Sustainability Model for the Livestock Sector in the Department of La Guajira - Colombia

Helia Rosa del Carmen Daza Guerra(✉), Carlos Jose Regalao-Noriega, and Karen Acosta Triana

Facultad de Ingenierías, Universidad Simón Bolívar, Barranquilla, Atlantico, Colombia
{helia.daza,cregalao,karen.acosta}@unisimonbolivar.edu.co

Abstract. A sustainability model allows present needs to be met without compromising future needs. Based on this, this study shows the development of a sustainability model for the livestock sector in the Guajira department in Colombia, where an analysis is made of the most relevant factors of the business, the characteristics of the area, the livestock and how everything impacts on the development of the activity in the environment. The analysis is based on three relevant perspectives, namely the economic, social and environmental levels, which, through the methodology used, emphasize the three pillars of sustainability applied to livestock farming in order to transform the sector into an environment that is sustainable over time.

Therefore, this research seeks to provide solutions to the needs of the sector in the environment studied and to provide sustainable characteristics to the area of action of livestock in the Guajira - Colombia, trying to increase the efficiency of the sector in relation to its stakeholders.

Keywords: Livestock · Sustainability · Sustainable development

1 Introduction

Taking as an example advanced capitalist countries such as Canada, Australia and New Zealand, which have development models focused on the use of agricultural resources for the leverage of their economies, we find that Colombia, being a developing country with a great capacity to exploit these resources, has focused its development opportunities on models that ultimately leave the primary sector of the economy behind. At present, the livestock sector in our country represents 1.6% of the national GDP [1], a representative percentage taking into account that livestock farming is an individual and above all rural activity.

Cattle breeding continues to be very important for the socio-economic development of the country, representing 88% of the national agricultural area [2]. Livestock production generates income and provides employment opportunities, not only for producers, but also for different workers during the production and distribution of food of animal origin. Hundreds of millions of people living in rural areas keep livestock in traditional

J. A. Marmolejo-Saucedo et al. (Eds.): COMPSE 2021, LNICST 393, pp. 196–215, 2021.
https://doi.org/10.1007/978-3-030-87495-7_13

production systems, to ensure their livelihoods, as a safety net and to help meet household food needs [3].

Livestock farming is one of the main activities of the agro-industrial sector in Colombia, with a 3.6% growth in GDP in 2018 compared to 2017 [4], supplying the country with milk and meat. According to the Ministry of Agriculture and Rural Development, the share of livestock in agricultural GDP is 9.1%; however, according to FEDEGAN in 1925, agricultural GDP accounted for 57% of the country's total GDP. Today it only accounts for 6.3%. In 1950, cattle farming contributed 14% of the total GDP, and today it contributes 1.4% as shown in Fig. 1 [1].

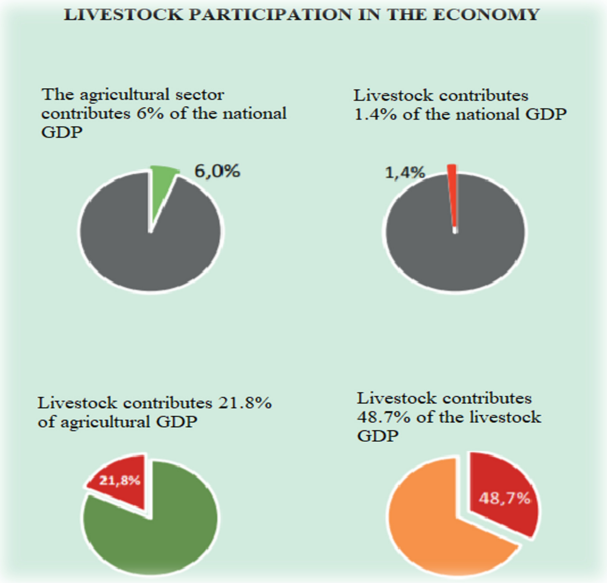

Fig. 1. Livestock participation in the Colombian economy. [Fedegan, 2018].

Livestock activity is present in 27 of Colombia's 32 departments, which means that a large number of the Colombian population is involved in this activity. For many years, it has been the way of life for peasants and businessmen in Colombia, and one of the main sources of income for the country, which is why it is of great importance in national agricultural and agro-industrial production [5]. This activity generates 810,000 direct jobs representing 6% of national employment and 19% of employment in agricultural activities [6]. In addition, Colombia has 26.2 million cattle, 597,177 cattle farms, 219 processing plants and a production of approximately 757,789 tons of meat in 2017, whose commercialization generated 7.2 billion for the country's economy. On the other hand, milk production is 7.1 billion litres per year and formal milk collection is 3.5 billion litres [1].

Colombia's livestock landscapes present a wide heterogeneity in terms of the ecosystems in which they are located and the arrangements used in cattle grazing areas [8]. Livestock farming in Colombia has evolved in the 20th century especially through improvements in breeds, pastures and nutrients. However, extensive cattle raising continues to predominate, as the main form of livestock exploitation within the highly heterogeneous structure [7]. Natural habitats include mature forests, secondary forests, thickets and riparian corridors, among others. Although traditionally treeless pasture has been used for cattle production, different types of silvopasture systems have been successfully established in the country in recent decades, contributing to improved sustainability and more efficient livestock production [8]. This is justified in each of the departmental development plans of the Colombian Caribbean region summarized in Table 1.

Table 1. Development plans department of La Guajira and municipalities. Own creation.

