproductive biology

The reproductive biology of sheep relies on natural insemination, that is made by a physical reproductive procedure. This process is based on the sperm joining the ovules fertilizing the female. The sexual maturity for both, females and males is reached in the first 18 months of life (Shapiro, n.d). In addition, the female ovulates every 14-20 days and the time of ovulation lasts for about 20-30 hours. In places with seasons, sheep usually ovulate in the fall and midwinter seasons, different from the ones that live in places that have no seasons that ovulate without interruption (Reavill, 2000). As well, the average gestation may take around 146 days or 5 months, where the female has an average offspring per birth of 1.3 and an average of 1.5 births per year. At the birth, the newborn has approximately a weight of six pounds that can vary depending on other factors, like the possibility of a multiple births. It's very common to see a double birth, but it all depends on their life quality. There is almost a 30% chance of having a birth with two newborns at the same time, but in some cases, this ratio may be higher.

3.4 Physiology

To begin with, *Ovis aries* have a heart rate between 60-90 beats per minute, and a breath rate of 12-20 breaths per minute. As well, its stable body temperature lays between the 102-103° F (Schoenian, 2015). There is also a group of 7 different blood types (A, B, C, D, M, R & X) which according to their analysis, they are compatible with one another (Cornell University College of Veterinary Medicine, 2013). This conclusion was based on positive acceptance of any

of the blood types in the receiving body. Although they are compatible, some secondary effects when the organism doesn't assimilate as expected the blood transfusion is dizziness and uncoordinated movements. However, in most of the cases, sheep finish assimilating the blood type either in a short or a long period of time. They have a complex digestive system composed of four chambers, which are filled with cellulose from the leaves and vegetation they eat (Czaplewski, 2016). First, the digestive system is in charge of decomposing the food by re-chewing the matter eaten. This first process is stored in the first chamber, and when the food parts are small enough, they pass to the other three chambers. These three chambers are filled up with bacteria, where these then decompose the food into proteins, fats, and minerals. Then, these are assimilated by the organism as an energy resource in order to work and develop.

Sheep in desert environments have different mechanisms, in order to make a proper adaptation. For example, these types of sheep have a different metabolism, making a higher water retention in their bios vessels and their renal cells. As well, organs adapt in order to have a better energy optimization. These changes involve their metabolism, the development of their body (size), and their saline-alkali tolerance. This last one is usually increased to improve energy optimization and tolerance to dehydration, becoming directly proportional to these improvements. Analyzing the plateau environment, sheep tend to develop other attributes, like the way the circulatory system works. This system is developed differently, due to the way the vascular system is formed. Also, sheep in this environment tend to develop certain genes that can be found in vascular smooth muscular contraction pathway. In addition, these genes are helpful for the diameter adjustment their blood vessels, allowing them to have a better performance of oxygen distribution (Hiendleder, Wassmuth, & Janke. n.d.). Although altitude doesn't impede

sheep survival, studies have perceived these changes between sheep located in high altitudes and arid areas.

As well, since sheep are herbivores, they suffer a great impact when there is an environmental change due to the distinct habitats present in different altitudes. In addition, herbivores tend to have problems on their thermoregulation and other aspects in their metabolism, caused by the different plant quality and biomass. Sheep different from other herbivores tend to change their metabolism along with the habitat change allowing them to easily adapt in high and low altitudes (Hiendleder, Wassmuth, & Janke. n.d.).

Chapter 4: Propagation and Management

4.1 Natural Regeneration

Ovis aries have a reproduction rate of 3 births every 2 years, having almost 50% chance of having a double birth. As a result, the probability of getting a third newborn increases, although it's not very common. Females located in seasonal places become fertile in the early fall until midwinter (Vuren, 2010). Different from sheep located near the equator that are fertile year-round like males. As well, the estrus cycle can vary from 14-20 days, where the heat lasts for an average period of 30 hours. Artificial insemination is also a usual process when genetics are being manipulated, involving risks and limitations.

The place where sheep start the fertilization process needs to be cleaned up before its use. It is first sterilized with lime (cal) putting then, the bed of sawdust or dry rice shell. This bed allows the sheep to live in a dry area, preventing diseases caused by humidity. In the lactation stage, the wool is cut and the hoofs are cleaned as a usual protocol. Then, when ewes are finished with the rising stage, they are exposed to the male, fertilizing them while they are on heat. When the pregnancy is confirmed with an ultrasound examination, they enter into the gestation state. This state is usually very calm in order to prevent abortion from stress. Females as well, are only intervened if they have symptoms of sickness or if there is a need of any minimum intervention like moving them for a different fold. Finishing the cycle, they stay in the gestation state until a few weeks before the giving birth, where then, they enter the pre-birth stage. In this last stage is where they give birth and it's the most critical stage of all. Everything needs to be under observation in order to prevent deaths from bad position births. The birth is only human intervened if there are any problems with the natural birth procedure. Finally, the

final stage when the sheep complete a successful birth is postpartum, where the newborns are vaccinated and it is raised by their mother in a different fold. The newborns are fed with the ewe's milk and other supplements in order to maintain them in good shape and healthy (Aristizábal, 2016).

Managing the propagation is mainly influenced by the type of female and the ram it is exposed to. According to Sheep Genetics Organization, there are many types of genetic crossing depending on the type of business. There are four types of crossings procedures, which are based on the main industry focus (lamb, wool, breeders, or milk). These crossings produce different attributes, that later can be inherited by the newborns obtaining as a result different kinds of genetic traits. These traits will eventually increase their performance in each of the different sectors, making them be more profitable (Sheep Genetics Organization AU, n.d.). These crossings can be obtained by different ways depending on the infrastructure and the inversion being made. One type is the natural pregnancy, and the other is by an artificial insemination process that will be explained in the second part of the chapter.

