

Handbook T-IV

Sustainability, Rurality and Society

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VALENCIA-GUTIÉRREZ, Marvel del Carmen
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ECORFAN Sustainability, Rurality and Society

Volume IV

The Handbook will offer volumes of selected contributions from researchers who contribute to the scientific dissemination activity of Universidad Autónoma de Guerrero in their areas of research in Social Sciences. In addition to having a total evaluation, in the hands of the directors of the Universidad Autónoma de Guerrero, the quality and timeliness of its chapters, each individual contribution was refereed to international standards (RESEARCH GATE, MENDELEY, GOOGLE SCHOLAR and REDIB), the Handbook thus proposes to the academic community, recent reports on new developments in the most interesting and promising areas of research in the Social Sciences.

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Preface

This *Handbook IV: Sustainability, Rurality and Society* is part of the basic and applied research carried out at the Autonomous University of Guerrero (UAGro) within the Line of Generation and Application of Knowledge (LGAC): Environment, Society and Tourism itself which was created in 2010 in the Faculty of Tourism and consolidated in 2013 as part of the Master of Science: Sustainable Management of Tourism, UAGro. Whose academic leader is Dr. Niño-Gutiérrez who collaborates with academic staff of the highest level in Mexico and abroad. In the first case, it is important to cite academics from universities such as: Autonomous University of Campeche (UACam), University of Colima (UCol), Postgraduate College of Chapingo, University of Guanajuato (UGto), National Technology of Mexico Campus Aguascalientes, Chapingo Autonomous University; Voceadores de México Primary School, Autonomous University of Guerrero and in the case of international participation in this number there are researchers from: University of Alicante, Spain; University of São Paulo, Faculty of Economics, Administration and Accounting and the Federal University of Uberlândia, Faculty of Management and Business, Brazil.

It should be noted that the content of this work was subjected to a review process by academic peers under the double-blind modality (*blind peer review*) by specialists in the field and in strict adherence to the editorial standards in force in the National Science Council. and Technology (Conacyt) of Mexico. Therefore, it is expected that the ideas that make up this volume will be useful for researchers, members of civil society, personnel of various public and private institutions at different scale levels: local, state, national, regional and global. To do this, Handbook IV shows figures, tables, diagrams, important and current references that help reaffirm knowledge of various aspects connected with geographic sciences, agricultural sciences, environmental sciences and health sciences, among others. Some central ideas of decade one of the contributions are highlighted below:

“Water multifunctionality, financial management and sustainability in the Pardo River Basin, Brazil”, by *FERRARESI-DE ARAUJO, Geraldo José, NIÑO-CASTILLO, Jacob Elías, RONQUIM-FILHO, Adhemar and ORANGES-CEZARINO, Luciana.*

Water resources are of fundamental importance for life, even with the increase in the consumption of this raw material on a global scale, given the increase in agricultural and industrial activities, in this sense it has also become an increasingly expensive and scarce resource.

Results: The charge for the use of water resources has to do with the revolution in water management, it derives mainly from its scarcity in quantity and quality, stimulating its burden, since free use has been seen every year once again as dishonest, since it is not an individual good, but diffuse, of all. On the other hand, regardless of considering water as a scarce resource, it is necessary not to lose sight of the fact that its demand is increasing due to population growth and the different socio-economic activities that are being carried out with increasing vigor. Although the PNRH already contemplates charging for the use of water, it was with the commitment of society and the Hydrographic Basin Committees that it was possible to induce the user to rational use, seeking to balance availability and demand, and, consequently, a harmonizing redistribution of the social costs resulting from its misuse. It should be noted that until today urban users paid for the distribution of water and not for the water itself.

Contributions: The charge for the use of water is part of a general principle of Environmental Law that imposes the payment of costs to those who will potentially obtain profits from the use of environmental resources. The collection, therefore, is fully inserted in the context of the most modern techniques of Environmental Law and is socially fair. Charging for the use of water resources is not an end in itself, but, on the contrary, an instrument used to achieve specific ends. The charge is not in the nature of a tax. The purposes of charging for the use of water resources are: a) recognize water as an economic good and give the user an indication of its real value; b) obtain financial resources to finance the programs and interactions contemplated in the water resources plans.

Conclusion: With these resources, based on a ten-year plan, executed through a multi-year plan, it is possible to contract a strategic investment in the areas of sanitary sewage, solid waste, drainage of fluvial waters and prevention and control of erosive processes. For this reason, the Pardo Basin Management Committee has worked and made strategic investments to ensure the sustainable management of water resources in the Pardo Hydrographic Basin.