Plan De Desarrollo	Nombre	Retos
Departamento de La Guajira	"Unidos por el Cambio"	"Impulsar la tecnificación del sector agropecuario y el acceso a crédito y mercados nacionales e internacionales"
Municipio de San Juan del Cesar	"Es el momento del cambio para el progreso social"	"Implementación de Buenas Prácticas Ganaderas (BPG)." Acciones del Programa de Ganadería Colombiana Sostenible en el municipio
Municipio de Barrancas	"Historia de Cambio y Prosperidad"	"Fortalecer el sector pecuario en el municipio" "Realizar un programa de Ganadería Integral sostenible"(bovinos, porcinos, caprinos)
Municipio de El Molino	+ Oportunidades + Progreso	"Fortalecida la economía del municipio brindando apoyo técnico y tecnológico a las labores agropecuarias de la población campesina de la región
Municipio Fonseca	"Unidos Podemos"	"Apoyar a la implementación de prácticas agropecuarias productivas sostenibles de arroz y Ganadería"
Municipio Villanueva	"Villanueva de Todos"	"Desarrollo Económico agropecuario y turístico para todos"

(*continued*)

Table 1. (*continued*)

Plan De Desarrollo	Nombre	Retos
Municipio Urumita	"Construyamos lo nuestro", "Urumita Gana"	"Urumita fortalece al campo – sector agropecuario y agroindustrial"
Municipio Manaure	"Con EnfoqueÉtnicodiferencial"	"Plan integral, de corto, mediano y largo plazo, multisectoriales y multidisciplinarios para estimular y recuperar la actividad agropecuaria tecnificada y eficiente en el departamento", "Implementación de Buenas Prácticas Ganaderas"
Municipio Riohacha	"Cambia la historia"	"Mejorar las capacidades de los pequeños productores rurales para la inclusión y participación sostenible en las cadenas de valor agropecuarias"

The year 2018 was a difficult one for cattle farming because it had many ups and downs and the problem of the health crisis had a serious and dramatic impact on the economy of this agricultural sub-sector of the country. Similarly, it is important to highlight that the strong summers impact the sector, making access to food and water sources difficult according to FEDEGAN [1]. Another issue that directly affects the sector is cattle theft, which leaves annual losses of 400 billion, according to DICAR in 2017, more than 3000 cattle were stolen in Colombia. As well as the low competitiveness of the sector, where the availability of the country's resources is wasted [9].

Taking as a reference the whole context and the needs presented in the sector, this article proposes a sustainability model that goes in the direction of making the livestock activity sustainable in time, involving all the variables that intervene, in order to achieve an integral combination of economy, environmental and social management in the livestock farms. This is done by analyzing representative variables in each of the dimensions of economic, environmental and social sustainability, achieving the sustainability of the sector with the integration of these three elements. Sustainability is an issue that has been gaining strength as the years go by, taking such relevance due to climate change and the consequences it brings with it, so this analysis is required, on one of the sources of pollution. In this sense, the proposed model is aimed at waste reduction and utilization, equity and social integration, communication and understanding of the problems in the sector and good profitability.

1.1 Sustainability and the Livestock

The society of the 21st century requires the incorporation of sustainable development in its daily life [8], covering the three economic, social and environmental dimensions, in order to make the process integral. Several studies have identified that companies do not develop a sustainability strategy because it is not their priority, they do not have a good command of the subject and there is a dilemma between being sustainable or profitable [10]. Therefore, sustainability can be seen as a new approach within business, where companies seek to promote social inclusion, optimize natural resources and reduce environmental impact, without neglecting the economic and financial viability of the company.

Although the concept of sustainable development does not have a single definition. However, historians of the concept place its origins in the environmental movement and environmental economics [11], In livestock systems, the concept of sustainability was developed in the 1990s, and has undergone changes over the years due to the nature of these systems. On the one hand, we can observe more or less intensified livestock systems where essentially productivist objectives prevail and where the version of weak sustainability predominates. On the other hand, we can observe extensive and ecological systems, where the balance of the social, economic and environmental dimensions is evident and where the version of strong sustainability predominates [12].

The main objective of sustainability is to reconcile economic growth with care for the social environment and environmental protection. However, in an environment of uncertainty, companies need tools to help them make decisions and define their strategies. Therefore, in view of this new reality, it is necessary to consider the use of models that allow the rediscovery of new ways of managing not only companies but also their objectives, strategies and policies in order to make the prosperity of companies compatible with a sustainable quality of life at a planetary level. To this end, we must rely on flexible models that allow for the hybrid processing of objective data and subjective estimates, that make it possible to forecast the future behavior of companies, institutions and social agents, and that make it possible to offer a redesign in the economic relations that affect all the entities involved" [12].

The models of sustainability that have been developed throughout history in Latin America are based on three elements: economic growth, fiscal stability and economic integration. However, for the contemporary era, they have shown a relevant shift, covering aspects that go beyond the economic, including human development, autonomy, multidimensionality and environment. "Many of the interpretations of sustainable development agree that, in order to achieve this, policies and actions to achieve economic growth must respect the environment and also be socially equitable in order to achieve economic growth" [13]. In addition, Garzon and Mares [14] in their work they comment that "sustainability is a complex and multidimensional concept that cannot be solved by a single corporate action and companies are faced with the challenge of minimizing waste from ongoing operations, preventing pollution, together with the reorientation of their portfolio of skills towards more sustainable technologies and technologically clean skills".