4.2 Artificial Propagation

4.2.1 Artificial Insemination

Artificial insemination is a different way of obtaining pregnancy that has become popular over the years although its costs and limitations. There are different types of artificial insemination, it all depends on the traits being looked for. The simple way is by having a non-manipulated ovule and fertilizing it using semen pallets. The other two ways are egg wash and

embryo washing which are very similar ways of achieving the same purpose. However, these are differentiated by the process and the quantity of the fertilized ovules (Aristizábal, 2016).

4.2.1.1 Pre-preparation

The pre-preparation consists on a series of protocols in order to complete a successful artificial insemination. These protocols can vary depending on the procedure and the country. The first step in an *in vitro* insemination is to get semen pallets of outstanding rams. These semen pallets can be found very easily; they are sold on websites and on different organizations although sometimes they can be expensive. Their value depends on the ram quality as well as their descent, and the number of prices it has won over the competitions made worldwide. The process of obtaining these semen pallets it's not very complex. This process is based on the natural pairing aerated by a tool that imitates the vagina of the female in shape and temperature. This allows the male to ejaculate in the tool maintaining the sperm on a test tube that then is refrigerated. Sometimes sperm gets into additional treatments in order to have higher probabilities of having either a female or a male. Then in order to use the sperm straw, the female is fertilized or the ovule by completing an *in vitro* process. When the *in vitro* process is the one selected, there is a need to first make an egg wash. In this process, the veterinary takes the ovules from the female, fertilizing them in a laboratory becoming into embryos. These embryos then can be placed into receiver ewes that complete the remaining gestation process developing the newborn. This is only practiced on high-quality animals as well as a high pedigree ones' due to its complexity and its expensive process. (Clarke, 2015)

4.2.1.2 How to Maintain Pregnancy & Gestation

The process in order to maintain the pregnancy is simple and not very complex. Females first need to be in a very calm area, separated from all of the other sheep that aren't in the gestation period. They need be in a separate fold where they will receive more supplements in maintaining, as a result, the pregnancy and their weight. Females will stay in this stage until they give birth, moving then into lactation stage. Abortions are mainly caused by stress and other factors that prevent them from staying calm and in rest. Diseases also contribute for an abortion to occur because these make the ewes pregnancy to be unstable (Aristizábal, 2016). Another key factor in order to maintain the pregnancy is the quality of the nutrition. This aspect has also a high influence on the newborn's weight, as well as their chances of surviving when born. Births with low weight newborns are due to poor nutrition, making them be weak during the procedure causing a high mortality rate. After the birth, newborns weight gain can vary from 50-150 grams per day on dairy breeds, different from meat breeds that gain from 50-250 grams per day (PennState, n.d.).

4.2.1.3 Storage

The storage of embryos and semen pallets is based on constant refrigeration process. The cooling agents and recipients need to be cleaned off from any other animal derivate. These elements used need to be exclusive for the management of this product. Dry ice is also used to maintain the cold cycle preventing contamination of the semen pallets and the embryos. As well, semen and embryo pallets need to be sterilized and stored on pallets in order to maintain the effectiveness of the product. There is also the need of having legal notice of product for the

destined country. This notice is made to prevent the spread of new diseases and illnesses that may affect the integrity of the country. (Clarke, 2015)

Chapter 5: Emerging Products & Potential Markets

5.1 The Overall Picture

Ovis aries has mainly three kinds of products that are meat, wool, and milk. Although all of these products may seem that can be taken from the same sheep species, breeds vary according to the product it is being produced. As well, farms and their locations vary according to what they are producing. For example, the wool sheep industry is mainly located in cold areas as a result of health issues. On the other hand, the food industry can be located in different areas, but these possess different characteristics in order to increase the efficiency in their production. Usually, developed countries produce these kinds of goods due to the high complexity of the process.

5.2 Food Industry

Sheep products have expanded and gained force during the past decades' worldwide. Food production has a huge industry that each day needs more products in order to feed the increasing worldwide population. The biggest sector is the meat industry, but the dairy sector is also strong producing milk and other derivatives such as cheese and butter. The high demand in the Middle East Asia and Europa has made sheep production expand in many countries like for example, Brazil, Mexico, and Colombia.

5.2.1 Meat Industry

The lamb industry is the biggest in the sheep sector, where its production can be placed anywhere worldwide. There are 3 main breeds for the meat industry and these are Dorper (Figure 5.3), Charollais (Figure 5.2), and Katahdin (Figure 5.1). These breeds are special because they

develop bigger body physiology due to its genetics. In order to have a better production, these breeds are crossed with milk production ones (Male-meat breed, female-milk breed), maintaining their physical traits for the newborn with a high milk production ewe. Due to their genetics, pure animals from breeds like Dorper and Charollais have a low production of milk compared to others. That is why it is crossed with the Katahdin breed, maintaining an ewe with high milk production and a newborn with the physical characteristics of Dorper or Charollais. (Aristizábal, 2016)



Figure 5.1 Katahdin Breed (Aristizábal,2016)



Figure 5.2: Charollais Breed (Farmers Weekly, n.d.)



Figure 5.3: Dorper Breed (Aristizábal, 2016.)

5.2.1.1 Consumption Inventories & Demand

The industry has expanded over the last years due to the high demand the product has all over the world. The largest producers are China, with a production of 4.4 billion pounds. Followed by European Union (1.9 billion lb), Australia (1.4 billion lb) and New Zealand (1

billion lb) (Brester, 2012). Although sheep inventories have declined in the past 50 years the production has increased or maintained the same in some countries, due to the high efficiency in production. The demand has also increased, although in some countries of the Americas have declined their consumption of lamb. The consumption per capita is still very low, compared to other animals. Studies suggest that the increase in consumption is proportional to the increase in personal income, urbanization, and population growth (Brester, 2012). Also, publicity against red meats and the increase in their prices have given a great impulse towards the consumption of lamb. The highest demand is located in Asia, Middle East, and Europe.