“Sustainable development of the dairy goat under the influence of heritability and genetic improvement”, by *GARCÍA-CASILLAS, Arturo César, ZEPEDA-BATISTA, José Luis, and VALENCIA-MAGAÑA, Favio*

This chapter presents information on the bases of heritability such as the use of genotypes associated with productive and reproductive traits in goat farming and molecular technologies in goat genetic improvement, which is useful for producers who want to implement sustainable production. of dairy goats for the commercialization of milk, through the comprehensive management of the national and international market, the authors conclude that the evaluation of dairy goats by heritability in the selection, assisted by molecular markers, is a methodology that interprets the interests of the producer and along with the use of DNA testing provided by genetic evaluation services should be accompanied by breeding values for individual traits, thus facilitating breeders who wish to apply their own weighting criteria to achieve sustainable dairy goat development.

“Sustainability and new rurality: Colombian territory and peace process”, by *SEGRELLES-SERRANO-José Antonio & NIÑO-CASTILLO, Jacob Elías*

Despite the new sustainable and ecological image that is trying to spread, the market continues to rule everywhere and it only remains to be seen what definitive form it will take and what subterfuges it will use to ward off criticism and continue to fulfill its inherent objectives: the accumulation and reproduction of capital.

Results: Land ownership in Colombia is highly concentrated. In 2014, properties smaller than 10 hectares represented 78.03% of the total and accounted for only 5.95% of the entire agricultural, agricultural, livestock, forestry and agro-industrial area of the country 80% of the country's small farmers have less than one Family Agricultural Unit (UAF), that is, they are smallholders. On the contrary, properties greater than 1,000 hectares represent only 0.19% and concentrate 53.97% of all land. However, the most striking thing is that the 275 properties larger than 10,000 hectares in the country account for 0.02% of the total and absorb no less than 40.89% of the land. As Eduardo Sarmiento (2015) indicates, the concentration of the agricultural sector is alarming because the structure of land ownership has not changed at all in two centuries. This sector constitutes a way of hoarding wealth, isolating it from the economy and obtaining large recovery benefits (Sarmiento, 2015).

Contributions: Local development implies the promotion of local entrepreneurial capacity to give value to both traditional resources (agriculture, livestock, handicrafts) and non-traditional ones (environmental protection and natural resources, renewable energies, rural tourism, conservation of cultural heritage). In a post-conflict scenario, local development emerges as a complementary tool to peace policies throughout the nation. In this way, through territorial planning, the space and its inhabitants would be recovered, so that mechanisms would be activated that would contribute to the reduction of poverty, with the endogenous resources themselves and with capitalization and exogenous support. Thus, there would be an increase in social cohesion and the local economy would be integrated with the regional and national ones.

Conclusion: It can be said that in Colombia there has been more territory than State. The lack of regulations has created the ideal conditions for the rural conflict with its two components: agrarian and armed. The protagonists of the first are the peasants with their struggle for land (among themselves and with landowners and investors), for well-being and for political inclusion. The protagonists of the second have been the guerrillas, the paramilitaries and the drug traffickers, who want to control the territories, the corridors and the population. To overcome the rural conflict, the UNDP raises another controversial point: "more State in society and less market in the State" (UNDP, 2011). Since the market has not promoted rural development, it is imperative that the State intervenes for the benefit of the rural environment and the entire Colombian society.

"The bioeconomic approach for the management of public policies against climate changes in the agricultural sector", by *MEDINA-CUÉLLAR, Sergio Ernesto, CONTRERAS-MEDINA, David Israel, and TIRADO-GONZÁLEZ, Deli Nazmín*

It is important since one of the main contributors to climate change is agriculture, so a bioeconomic approach to the management of public policies is paramount.

Results. Present study describes the historical conception of the causes that originated the ecological economy, and the bioeconomy, as well as the social motivations that led to considering it as a sustainable development alternative based on the understanding and application of energy, flows from the perspective of the laws of thermodynamics that saw their conception in sciences such as physics and chemistry.

The contribution of agriculture to sustainable development is relevant, so the implementation of the concept of sustainable agriculture in educational institutions has a primary role as the main source of scientific truth and center of knowledge, without detracting from the legitimacy and value of other epistemic systems such as peasant, traditional or local knowledge.

Conclusions. The activities of human populations are immersed in the public function must visualize the range of options for social and economic development in favor of the governed sphere. Once there is prior knowledge about the indicators and the importance of each one of them, it is necessary to take active measures to reduce risk or increase a benefit. A clear example is that in the bioeconomic situation, the order is inappropriate for a design methodology where the government initiative stands out, in this case, it was first the theoretical part and the superimposed concepts of other currents to generate a combined approach of the previous attributes and to obtain resources with effective technical management so that similar conditions are maintained or away from the deplorable synthesized by scholars.