Como objetivo principal del desarrollo sostenible es la creación del valor dentro del negocio o en el proceso, por medio de la actividad comercial, que se pueda lograr a

través de la propia actividad comercial de la empresa, la disminución del consumo de electricidad, agua y otras materias primas, el uso de nuevas tecnologías y la innovación de productos [15].

In terms of Sustainable Livestock, Colombia has focused on a concept of integral sustainability, which includes Economic Sustainability, Environmental Sustainability and Social Sustainability. According to Celso Alfredo Salazar, 2011 "Livestock and agro-productive activities, in general, are under great pressure due to the changing competitive conditions that, in an increasingly dynamic and global scenario, require livestock producers to have skills that are not only productive, but also strategic in the search for markets and the generation of added value for their production. [16] In this sense, a strategy must be sought for improvement at the productive, environmental and social levels, focused on the sustainable development of the livestock sector.

1.2 Livestock in the Guajira

Specifically, the department of La Guajira occupies the 25th place in extension with 20,848 km^2 equivalent to 1.8% of the national territory, located in the area called "dry Caribbean". The region is characterized by three main productive activities such as mining and quarrying, and social, communal and personal service activities and the productive orientation of the livestock of La Guajira, is focused on breeding (50% of the herd) and the dual purpose (46%) as shown in Fig. 2 [1].

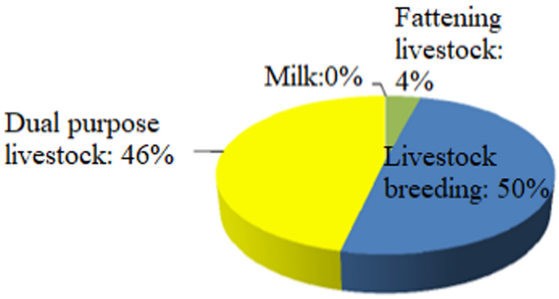

Fig. 2. Productive orientation of La Guajira. [Foro Ganadería Regional 2014–2018 Guajira.]

Its cattle inventory is one of the smallest in the country, occupying 20th place, with 330,000 cattle distributed in 4,591 farms, occupying an area of 1,578,371 ha. This characterises the Guajira's cattle ranch as one of the lowest in terms of load capacity (0.22 head/ha). Guajira cattle ranching produces 389 million litres of milk per year (1,066,000 L of milk per day) 10, and slaughters around 520,000 cattle (2013), according to the Fedegan established in the Regional Livestock Forum [1]. The department has 15 municipalities distributed in 3 sub-regions: Guajira Alta (Uribía and Manaure), Guajira Media (Riohacha, Maicao, Dibulla and Albania) and Guajira Baja (Hatonuevo, Barrancas, Fonseca, Distracción, San Juan del Cesar, El Molino, Villanueva, Urumita and La Jagua del Pilar), the activity is concentrated in the lower Guajira.

Similarly, the department of La Guajira is affected year after year by factors such as low competitiveness (production and application of new technologies), climate change, theft of livestock and outlaw groups, health problems (foot and mouth disease). In general, there are many advantages in favors of production such as access to water, availability of pasture and feed, having a large herd and adequate agro-ecological conditions. However, there are deficiencies in the competitive advantages in milk and meat production, given that the use of good technologies and processes that lead to efficient indicators compared to international standards.

One of the points that most affects the productivity of the sector is climate change, where you can find very dry summers or wetter winters. According to the Fedegan [1], Between 2009 and 2012 there were two La Niña phenomena, and an El Niño phenomenon, causing the displacement of 2 million cattle and the death of more than 180,000. Given that the department of La Guajira is located in the dry Caribbean of Colombia, it is one of the sectors most affected by climate change, bringing as a consequence for the farms a lower availability of water for irrigation and watering holes for the cattle, the increase in production costs in terms of the use of labor to feed the cattle, the purchase of food inputs, vitamins and inject able tonics, a higher incidence of forest fires and the deterioration of the pastures. Likewise, for the animals there is a loss of weight due to dehydration, an increase in parasite problems and diseases (tick fever, diarrhea and pneumonia); due to a decrease in fodder consumption and caloric and water stress, there is a decrease in milk and meat production, and in the birth rate [17]. In accordance with all the previous problems, the identification of the variables involved in the sustainability of the sector and the existence of a validated model that allows this sustainability to be achieved, and the redesign of the livestock activity, seeking to ensure that all the points that directly affect the sector, such as climate change, the lack of technology, the fact that it is an uncompetitive sector, the groups on the margins of the law, among others, can reduce their impact and make the livestock sector in the department sustainable over time.

Since livestock farming is one of the most relevant activities in the Colombian economy, it is necessary to focus on seeking improvements in the sector and to have a prospective view of Colombian livestock farming for the coming years; this is in order to avoid the different variables impacting the sector, having a vision and projection of the business. Nowadays, cattle breeders must improve their productivity and competitiveness within the farm, in order to have international standards that allow us to compete in the foreign market; therefore, it is of vital importance to define efficient productive models. Likewise, it is necessary to demand the adequate conditions for competitiveness such as interest rates, development of roads and infrastructure, cost policy among others, greater state support for the rural sector, clear public policies towards agriculture and strong institutions; and in this way better manage the serious market problems that affect this sector.