5.2.1.2 Exports & Imports

The principal exports are located in Australia and New Zealand. Australia in previous years has exported almost 650 million pounds that correspond to 44% of its total production (Brester, 2012). The total value of the Australian lamb export is equivalent to 700 million US dollars since 2011. On the other hand, since 2011, New Zealand exports 750 million pounds of lamb to worldwide destinations. These exports are equal to 84% of its total production, with a price of 2 billion US dollars in the market. The European Union, on the other side, is the world's greatest importer of lamb, with 490 million pounds per year. Followed by the United States and China with 140 million pounds. As well as the imports, the consumption per capita has also increased in many countries. For example, China has increased by 6% in their per capita lamb consumption since 1980. This is due to the increase in the consumption and their population, that is over a billion people. Their imports have also increased since their production is not enough to supply the whole demand of the population. As well as China, the US imports have also increased. Different from the European Union that has maintained stable. All of the US imports

of its lamb come from Australia and New Zealand (Brester, 2012). Finally, the importations, as well as the demand in Middle East countries, have increased dramatically. As a result, to this increase in the demand, the production of lamb has expanded into some Latin American countries, like Brazil, Chile, Mexico, and Colombia.

5.2.2 Dairy Industry

In the dairy industry, there are six main breeds for this kind of sector. The breeds are Alpine, LaMancha, S, Oberhasli, Saanen, Toggenburg. These are the main breeds that control the milk production sector, but its diet also has great influence on the amount and the quality of the production. Sheep can start producing milk at the age of 7 months. So, it's crucial to start young in order to increase the efficiency. As well, discarding animals that have low production rates and replacing them with new ones can increase the production and the efficiency. Reducing birth synchronization (the possibility of having many or all births on one period of time) is very important because when reduced it allows milk production to be year-round (PennState, n.d.).

5.2.2.1 Consumption Inventories & Demand

Dairy sheep products are mainly made in the Mediterranean countries like Italy, France and Greece (Australian Government, 2016). These countries produce more than half of the total worldwide production (10 million tons of milk per year). To complement the worldwide production, Australia, New Zealand, and China are the next countries to follow in the list. The production of the dairy sector is mainly based on secondary products like cheese, yogurts and the actual milk. Australia produces almost 500,000 liters of milk yearly, with a gross value of 4.2 million US dollars (2012). The dairy farms in Australia are located in the southern part of the

country (red colored in *Figure 5.4*). The area showed in yellow (*Figure 5.4*), on the other side, represents the potential growth for the dairy industry. To finish with, the demand for dairy products has increased although it isn't as significant as compared with the meat demand (Australian Government, 2016).

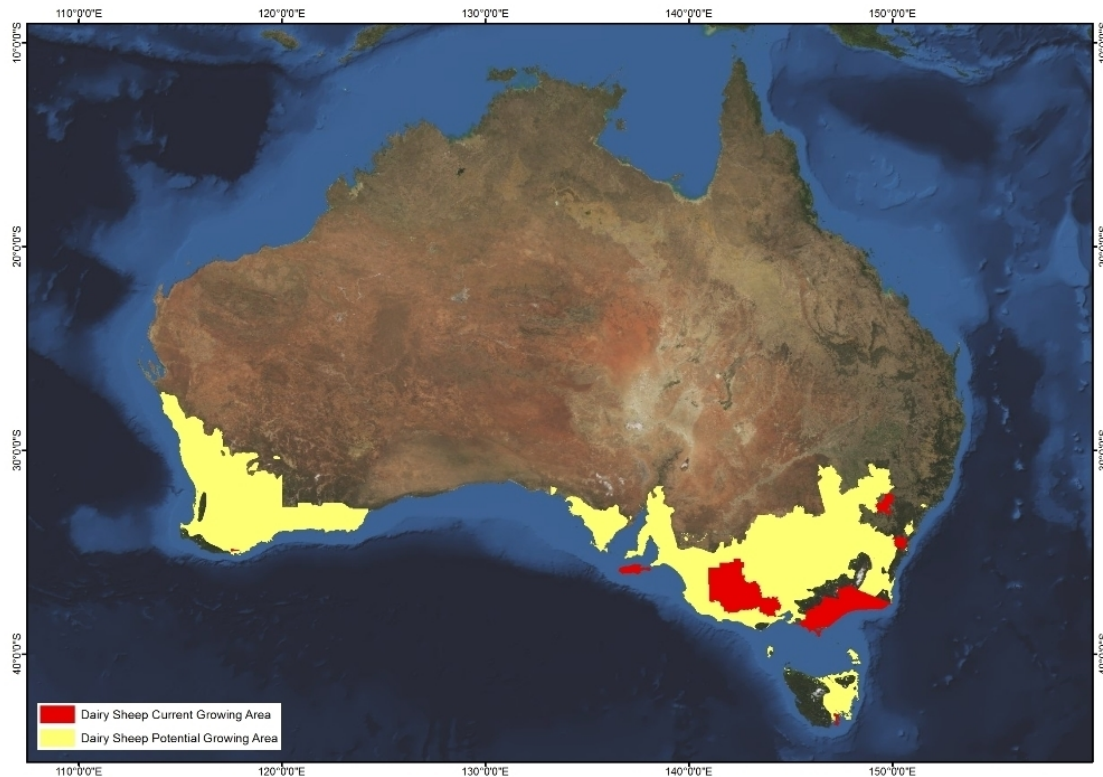


Figure 5.4: Location of Dairy Sheep and Potential Growing Area (Australian Government, 2016)