When the problem of climatological conditions emerges and it is emphasized that the first affected sector is agriculture, evidently due to its dependence on the environment, the bioeconomic fits perfectly with the presented context and it is the approach and the alternatives that appear as a possible agent. mitigating and that would benefit in the same way, that is, without trying to counteract any productive work (except those that generate environmental damage). To maintain the praxis from generation to generation, it is for this and other remarkable facts that it must be taken into account for the creation of public policies in favor of this sector, without delimiting the others, but with a fundamental approach, as well Likewise, the measures that are taken into account to reduce environmental fluctuations will be another key and sustainable factor for activities of any kind, belonging to sectors other than agriculture. The tonality of preserving the means with which profits are obtained is the adaptive bioeconomic approach in public policies in the face of climate change in the agricultural sector.

“Rurality and multifunctionality in the “El Veladero” National Park, Acapulco, Mexico”, by *ZARATE-AÑORVE, Samuel & NIÑO-CASTILLO, Isaías Naú*

Officially, the Mexican government starts from the 1996 law, regarding Protected Natural Areas, where it seeks to promote the conservation of endemic species of the country together with the conservation of its ecosystems, for which it is essential to promote environmental education so that each citizen acquires responsible environmental behavior, together with the government participating together with the private sector in matters of protection so that the ANP can be managed based on specific and effective management programs and plans (Niño-Gutiérrez, 2017). With the above, it is possible to glimpse the notable difference regarding the bases with which the ANP were conceived, which at first sought only to conserve primary natural resources for their later use and use for recreation, and then move on to something more complex as it is a generalized environmental education of its population.

Results: In the municipality of Acapulco there is a total population of 600 thousand inhabitants, which is directly linked to the social pillar of sustainable development, where the population, seeing the municipal land reserve decrease, tends to settle in places of steep slope found in the cliffs, hills, hills and nature reserves, as in the case of "El Veladero", where there are three human settlements: Pueblo Nuevo, Vista Hermosa and Praderas de Guadalupe. According to INEGI, 68 Basic Geo-Statistical Areas (AGEBs) have been identified, where 65 neighborhoods are located, made up of 1,028 inhabitants, of which 15 are located in Pueblo Nuevo, 532 in Vista Hermosa and 481 in Praderas de Guadalupe.

Contributions: a) the destination of Acapulco has a variety of natural, landscape, historical resources, traditions, living culture, among others. Some of them declared as Federal Protected Natural Area, as is the case of the “El Veladero” National Park since 1980 and in other cases cultural heritage that represents an important potential for the diversification of national and foreign tourism, b) existence of tourist and artisanal products with potential for marketing in the tourism sector and c) the International Tourism Fair (FITUR) is held for cooperative advertising campaigns, business meetings with wholesalers and tour operators, among others.

Conclusion: The multifunctionality in the new rurality is a modern strategy that allows options for the development of places and population that wishes to progress, so that, through the conservation of "El Veladero" through local citizen participation, it can promote the diversification of Acapulco's tourist offer, which holds conventional sun and beach tourism as a focal node. But that, through the updated analysis of the population, economic, social and environmental variables existing in the ANP, it is possible that multifunctionality and the new rurality are strategies that allow reorienting the local development of sites such as the "El Veladero" National Park, located in emerging countries.

“Conflicts in livestock-wildlife interaction (health aspects and predatory behaviour)”, by *CRUZ-TAMAYO, Alvar Alonzo, DUARTE-UBALDO, Ivonne Esmeralda, MENDEZ-ORTIZ, Francisco Alejandro and VARGAS-MAGAÑA, Juan José*

In this chapter, some basic knowledge about the conflicts that arise in the interaction between livestock and wildlife is disclosed, where, on the one hand, there is the situation of the depredation of livestock mainly by carnivores and the strategies to combat it, while on the other hand there is the impact caused by livestock in the environment that promotes the proximity between both areas, thus affecting the ecological balance and not allowing sustainability to be reached correctly.

Based on the proposed study, the authors propose an area of opportunity for the proximity of livestock and wildlife to increase the income of producers by including wildlife in their production system, allowing them to use grasslands for domestic livestock, promoting their reproduction to offer recreational services such as photographic safaris and controlled hunting. They propose migrating towards a diversified livestock that in some way benefits the habitat of wildlife that for decades or centuries has been pressured and endangered its existence.