2 Materials and Methods

As detailed in Fig. 3, the methodological approach on which the research is based is of a mixed type; quantitative and qualitative data will be collected, analyzed and interpreted in order to obtain answers to the problem posed and to help with the analysis

of the descriptive context of the livestock sector. Therefore, a review of the literature will be carried out in order to obtain all the information related to the development of the sustainability model, and as an important part of the development of the model, the administrative methodology of each farm will be analyzed through surveys to farmers and employees, in order to obtain details of the farm management, to analyze the specific characteristics of the business. With the above, a content analysis was conducted, involving literary analysis and primary sources of information with which the variables were defined and the development of the model was carried out.

As detailed in Fig. 3, the methodological approach underpinning the research is a mixed one. Quantitative and qualitative data collection, analysis and interpretation will be carried out in order to obtain answers to the problem posed and will assist with the analysis of the descriptive context of the livestock sector. The administrative methodology of each farm will also be analyzed through surveys of farmers and employees, in order to obtain details of farm management, to analyze the specific characteristics of the business.

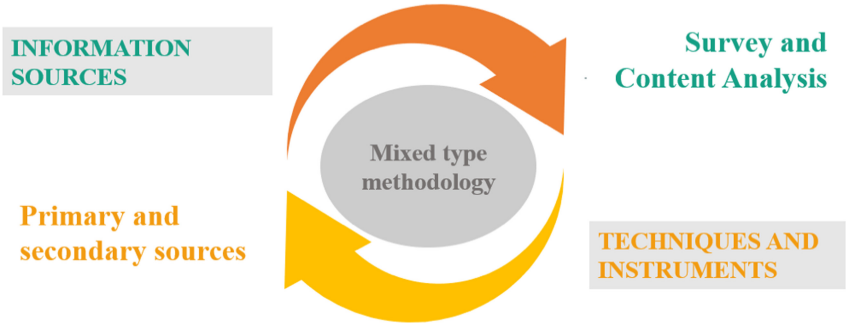

Fig. 3. Materials y methods. Own creation.

2.1 Source of Information

For the development of the investigation they are the primary and secondary sources, where testimonies and information of the stakeholders who intervene in the process will be gathered by means of a survey. In the same way secondary sources will be taken into account like statistics of the DANE, ICA among others, in order to obtain a wider information of the characteristics of the sector.

2.2 Techniques and Instruments

As an important part of the research process, direct information will be sought from farmers, workers and in general from all the relevant stakeholders in the project, with which relevant information will be taken, with which improvements can be defined and projected for the sector. Similarly, through the analysis of content, a subsequent study of the information collected in the surveys is carried out, also with secondary information from entities such as Fedegan, MinAgriculture, ICA, among others.

2.3 Procedure

Three stages are taken into account for the development of the project, detailed in Fig. 4, which begin with the collection of data, primary sources through a survey. Secondary sources are also analysed, including a literature review and statistics on the sector provided by government agencies. From this point onwards, we proceed to triangulate the dimensions of sustainability and the variables involved in the livestock process, building the model. The final stage is the validation of the model, where the type of validation methodology is established, to then proceed with the validation of the model.

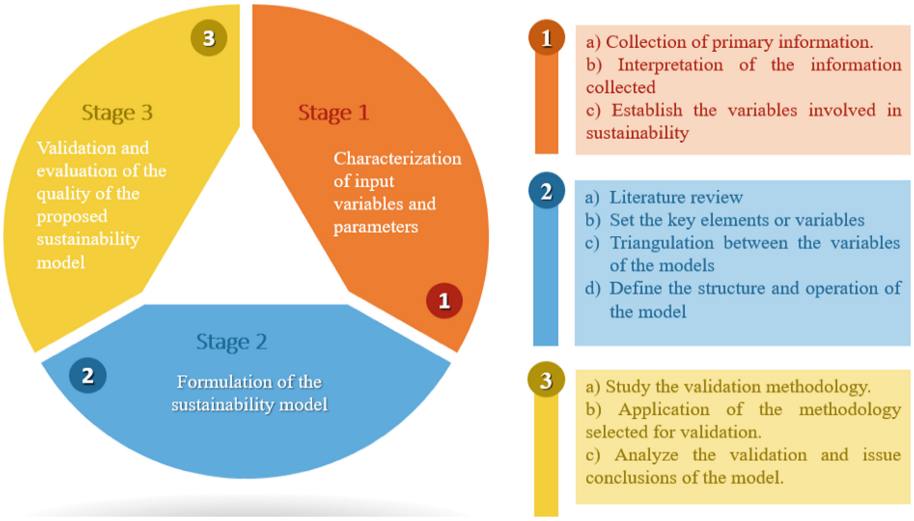

Fig. 4. Process. Own creation

3 Results

3.1 Defined Variables

Given the situation of livestock farming in the department of La Guajira, the following variables are defined for the model, focusing the sector on sustainability, with three dimensions, focusing on the triple bottom line, for the development of the model, where the economic, social and environmental dimensions are related as the main factors, and framing different variables that allow the sector to be analyzed from these, detailed in Table 2.

Table 2. Sustainability model factors and variables. Own creation.