5.2.1.2 Exports & Imports

The exportation is based on secondary products, like cheese and yogurts. Certain characteristics like the richness in fats, solids, and minerals make it ideal for the production of these products (Australian Government, 2016). Countries like France, Italy, and Greece are specialized in the production of cheese like the Feta, Ricotta, Haloumi and Pecorino. These

products are worldwide exported, due to its exclusive recipes and its high quality. On the other hand, countries with higher milk importation rates are Italy, France, Greece, China, and United States (Schoenian, 2015)

5.3 Textile Industry

The textile industry is based on the production of wool. There are certain breeds for wool production, where they are categorized by different characteristics. These characteristics define the value of the wool, as well as the amount that is produced. The value depends basically on the fiber diameter, where the smallest is finer and more expensive. Fine wool is produced by breeds like Rambouillet, Shetland, and Icelandic. These breeds produce low amounts of wool, different from breeds like Romney, Columbia, and Lincoln that produce large amounts of wool. The price, as said before, is established by the fineness of the hair, but it's also influenced by how clean it is and the contamination (organic matter) it has. The white wool is the most valuable, due to the fact that it can be easily dyed (Schoenian, 2015).

5.3.1 Consumption Inventories & Demand

The world's production of wool is around 2 million tons (2012) where the biggest consumer and producer is China due to its economy and the numerous textile companies located in their territory. China produces around 400,000 tons of wool yearly, followed by Australia with 362,000 tons, and New Zealand with 165,000 tons. Manufacturing companies have the greatest demand for this product because it's used to make all kinds of clothing. It is important to clarify that all kinds of breeds produce wool, but not all kinds can be used to make cloth (Wilcox, 2016).

5.3.2.1 Uses

Wool is used primarily as cloth, where many secondary products are made. The wool is divided into fine and medium, where products differentiate on their quality and their complexity. Medium wool is used to make sweaters, blankets, and socks. Different, from fine wools that are less likely to itch that are used to make different types of clothing (Schoenian, 2015).

5.3.2 Exports & Imports

The biggest importer country is China, followed by the United States where wool is also used by manufacturing factories. On the other hand, Australia and New Zealand are the biggest wool exporters, although many of the breeds in this country don't produce high-quality wool (Wilcox, 2016).

Chapter 6: Case Study Ovinos Buenvivir

6.1 Introduction to Ovinos Buenvivir

This ovine farm first started in 2015, where at first, it was only an experimental business. The farm is located in Zanjonondo, near the town of Buga. Where its temperature can vary between 20°C and 33°C (*Figure 6.1*). The rainfall in this area depends on the seasons, and in recent years, the summer and the winter seasons have been very intense and extreme. Due to this factor, the farm has been conditioned. For example, in order to have irrigation during the summer, ground water installations were constructed. As well, ditches have been made in order to prevent flooding in winter, although it's very unusual.