“Parasitized animal selection in small ruminant production systems: field conditions alternatives”, by *VARGAS-MAGAÑA, Juan José, MÉNDEZ-ORTIZ, Francisco Alejandro and CRUZ-TAMAYO, Alvar Alonzo*

This chapter presents a review of the main animal selection systems in the field to reduce the amount of deworming that causes stress and loss in small ruminants, they present the methodology of counting eggs in feces that they consider the most effective way to know the degree of parasitosis of an animal and serves as a point of comparison with other systems. The degree of anemia is also measured with the FAMACHA® card and animals are selected, applied where the parasite is hematophagous. Body condition is used as an indirect measure of body weight and is used as a selection criterion. Symptoms such as diarrhea, low weight gain and decreased milk production are criteria for selecting animals with parasites, although the type of parasite, the production system and the breed are indicators to decide the type of management that is most appropriate suitable for deworming, as long as they are necessary

“Study Habits and Their Relationship with Academic Performance. A recap on the Different Methodologies”, by *PEÑA-ESCALONA, Fleider Leiser, VICTORINO-RAMÍREZ, Liberio, GONZÁLEZ-GARDUÑO, Roberto and VÁZQUEZ-CISNEROS, Christian Alfredo*

Study habits have a fundamental role in academic performance, since they are not measured solely by the amount of time spent studying, but it is a matter of quality of study. There are aspects of study habits that relate to academic performance in the students' trajectory.

Results. In the correlations between study habits and academic performance, a very low coefficient was observed in all cases without exceeding 28% (Table 3). In the study habits scales a highest correlation occurred between TEC and TRA. In other studies, an important correlation has been observed between academic performance and the scales for general attitude, time planning, place of study, study techniques, and homework. This implies that, for example, the conditions regarding the place of study are positively related to academic performance, regardless of the study techniques that are applied or the attitude that one has toward study (Capdevila & Amp; Bellmunt, 2016) . Some of the modifications in the study habits scale were those indicated by Sánchez Balcázar *et al.* (2016), who from 86 items developed a nominal scale from 1 to 10, with which it is possible to numerically relate study habits and academic performance. Using this scale, the researchers found a 40% relationship between these two variables.

The contribution of proper study habits are associated with a good level of academic performance these two aspects contribute as a consequence to a favorable academic trajectory during the stay of students in an educational institution.

Conclusions. Study habits have been observed to depend on various factors that need to be taken into account in the analysis because the scales by themselves do not reflect a relationship with academic performance. A few studies have reported high correlations between study habits and academic performance, so they indicate that if students improve their habits, they will perform adequately, and their academic performance will be optimal. However, many other studies, including among agronomy students, have showed low correlations between these variables.

“Retirement and life project in a group of people from the state of Campeche, México”, by *LÓPEZ-MÉNDEZ, Magnolia del Rosario*

It is important to set goals for retirement, make plans for the future, it is necessary, plan for retirement since it will not only improve this stage of life, but also improves the life of each person for the peace of mind that comes with knowing that you have a plan for that future. Your life is no longer organized through work, but through free time, so many times you are not prepared to have that time.

Results. Of the 13 participants, 8 were female and 5 male. The socioeconomic information of the participants that was obtained was that the ages are in the range of 60 to 78 years, 10 are in the interval of 60 years and 3 of the seventies, in terms of their perceptions, these range between three and thirty thousand pesos with one person in each case, generally from 3 to 5 thousand pesos there are four people, from 10 to 15 thousand pesos there are eight and only one receives 30 thousand pesos, likewise only one person receives two pensions, this amount is monthly and according to the perception of retirees, it covers basic needs as long as they manage it correctly, some of the retirees mentioned that since their children are still studying, once they finish their degree their pension would be only for their expenses and it would give them more. What stands out is that according to the law they should be paid based on minimum wages, but they are paid based on UMA, which implies that they have a slightly lower perception than what the law stipulated. According to retirees, their pension money may be a bit fair, but it is enough for their personal expenses or to treat themselves from time to time.

A relevant aspect is that a worker contributes to society his work, his value, his knowledge, so an education is required to achieve a quality retirement that can be extrapolated beyond the personal sphere, to guarantee the greatest possible well-being to retirees, a sustainable vision is required in all environmental aspects, economic and social. The social aspect is considered because of the relationship between social welfare and the environment and economic prosperity.