Factores		Descripción	Variables	Descripción
Sustainability	Economic	Focused on the production of the good or the service, guaranteeing the development of the activity and the generation of profit by it	Productive areas	Large spaces where a wide variety of activities are developed for the creation or treatment of products
			Infrastructure	Necessary facilities for the development of an activity
			Technical and administrative records	Consignment of relevant data in a document; being evidence of the information official form
			Additional expenses in summer	Incurred expenses that complement the 'main expense' incurred
	Social	It is based on principles focused on creating just social conditions	Health, safety and well-being in workers	Focused on the prevention of occupational injuries and illnesses, in addition to the protection and promotion of workers' health
			Biosecurity	Norms, protocols, and principles to avoid risk to health and the environment from biological agents

(*continued*)

Table 2. (*continued*)

Factores		Descripción	Variables	Descripción
	Enviromental	Use natural resources responsibly, bearing in mind that it is not possible to replace natural capital	Environmental management	Plan for the prevention, mitigation, control, compensation and correction of negative environmental effects or impacts, given by the development of an activity
			Animal welfare and treatment	State in which the animal is found, taking into account the living conditions appropriate to its needs
Ganadería	Economic	Focused on the profitability of the business, seeking to be a productive farm throughout the year	Productive areas	Type of activities carried out within the farm in addition to livestock
			Infrastructure	The farm must have the necessary infrastructure for the livestock activity to develop fully
			Additional expenses in summer	Given the arid area where the activity takes place, additional food expenses are incurred due to the low production of natural grass on the farm

(*continued*)

Table 2. (*continued*)

Factores		Descripción	Variables	Descripción
	Social	Stable and fair conditions for workers and the community	Health, safety and well-being in workers	Trained personnel, affiliated with the EPS and ARL, the house has the necessary resources to live with dignity
			Biosecurity	Development of activities for the conservation and security of the environment where the activity takes place, including biosafety equipment, disinfection programs, entry of authorized personnel on the farm, among others
	Ambiental	Minimize the environmental impact within the farm, in addition to animal care and welfare	Environmental management	Environmental activities are carried out on the farm that promote the correct use of the land and the farm's environment in general
			Animal welfare and treatment	Preventive diagnostic activities for farm animals, with medicines approved by the ICA

3.2 Definition of Steakholders

Within the livestock process, different stakeholders are involved, whether they are internal or external to the farm, and these stakeholders can directly or indirectly affect the process. In this case, stakeholders are included in the process in order to involve them in the model, highlighting the relationship between each dimension, the defined variables and the stakeholders. In Table 3, the stakeholders involved in the livestock process are shown:

Table 3. Stakeholder. Own creation

Partes Interesadas	Definición
Clients	Wholesale - Retailers
Farmer	Farm Owner
Employee	Managed - Farm Foreman
Investor	Investment in livestock
ICA	Colombian Agricultural Institute
Fedegan	Colombian Federation of Livestock
MinAgricultura	Department of agriculture
Comunity	Community that intervenes or is affected in the process
Providers	Food, services, etc. providers
Asocebú	Cebuino Cattle Association
Other Livestock Farms	Alliances with other farms
Financial entities	Capital for investment

Stakeholders include customers, wholesalers and retailers, including the type of product to be purchased, either milk or meat, farmers as owners of the company, employees, investors in livestock, government entities, suppliers of inputs needed for the process, grass, seeds, associations such as Asocebu, alliances with other farms, financial institutions. In general, they intervene in the livestock as a fundamental part, for the development of the process, leading to the final objective of the farm, either for meat production, milk, or dual purpose.

3.3 Selection of the Sustainability Model for the Livestock Sector

The study carried out by Juan Plasencia et al. shows that the most referenced and implemented sustainable development models are TBL and the four-pillar model. These models are the basis for most of the instruments, standards, indices and indicators developed by international organizations and institutions. [18] According to the theory of sustainability different variations can be found which can be seen in Table 4.

Bearing in mind that the TBL model is one of the most used at present, and that it can be perfectly adjusted to the livestock sector, in order to seek sustainability based on the three economic dimensions, in search of utility and constant production during the year, social, taking into account that most of the employees in the sector belong to vulnerable groups and with respect to the generation of employment in society and the environment, focused on the welfare and treatment of animals and the preservation of the environment, as an important part within the process of the development of the activity. Similarly, this model of sustainability has some variations depending on the relationship and importance of the dimensions.

– Dimensions as independent systems

Table 4. Theoretical models of sustainability. Own creation.

Tipos De Modelos De Sostenibilidad		
Triple bottom line	TBL o 3BL	Sustainable development must be evaluated from three dimensions, economic benefits, achievements in equity and social justice and protection of the environment
Pressure - state - response and variations	PER	The impact that human activities exert on the environment, results in changes in the quality and quantity of environmental conditions (state), or what society responds through through environmental, economic and social actions
4 pillars of sustainability		The CDS, I call the four pillars of sustainability: economic, social, environmental and institutional
Lowell center for sustainable production	LSCP	A new model based on environmental, safety and health aspects of production
Sustainable balanced scorecard	SBSC	Its objective is to incorporate ecological, social and ethical aspects to the strategic core of the organization, through the balanced scorecard tool
Environment - social - governance model	ASG	It integrates the environmental, social and government dimensions. Used primarily for investment analysis
Cubrix model	Cubrix	It proposes the development of seven key levels in the management of the organization

– The three dimensions are related to each other
– The three dimensions are equally important
– Ecological Dimension is the focus
– Economic dimension is the focus

For this case the model is selected where the three dimensions are related to each other, giving it the same relevance and showing the following economic-social, environmental-social and environmental-economic interactions.

3.4 Definition of the Sustainability Model

The main objective in a sustainable business is the creation of value. Achieving this through commercial activity, in the case of a livestock company, focused on reducing environmental impact, the use of new technologies, product innovation. All of which

generates a greater profitability and impact on the needs of consumers measured through indicators. These are defined as aspects of interest to the company and are analysed on the basis of general corporate sustainability guidelines [15].