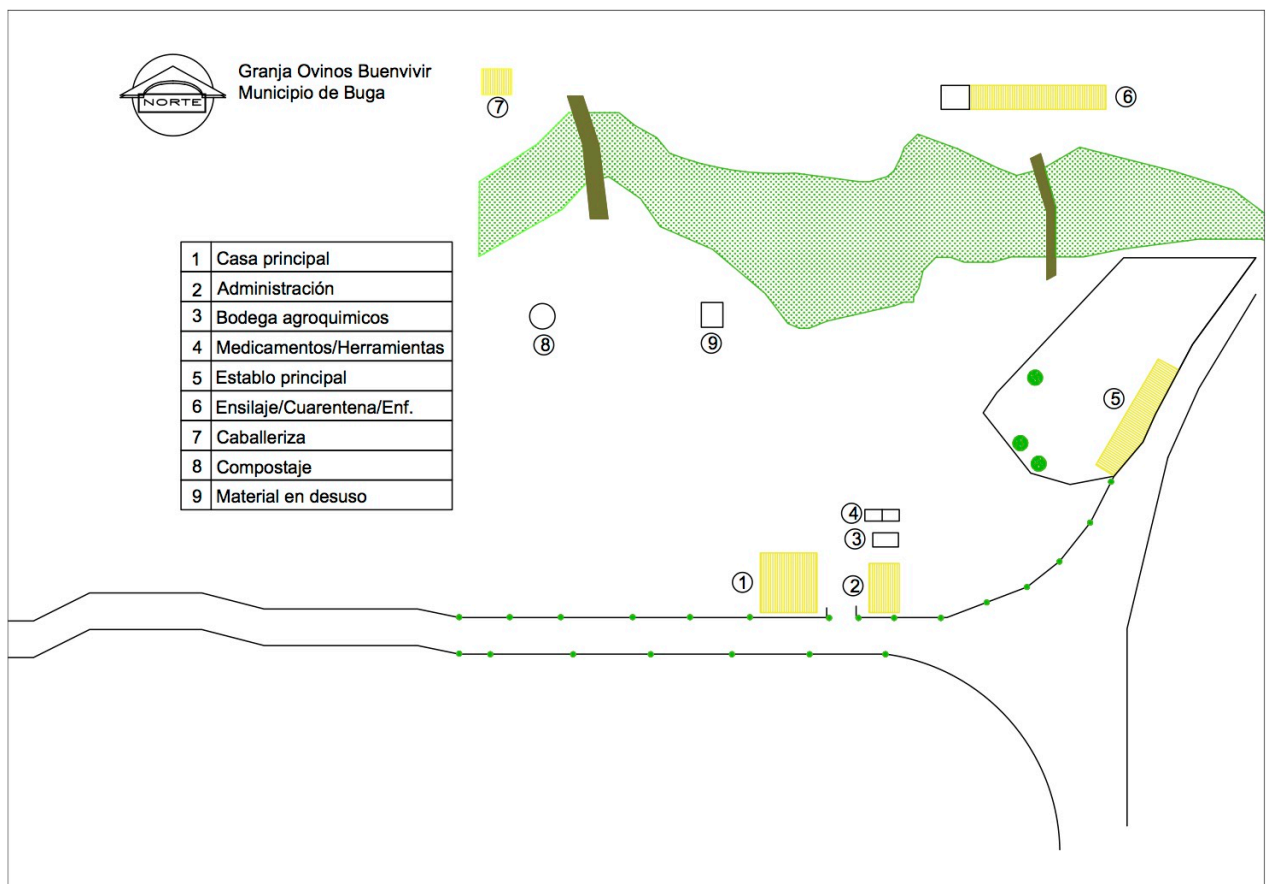


Figure 6.1: Granja Ovinos Buenvivir Plan (Aristizábal, 2016)

The farm is approximately 25 Ha (25,000 square meters) where it is divided into three lots. The first lot is approximately 1.2 Ha, where the following crops are located: *Leucaena* (sp), *Tithonia diversifolia* (*Boton de Oro*), *Gliricidia sepium* (*Mataratón*), *Cuba 22*, Purple Grass (*Pasto Morado*) and *Pasto Estrella*. In order to be more productive, the grass is cut at its optimal nutritional point. As well, in order to be more organized, the lot has been divided into smaller sections, where the crops are planted at different times. The second lot has three houses (in the plans are only showed two), in which two of them are used for recreation purposes. The last plot house is where the administration of the farm is held. In this house is where the workers live, security cameras are located, and the tools are stored. Downhill in the second lot, fodder banks are located, as well as the sheepfold, and the water sources used for irrigation. Additionally, in the third lot, more crops are located, accompanied by another shed and a stable. The shed in the third lot is used to store silage and hay, but it's also used as a zone for quarantine and nursery, for sick and new sheep.

The farm's main use is for family recreation, but we decided to start the business as a hobby. We used to have cattle, but later in 2015, we decided to change to sheep and lamb production. Most of the installations for the cattle were reconditioned in order to be compatible with sheep. This change was due to the difficult market and business of cattle in Colombia.

6.2 Development of the Farm

The farm has stayed in the family for over three generations and has always maintained the ideas from the generation before. The first generation started around the 1990s, and they

focused on planting the area with trees and crops. The second generation focused on building the houses and starting a business, in order for the farm to be self-sustainable.

The first business, as said before, started with cattle production (Brangus cattle). During this period, the cowshed, the stable, and a deep well were constructed. Then, after ten years, the third and second generation decided to migrate slowly into the sheep and lamb business. In order to make a proper migration to this new process, there was the need of some new accommodations. These were built and some others were restructured. The cowshed was the first to be restructured, enlarging the roof. In order to have sheep in the cowshed, the roof needed to be extended in order to cover all the constructed area, maintaining the sheep dry and in shelter. Also, the height of the roof was increased, this was due to the fact that there was a need for a higher ventilation. Feeders were also modified, increasing their height. Later on, as a result of increasing sheep population, the sheepfold was divided into several sections depending on the sheep stage.

The divisions for females depend on the cycle and stage they are in. There are five different sections (stages) which are mount, gestation, pre-birth, lactation, and raising (*levante*). There is one other section but is only used for the sheep designated for meat production. It's cataloged as the feeding stage (*ceba*). The shed located in the third lot was also reformed because it was actually made for vermiculture "*lombricultura*". This shed was then transformed into the nursing section, the quarantine section, and the silage storage. In addition, some of the crops had to be replaced as well. The Purple grass (*Pasto Morado*) and the *Pasto Estrella* were replaced with *Cuba 22* grass, Corn, *Tithonia diversifolia* (*Boton de Oro*), *Gliricidia sepium* (*Mataratón*)

and *Trichanthera gigantea* (Nacedero plants). To finish with, an expansion of the sheepfold was undertaken, adding reactional areas and another section.

6.3 Current Situation

Currently, the farm is in the process of reaching the break-even (*punto de equilibrio*) business point (where there is no loss or gain in profit). This point is estimated to be reached when the farm has about 150-200 female sheep. At the end of 2016, there we reached the 100-female sheep, and the projection on reaching the 150-female sheep is estimated to be at the end of 2017. Also, the farm currently produces around 2-5 lamb per month, but the processing of these may vary depending on the demand.



Figure 6.2: I.C.A Certificate for Good Cattle Practice in the Production of Sheep & Goats for Human Consumption (Aristizábal, 2016.)

6.3.1 The Management of the Farm

The farm has only one worker which is helped by his wife for certain tasks. The day-to-day work is based on the planting and cuttings of the grasses and the fodder banks in the lots. Then the next step is to transport them into the sheepfold, so later the sheep can be fed with it. The farm usually spends around 24 bags concentrate (*Concentrado Terneras y Standard 70*) as well. Also, it's estimated that its spend around COP Pesos \$100,000 on medicine and sanitary supplies per month. When the winter comes, silage packaging is made, so food available for the sheep during summer. Every three months the beds of the sheepfold are replaced and are taken into the compost area, making natural fertilizers that are used in the lots.

Talking about the management of the animals, the ewes are sheared when they give birth. Later on, the newborn is vaccinated and dewormed. As well, they are fed with excess of concentrate so they gain good weight until they are weaned. For the ewes, the amount of concentrate given depends on the stage at which they are. Stages of lactation, gestation, and pre-birth require high quantities of concentrate. Different from raising, mount and the feeding stage, which needs way less concentrate. Vaccination and deworming procedures for females are done when they enter into pre-birth and birth stages. The hooves are also cleaned after giving birth and again before entering the mounting stage.

6.3.1.1 *Quality Analysis*

With the analysis done by BALAR Ruminant Solutions (Sheep veterinary and lamb business accessors), we got to the conclusion that the best quality is obtained depending on the

breed, the period of raising, and the kind of food (grass and concentrate) they are being given, as seen below:

6.3.1.1.1 Breeding Quality

Part of the quality in the lamb industry relies on the kind of breed its being used. There are certain breeds that are specific for meat production. For example, Charollais and Dorper (Figures 5.2 and 5.3) are mainly used as meat production breeds. These, later on, are usually crossed with good milk production breeds, such as the Katahdin. These crossings are due because of low milk production meat breeds usually have. So, they are crossed to increase the weight gain in the newborns and optimize the production. As well, some other breeds may increase the amount of marbling in the meat, giving it a better flavor and texture. The Katahdin breed differentiates from all others due to its efficiency in milk production and a great meat conversion, according to BALAR Ruminants Solutions. Katahdin females are usually crossed with Dorper and Charollais, obtaining an excellent meat conversion in the newborns, but maintaining as well, a good mother with a high milk production.

6.3.1.1.2 Food Quality

In order to maintain a good food quality, Ovinos Buenvivir has increased its protein crops. The main source of food for the sheep are grass cuttings, but these only contribute as a fiber and not as a protein source. This is why there has been an increase in the plantings of *Botón de Oro*, *Mataraton*, and *Nacedero*. Although these plants are contributing with high amounts of protein, concentrate is still needed in order to keep boosting the milk production and the meat conversion. The protein increase does not only make the animals create more muscle, it also allows the meat marbling to be better, giving it a better flavor.

6.3.2. Breeding and fattening (Feed lot)

In the farm, there are two types of business. One is the breeding, which the main focus is to produce good quality ewes. Then, the profits are obtained by later selling them as replacement or as starting ewes. The demand for this market is strong, and it's planned to be the main income due to its high profits. There would always be a stable demand for this sector, but now since it's a new business in Colombia, the demand is pretty high. As a result, we want to take advantage of this demand, producing good quality ewes, and selling them as starting mothers to new farms. Later on, when there is no more demand for this market, it's planned to keep selling ewes as a replacement for the old ones.

The other business is the lamb fattening (*ceba*) production, which is in charge of generating cash flow for the farm. This business is not as profitable as the breeding one, but it has a constant money flow that allows the farm to cover its expenses. The cycle of the production can last from 8 to 11 months since the pregnancy has been confirmed. When the ewes give birth, the lambs are first fed with milk produced by their mothers. Later, by the age of three months, the lambs start the fattening process, with grass, protein, and concentrate. To finish the process, the lamb can either be sold standing or processed, but in order to increase the earnings, it is sold processed by Ovinos Buenvivir.

6.3.3 Management of the Meat process

The management of the meat process is made by a private entity in order to maintain a premium product. This entity employs highly trained butchers giving us well-managed and neat

products. They also count with IMVIMA (*Instituto Nacional de Vigilancia de Medicamentos y Alimentos*) certification, that allows us to be sure that the products are being manipulated in good sanitary conditions. Finally, this entity uses natural and non-chemical preservatives, like smoking and vacuum packaging, maintaining our premium quality.

6.3.4 Management of the Meat Marketing

The meat marketing has been very difficult, due to the small market created by the culture and high price of the product. Ovinos Buenvivir has started to open this new market by selling their products to friends and family. We have also participated in small events, like the Colegio Bolívar Farmers Market, but the commercialization has mainly expanded by word of mouth. Usually selling our products to restaurants and butcher shops has been difficult as a result of the production rate and the price.



Figure 6.3: Lamb Products by Ovinos Buenvivir (Aristizábal, 2016.)

Chapter 7: Other Farms Case Studies

In the department of Valle del Cauca, there are two types of business models for sheep and lamb production. These two models can be cataloged into intensive and extensive methods, which differentiate by some little variations. The different kinds of productions vary due to one main factor, that is the owners' main objective.

7.1 El Redil

El Redil is a farm located in the northern part of the department, in the outer part of a little town called Cartago. This farm has three potential markets, basing their production on lamb meat, breeding's, and genetics. They make part of Colombia's best farms in genetics, where they have the ability to produce and obtain different types of embryos, and semen pallets from worldwide champions. They sell these genetic features to other farms, allowing them to purify their breed, improving their quality. They also sell replacing and starting ewes, having a wide variety of choices due to all the many breeds they manage. Finally, they also have meat production, where they process their own meat. They have a variety of costumers, that include restaurants and companies like Colanta.

Their production is based on the extensive methodology. This method is based on lot divisions, allowing the sheep go to pasture. As well, some of the sheep are allowed to go into shelter at night, but most of them, stay on the lots, except for the sheep used as a genetic improvement that spend all day on shelter. This methodology is more profitable than the intensive, as a result of the lower costs in man labor and infrastructure. Finally, the main

objective of the owner is to produce excellent genetics, lamb, and ewes, becoming one of the best farms in the Colombian market.

7.2 Bergerie

Bergerie is a farm located in the outer part of the city of Yumbo. This farm also manages three kinds of business, that are lamb meat, breeding's, and genetics. They are very strong in the genetics sector, but their strongest business is breeding and meat production. As well, this farm is the only one that has a direct meat selling point to the public called Kött. For this reason and their high meat production, they are dominant in the meat business. The breeding demand for their sheep is also very high, due to their good ewes and the increasing investment in the sheep and lamb business.