There are many factors involved in livestock systems that make them very complex, such as physical, sociological, economic, political factors, etc. These include and condition the production playing an important role in the evolution of the system. Many studies consider livestock systems as dynamic systems where the interrelation of the elements that make up the system generates a complexity inherent to its own nature that conditions the different production practices; location, demography, markets and production potential play an important role in the way these systems can evolve [12]. Livestock are generally raised mainly on grass, grazing land and non-food biomass from maize. millet, rice and sorghum crops and in turn provide manure and traction for future crops.

Animals act as insurance against hard times and provide farmers with a regular source of income from sales of milk, eggs and other products. Thus, in the face of population growth and climate change, smallholder farmers should be the first target of policies to intensify production - carefully managed inputs of fertilizer, water and feed to minimize waste and impact, supported by improved access to markets, new varieties and technologies [19]. A model of sustainability includes three very important aspects, economic, environmental and social; knowing the most relevant characteristics and problems in the sector, the following model is designed with the aim of having the sector become more sustainable by seeking an improvement in the supply of meat and milk products, being constant throughout the year, likewise focus the sector in favor of environmental conservation, waste reduction, the use of renewable energy, preserving native species and in the social sphere, the search for equity, support to the community, being fair with the remuneration of employees.

Economical: Improving the economy in the sector is one of the key and relevant points, taking into account the problems that arise in the Guajira, which prevent excellent results from being obtained. It is important to take into account good livestock practices, as well as to implement strategies that provide support to the livestock during the hardest time of the year and mitigate the consequences of summer in the sector, managing to keep the livestock in good condition, without lowering production and without incurring additional costs.

Environmental: In general, within the cattle company there are many environmental factors among which it is important to take into account, taking into account these are in the natural environment, in search of obtaining the resources of nature for animal welfare. Therefore, the management within the company must be focused towards the care of the environment, mitigating the impact that the activity may cause, as well as the animal welfare, as the main product.

Social: The sustainability model for the social aspect focuses on the generation of employment in the community, support for vulnerable groups, fair remuneration for employees, and optimization of the waste generated in the activity in order to generate an additional source of income for the community. In accordance with the definitions of sustainability and related dimensions, integrating the concept of livestock farming

in the Guajira, the following general model is established in Fig. 5, where the relationship between the economic-social, economic-environmental and social-environmental dimensions can be seen, and in its integration, achieving sustainability in the sector.

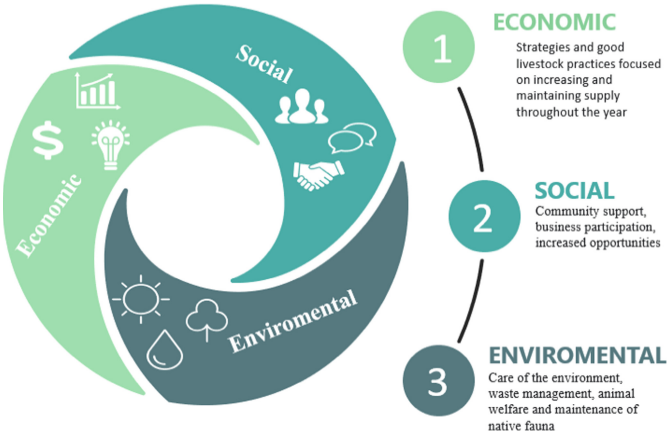

Fig. 5. General sustainability model. Own creation.

In accordance with the above, the sustainability model is defined by relating the variables, dimensions and related Stakeholders in the process and establishing the model involving the variables defined in Fig. 6.

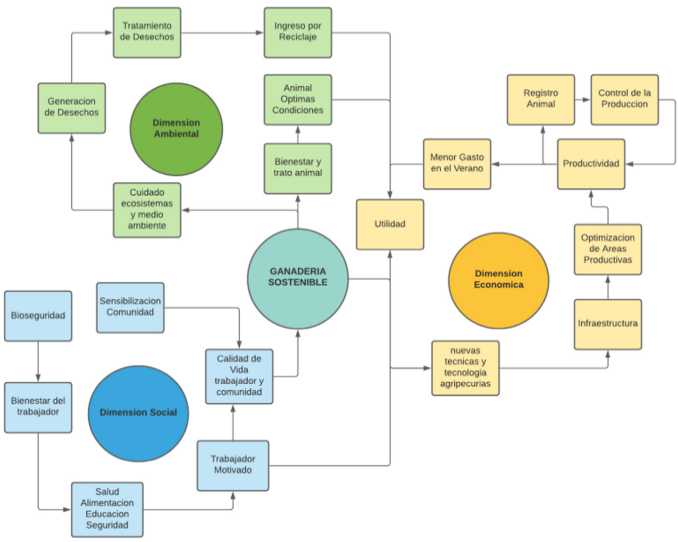

Fig. 6. Sustainability model for the livestock sector in the department of La Guajira. Own creation.

As shown in the image above, the variables defined above are involved, aiming at production, which would bring the livestock sector closer to sustainability.

- Economic Dimension: focused on improving investment in technology, improving infrastructure, optimizing the process, which helps to increase the utility of the farm.
- Social Dimension: aimed at two important parts, such as the welfare of the worker and biosecurity. From the above, it is possible to have motivated employees, positively impacting productivity, which helps us to increase the utility.
- Environmental Dimension: this is analyzed from two perspectives, the generation of waste and the well-being and treatment of animals; therefore, the aim is to obtain additional income with the treatment of the waste produced on the farm, and in addition to this, the maintenance of the livestock in optimum conditions, which contributes to the quality of the product generated, positively impacting the utility of the process.