Their production is based on intensive feeding, which means the sheep are housed and are fed in their corresponding sheepfolds. These sheep are usually fed with the secondary products that are left from the principal business of the owner. This principal business is based on the production of different kinds of high quality vegetables. These products allow their diet to be healthy, due to the diversity of proteins and vitamins these vegetables may have. In addition, these sheep are being fed with secondary products from a primary and totally different business making the sheep business way more productive. The main objective of the owner, in this case, is to use his secondary products as a food resource, instead of throwing them away.

7.3 Cane Growers

The cane growers have been a new sector that has introduced sheep into the lamb business. Their main focus is to produce meat, and they base their production on an extensive practice. Their method consists on letting sheep wander in between the cane plantations, eating the undergrowth. This is a very cheap method of production, due to the fact that it's not required a lot of man labor. On the other hand, it also contributes to savings of the sugar cane companies, requiring less man labor for the cleaning of the paths. In addition, sheep that go out to pasture usually eat all kinds of grass and moderate amounts of protein. This is due to the fact that most of the wild grasses have high amounts of fiber and low amounts of protein. This method is a very profitable, as a result of its low costs and low man labor needed. Finally, it is key to highlight that this methodology doesn't focus on the production of high quality meat.

7.4 Lujadi

The Lujadi farm is mainly characterized for its genetics. This farm was one of the strongest genetics farms in Colombia, but unfortunately, it disappeared as a result of personal problems. Its main and only focus was selling genetics due to its expensive from of production caused by the small farm of the owner had.

The production was characterized for being intensive. All the sheep usually stayed in shelter all day, being fed at the sheepfolds. This way of production allowed them to have healthy sheep, having high probabilities of double birth, and high weight gain rates in the newborns. Although it's methodology was organized and efficient, their way of production it required a lot of man labor and supervision, condemning the business to be less profitable and problematic.

Finally, as a result of the high costs and the difficult management, the final decision was to discontinue production.

7.5 International Case Studies

Worldwide the lamb production and demand has increased significantly making people analyze the methods of production. In recent studies, the results in China and other places suggest that the extensive methods should be changed into intensive based methods due to many reasons. Some of these reasons involve the population increase and space limitations. These space limitations are a result of the population increase, supporting the theory of finding a better use for the territory, and the optimization of the business. Extensive methods in China involve large extensions of land, increasing the cost of maintenance. Applying the intensive methodology in China will make viable the business in the future, thanks to its smaller size and the process optimization (Condon, 2016). As well, studies done in Australia by Karl Behrendt and Peter Weeks (Commissioned by Meat & Livestock Australia) affirm that the total return and the profits of the business may increase depending on the selling volume. Citing an example, the authors say “Australian and NZ typical sheep farms are the largest by global standards, having from 2 to 8 times higher total returns (revenue) from the business” (Behrendt & Weeks, 2017). Expanding more on their study, they affirm that when the volume of lamb sales increased, the returns took less time, making the profit to increase (Condon, 2016). As well, they analyzed countries with intensive and extensive production methods. Coming to the conclusion, that the intensive methods had a greater volume, producing more profits. As result of these studies, the intensive production methods of lamb have taken force and are being analyzed as a possible substitution of extensive production methods.

Chapter 8: Analysis

8.1 Lamb Production in Colombia

The business of lamb production in Colombia is partially new in some areas, like in Valle del Cauca, where this business started about ten years ago. Different from some other departments like Antioquia and Cundinamarca, which started before the XXI century. Due to this factor, the market, the demand and the experience in the lamb industry are much stronger in these areas than in Valle del Cauca, making it be a much harder business. In addition, the production conditions as well as the infrastructure, make this business in Valle del Cauca, be more complex and less viable than in other areas. Nevertheless, the lamb business in Colombia has an impressive potential, but in order to take advantage of this, the business needs to be well organized and in optimal conditions.

8.1.1 Market in Valle del Cauca

The market in Valle del Cauca has been very difficult to build as a result the cultural aspects. This is partially influenced by the misunderstanding people have about Lamb and Goats. Natives often confuse the meat of lamb with goat meat, being both very different in texture, flavor, and quality. In Colombia goats have been common since the Spanish colonization, making the culture of eating these all across the nation. As a result of the culture, and the ignorance many Colombians have about sheep and goats, a misunderstanding has been created, making the meat of lamb be devaluated. Changing this perspective is not easy, but it has been changing slowly and the consumption of lamb has started to increase.

On the other hand, the quality of the products and their prices have made the market be more challenging as well. Much of the lamb produced in the Valle del Cauca is made based on extensive methods, where the quality of the lamb is reduced due to the kind of food being given and the outdoor conditions they are facing. As a result of these factors, the quality is decreased, making lamb to have a different flavor and texture (harder). The commercialization of this type meat also contributes to its discredit and its commercialization problems.

Another factor that affects the way people buy lamb is the complex cooking this meat involves. People are not used to cook this kind of meat. So, as a result of the wrong cooking, the meat properties change, lowering its quality at the time of eating it. So, in order to maintain the good quality of the meat, it needs to be cooked at a low temperature for a long period of time. This process involves a high amount of work and knowledge, making it be less desirable for some customers.

These factors, the ignorance about lamb, the low-quality products, and the difficult process of cooking the meat, affects significantly the market and its demand, making this business to be challenging in Colombia.

8.1.2 Production in Valle del Cuca

The way lamb is produced also has a large influence on its viability. This is caused by the cost of maintenance, medicine, and employees, that can vary depending on the method being used. The extensive methods used by most of the lamb farmers are more profitable but less beneficial for the volume being produced and the quality of the lamb. In addition, they are more

viable than intensive methods, but in order to have a premium quality and be more efficient, the intensive methodology is far better. For example, the sugar cane growers described earlier in this document, use an extensive methodology, having no control of the factors the lamb is being exposed to (food and habitat). This eventually will result in a decrease in the quality of the meat, harming the market and its producers. Usually, in extensive methods, there is less control and therefore it can be more difficult to manage diseases and their development. Also, due to the population and the worldwide increase in the demand of lamb, there is a need to make the lamb business more efficient. The extensive methodology can be very profitable, but in order to have a good quality and an optimized production, these methods need to be changed.