3.5 Model Validation

The methodology selected for the validation of the sustainability model is Max Black's theory of models and metaphors [20]. In this way, taking into account the TBL sustainability model, it is projected towards the sustainability model of the livestock sector, focused on the most relevant variables that influence the development of the sector. In this sense, the structure of sustainable development can be seen in Fig. 7.

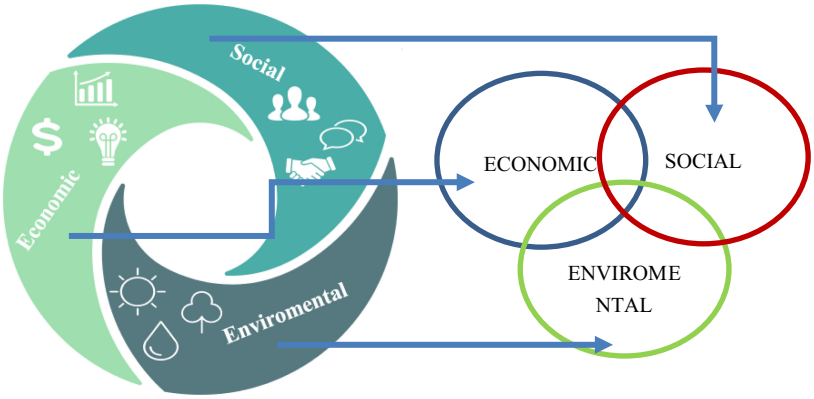

Fig. 7. Livestock sector model vs TBL model sustainable development.

The theory of Models and Metaphors proposed by Max Black, exposes the interaction of two object domains, each one containing a set of associated ideas that characterize and identify them. In this sense, the theoretical model of sustainability presented by John Elkington and the model proposed on the basis of this for the livestock sector in the department of La Guajira are analyzed, transferring the analysis of the three economic, social and environmental dimensions in the search for sustainability. Consequently, and following the guidelines of the theory of models and metaphors, the theoretical model

interacts with the practical model for the livestock sector, where each of these has its associated ideas. In this way, the metaphor juxtaposes and transfers from a primary model the ideas and implications to the secondary model, illuminating certain features and obscuring others. The primary (theoretical) model is then seen through the framework of the secondary (practical) model. As a result it can be seen that the model planted on the basis of the theoretical one can be analysed that the two systems are seen as more similar to each other. In this sense, the interaction "creates" the similarities between the compared models. Given the application of the theory of the metaphor in the theoretical sustainability model towards the sustainability model of the livestock sector, finding the similarities, taking into account that the developed model is focused towards the theory of sustainability TBL, therefore, it can be said that the proposed model has a theoretical support, validating its content, given the translation of the plan-tee theory.

4 Discussion and Conclusions

In accordance with the established methodology and procedure, a sustainability model is defined for the department of La Guajira, framed by the characteristics of the sector, the stakeholders, the dimensions of sustainability, and the existing theoretical sustainability models. As a first step in the development of the project with the investigation of secondary sources, there are not many sources of information available regarding the subject under study. This led to the analysis of sustainability models from different sectors and different countries, with the aim of finding a reference as a guide, clarifying the form of the model, integrating it with the variables defined through the survey and different studies of the sector carried out in the department of La Guajira. The analysis of the livestock sector and the literature research led to the development of the model towards the triple bottom line (TBL), involving three dimensions, economic - social - environmental, which would lead the livestock sector of La Guajira to be sustainable over time. This is one of the most widely used models today, easily adjustable to the characteristics of the sector, including the relationship between the three dimensions, so that by complying with the model's guidelines, the sector can achieve sustainability.

In this way, each dimension or factor is related to the variables analyzed, the productive areas, technology, infrastructure, animal treatment and welfare, waste management, bio-security and worker welfare, focusing the processes within the farm on sustainable development. These variables frame the three dimensions, relating them to each other, which defines that the greater the focus of the farm on these three pillars, the greater the sustainability within it. Once the model had been defined, it entered the process of validation, but in the first instance, the different validation methods were analyzed, taking Max Black's theory of models and metaphors as a methodology. The author explains that it is possible to analyze the relationship between the theoretical model (Triple bottom line), and the practical model (Livestock sector in the Department of La Guajira), juxtaposing the characteristics of each one, and finding the similarities, managing to show that the practical model has the theoretical support. From the above, it is hoped that the sustainability model can frame a change in the sector, taking into account all the disadvantages that arise in the development of this, focused on the search for results in the economic dimension, with the increase in profits per year, reducing environmental

impact and animal welfare, and in the social dimension, with the welfare of workers and biosecurity.

For the development of the model that adjusts to the characteristics and needs of the region, there is the inconvenience of the availability of information and literature, there are few works of sustainability models in the studied area, however, the theory of sustainability models is clear, so it can be easily transferred to a particular sector. Likewise, the study and analysis of the sector, taking primary sources as an important basis within the characterization of the model, identifying the relevant variables within it.