With the intensive methods, the quality and volume of the production are increased, differently from the extensive methods. The quality is increased due to the control of the food and the habitat sheep are exposed to. As a result, the control of the habitat helps the management of diseases and the life quality. Allowing sheep to be healthier and higher meat conversion rates. As well, the food intake is selected and controlled, making sheep to have multiple births, and lambs to have higher conversion rates. With the increase in the conversion rates, the period of feeding decreases, making the production more efficient. Also, the process and some procedures can be mechanized, optimizing the work and the use of less man labor. At the end, this method is designed for optimization of the production and quality, but it requires more infrastructure, organization, and management that can eventually reduce its profits.

8.2 Viability of Intensive Lamb Production in Valle del Cauca

Intensive lamb production isn't viable in present time as a result of many reasons and factors. One of these reasons are the elevated costs, due to the maintenance of the infrastructure, and the extra work to be done. The initial costs of the construction make this method to have a far longer time period for the investment to return and be profitable. However, the extensive methods involve large extensions of land, preventing the optimization of the business and the involvement of small farmers. With the intensive production methodology, small farmers are allowed to participate the business, gaining profits as well. This is possible due to the optimization of the crops, which may involve the possibility of using better crops, and the use of hydroponic farming. Due to the efficiency of the crops, there is also the possibility of silage savings, allowing the farm to have available food in periods of drought.

As well larger farms using this methodology are allowed to increase their production due to the organization, and the optimization. As an example, the optimization of crops will increase the production of food, leading to an increment in the number of ewes and with it the number of lambs being fed. As well, the intensive methodology allows diseases to be controlled, maintaining lamb healthy, and away from ticks. However, maintaining the animals close together can contribute to the spread of diseases quickly, so an optimal sheep balance must be considered and worked out.

Analyzing the conditions of Valle del Cauca and the methodology, in the future, intensive lamb production can be viable. To start with, this methodology allows spaces to be used better, allowing the production to increase its volume. With it, the department can increase its economy,

exporting lamb to the Middle East, Asia, and Europe. In addition, this method will allow many farms to be accredited, allowing them to sell their products easily and satisfy the requirements for exportation. The viability problem of this business may be affected by the local demand, but if there is enough volume for exportation, it shouldn't be affected. The only way lamb intensive production can be viable in Valle del Cauca is by having enough volume, costs reduction, and an optimized the production. With these factors met, it will satisfy the local demand, as well as the potential export market.

Chapter 9: Conclusions

Finally, as a first conclusion, the production of lamb in Valle del Cauca should point towards the intensive methodology. This conclusion is based on the population increase and the optimization of the business. Although it might be more expensive at the beginning, and maintenance costs, it gives the possibility of increasing the production without the requirement of large extensions of land. As well, the main production of Valle del Cauca is sugar cane, and if there is the possibility of a better use of the soils, the lamb production can be way viable. In addition, this process gives the possibility of developing an international market, exporting excellent quality meat, which has a very strong market all around the world. However, in order to make it viable, a plan needs to be followed that works toward the successful implementation of the intensive lamb production methodology.

There are some factors to be analyzed before implementing this type of business in Valle del Cauca. The first factor to be analyzed is the demand. It clear that the demand in this department is high, but this is a result of the local low production rate. So, the first step to follow is to start with a small production, enough to meet the supply. If there is a huge production then the supply would be excessive, lowering the price, leading to a loss in the production. This first step is extremely important because, in order to be successful, local supply needs to be met in a constant manner. The production needs also to be organized and standardized, preventing the non-constant supply, that can create loss at the time of the commercialization.

The next step is to raise the demand, opening the possibility of mechanizing the process, increasing the production as well as the profit. This needs to be the second step because if it is

done at the beginning, it will cause the non-constant supply that will then produce losses. Opening the possibility of increasing the demand, will open as well the possibility of growing the farm, increasing as well the production. As a result, this will permit the possibility of exportation in the future. On the other hand, with the profits obtained by the first step (meeting the supply and maintaining it constantly), the debts of the investment can be paid and the expansions can be financed. However, there would be a point where the local niche (premium) market would be saturated, making the third stage to take place.

The third step consists of lowering the production costs. This means that the process needs to be mechanized in terms of the crop growing's, the food (grass) distribution, and meat processing. With these three optimizations, the cost will decrease, as a result of the less time needed to complete the tasks, and less man labor to pay. Then with the production optimization, there would be a profit increase, opening the possibility of selling lamb products into new sectors of the population.

When all these three steps are well developed, Valle del Cauca lamb producers may look into the possibility of exportation. Meeting the national market demand is not viable, due to the high transportation costs, and the increasing local farms in the nation territory. So, the exportation of lamb by the other hand, is more viable, due to the unions that can be made. Meeting this way, the volume requirements for exportation. This is the last step to cover, due to the high supply requirement for this process. So, in order to meet the international demand, the local production needs to be strong and stable, allowing the owners and investors to expand their farms into without a high probability of bankruptcy.

The production methods of all around the world are going to migrate into the intensive production methodology in the future. This is a result of the population and demand increase. Which looks for the optimization of the soils due to the limited space available on the planet. As a result of the increasing population, the price of the land would rise, as well as the need for higher food production volume. So, the best methodology that meets these requirements is the intensive, due to the high volume produced in small pieces of land. There is not any doubt that all the production methods will someday end here. So, implementing this methodology as soon as possible will permit a better development of the economy as a result of the premature migration into this type of system.

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