From the above, it is expected that the sustainability model can frame a change in the sector, taking into account all the problems that arise in its development, focused on the search for results in the economic dimension, with the increase of profits per year, the decrease of environmental impact and animal welfare, and in the social dimension, with the welfare of workers and biosafety. With the development of the sustainability model, it is expected to promote within the sector and in a region where conditions are becoming more unfavorable for the sector every year, with the impact of climate change, inequality, low product prices, which are making the sector less competitive and sustainable every day. In this sense, the analysis carried out provides the variables and conditions within the sector that allow livestock farming to be sustainable over time.

Likewise, in order to give continuity to the research, the need for the implementation of the model within a farm in the area is left open, in order to obtain accurate data and validation in real time of the model, obtaining information related to the variables and each dimension, leading to the analysis of new variables that were not contemplated in the model and that can be framed in the sustainable development of the sector. As well as the need to analyze the existing relationship between the model and the other regions of the Colombian Caribbean, making the comparison of the characteristics of each region and the applicability of the model within each department.

References

1. FEDEGAN: Foro ganadería regional visión 2014–2018 (2014)
2. Mahecha, L., Gallego, L., Peláez, F.: Situación actual de la ganadería de carne en Colombia y alternativas para impulsar su competitividad y sostenibilidad. Rev. Colomb. Ciencias Pecu. **15**(2), 213–225 (2002)
3. Makkar, H.P.S.: Aumento sostenible de la productividad del ganado mediante la utilización eficiente de los recursos alimenticios en países en vías de desarrollo, pp. 55–59 (2014)
4. DANE: Boletín Técnico Producto Interno Bruto (PIB) 2018, pp. 1–45 (2019)
5. ABC del Finkero: El problema de la ganadería en Colombia - ABC del Finkero (2013). http://abc.finkeros.com/el-problema-de-la-ganaderia-en-colombia/. Accessed 04 Nov 2019
6. Portafolio: La ganadería sigue siendo la actividad que más aporta al PIB | Economía | Portafolio (2017). https://www.portafolio.co/economia/la-ganaderia-sigue-siendo-la-actividad-que-mas-aporta-al-pib-509081. Accessed 04 Nov 2019
7. Cuenca, N., Chavarro, F., Díaz, O.: El Sector De Ganadería Bovina En Colombia. Aplicación De Modelos De Series De Tiempo Al Inventario Ganadero. Revista de. Rev. la Fac. Ciencias Econ. **16**(1), 165–177 (2008)
8. Nieto, J.A.M., Echeverri, C.G., Vega, C.J.Q., Chara, J., Medina, C.A.: Dung beetles associated with sustainable cattle ranching systems in different regions of Colombia. Biota Colomb. **21**(2), 134–141 (2020). https://doi.org/10.21068/C2020.V21N02A09

9. Ganadero, C.: DICAR reveló que en 2017 fueron hurtados 3.000 bovinos | CONtexto ganadero | Noticias principales sobre ganadería y agricultura en Colombia. https://www.contextoganadero.com/regiones/dicar-revelo-que-en-2017-fueron-hurtados-3000-bovinos. Accessed 04 Nov 2019
10. Carro Suárez, J., Reyes Guerra, B., Rosano Ortega, G., Garnica González, J., Pérez Armendáriz, B.: Modelo de desarrollo sustentable para la industria de recubrimientos cerámicos. Rev. Int. Contam. Ambient. **33**(1), 131–139 (2017). https://doi.org/10.20937/RICA.2017.33.01.12
11. Chavarro, D., Vélez, M., Tovar, G., Montenegro, I., Hernández, A., Olaya, A.: Los Objetivos de Desarrollo Sostenible en Colombia y el aporte de la ciencia, la tecnología y la innovación. Colciencias **1**(3), 183–188 (2017)
12. Angón, E., García, A., Perea, J.: Evaluación de la sostenibilidad en sistemas ganaderos. Ambienta (118), 82–89 (2016). http://www.revistaambienta.es/WebAmbienta/marm/Dinamicas/secciones/articulos/Angon.htm
13. Miren, A.: Teoría de las Tres Dimensiones de Desarrollo Sostenible. Ecosistemas **2** (2002). https://doi.org/10.7818/RE.2014.11-2.00
14. Garzon, M., Mares, A.I.: Revisión Sobre la Sostenibildad Empresarial. Rev. Estud. Av. Liderazgo **1**, 52–77 (2018). https://www.regent.edu/acad/global/publications/real/vol1no3/4-castrillon.pdf
15. Valencia-Rodríguez, O., Olivar-Tost, G., Redondo, J.M.: Modeling a productive system incorporating elements of business sustainability. DYNA **85**(207), 113–122 (2018). https://doi.org/10.15446/dyna.v85n207.71209
16. Salazar, C.A.: MERCADOS GANADEROS DE ALTO VALOR AGREGADO como alternativa comercial, no. 00086 (2011). http://www.sac.org.co/images/contenidos/Cartillas/CartillaMercadosGanaderos.pdf
17. DANE: El fenómeno El Niño y sus efectos en la ganadería bovina colombiana. Boletín Mens. INSUMOS Y FACTORES Asoc. A LA Prod. Agropecu **24** (2014)
18. Antonio, J., Soler, P.: Modelos para evaluar la sostenibilidad de las organizaciones **34**(146), 63–73 (2018)
19. Herrero, M., et al.: Smart investments in sustainable food production: revisiting mixed crop-livestock systems. Science (80-) **327**(5967), 822–825 (2010). https://doi.org/10.1126/science.1183725
20. Max, B.: Black_Max_Modelos_Y_Metaforas_pdf.pdf