Conclusions. In spite of the fact when the retirement stage occurs, this is one more step in the working life of working people, retiring from work was a decision made based on their personal goals and in other cases because they ignored the law which mark that from the age of 60 they can retire, this is important because in the case of the analyzed sample, retirement is a positive and opportune experience that allows them to enjoy free time, family, carry out personal projects that they had stopped. On the other hand, the feelings expressed by retirees are of joy and satisfaction for the things they can now do without pressure of any kind and above all because they continue to be financially independent. Despite the fact that they present some problems typical of old age, such as diabetes and hypertension, they know that they have the IMSS or ISSSTE that provides them with medical attention and medicines. Finally, with this selectivity, we are pleased to endorse that the work is already part of the paradigm of being and doing of the citizens of the world.

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Chapter 1 Water multifunctionality, financial management and sustainability in the Pardo River Basin, Brazil

Capítulo 1 Multifuncionalidad del agua, gestión financiera y sostenibilidad en la cuenca del río Pardo, Brasil

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Abstract

Before the worsening of environmental issues, nations have been rethinking the management of their natural resources in order to promote sustainable development as well as promoting economic growth, environmental preservation and social inclusion. Among these resources, water can be highlighted. Therefore, the objective of the article is to analyze the fundraising for the preservation of the Pardo Basin based on Decree Number 58 771, of 12/20/2012 and how it has been applied for its preservation. The methodology used was the research applied from the bibliographic survey with SciELO, Web of Science and the Integrated System of Water Resources Management of the State of Paulo. It can be seen that PDC 3 received the largest investments, in sanitary sewage, solid waste, treatment and final disposal or other solid waste management actions, river water drainage and actions aimed at promoting pollution containment diffuse, process prevention and control. The second most important was PDC 5 referring to loss control in water supply systems, with an emphasis on public supply networks. With these financial resources raised in the collection, from a ten-year plan, executed through a multi-annual plan, -contact a strategic investment in the areas of sewage system, solid waste, drainage of river waters and prevention and control of erosion processes. Therefore, the Pardo Basin Management Committee has been working and making strategic investments to ensure the sustainable management of water resources in the Pardo Hydrographic Basin.

Hydrographic basin, Environmental management, Water resources, Pardo River, Sustainability

1. Introduction

Water resources are of fundamental importance for life, even with the increase in the consumption of this raw material on a global scale, given the increase in agricultural and industrial activities, in this sense it has also become an increasingly costly and scarce resource. Aware of this reality, governments, companies and non-governmental organizations have increased the instruments for planning, execution and control of water resources according to the concept of sustainable development, which according to the Brundtland report presented by the World Commission on Environment and Development (1987) defined as that which meets the needs of future generations to satisfy their own needs" (p.46) so that environmental, economic and social activities are maintained and preserved.

Brazil, can be considered a country in a privileged position in relation to the nations of Mediterranean Africa, the Middle East, Australia and Chile, according to the National Water Agency (2019) worldwide, or a country where there are about 12% of the planet's water availability, but its distribution is not uniform in the national geographic space. The northern region of the country concentrates about 80% of the amount of available water, but represents only 5% of the Brazilian population. The regions near the coast have more than 45% of the population, therefore, they have less than 3% of the country's water resources.

In this order of ideas, even in a privileged hydrological position, the country must pay attention to the management of its water resources, given the inequality of its distribution in the national territory and its strategic importance for the preservation of life and the economic-social development of Brazil. In this sense, watershed management becomes fundamental. The National Hydrographic Division, instituted by the National Water Resources Council, establishes the twelve Brazilian Hydrographic Regions, namely: Amazonia, Tocantins-Araguaia, NE-West Atlantic, Parnaíba, NE-East Atlantic, São Francisco, East Atlantic, Southeast Atlantic, Paraná, Paraguay, Uruguay and the South Atlantic.

Especially regarding the Paraná River Basin, according to the National Water Agency (2015) it has an area of about 879 873 km², and is located in the states of Paraná, Santa Catarina, Rio Grande do Sul, São Paulo, Minas Gerais, Mato Grosso do Sul, Goiás and Federal District. Given its location in the most industrialized and populated region, according to the National Water Agency (2015), the estimated current water demand in the Paraná Hydrographic Region (base year 2010) is 736 m³/s of captured flow (6.4% of its average flow), equivalent to 31% of Brazil's total demand. The largest water uses in the hydrographic region are for irrigation (311.4 m³/s), industry (202.0 m³/s) and urban supply (177.2 m³/s).

One of the basins that is part of the Paraná water catchment is the Pardo Basin, located in the northeast of the state of São Paulo, between parallels 20° 51' and 21° 50' South Latitude and meridians 46° 41' and 48° 12' West Longitude, covering 14 cities, with emphasis on the city of Ribeirão Preto (Dos Santos *et al.*, 2008). According to Sampaio (2013) the Pardo River Basin was defined as Water Resources Management Unit 04 (UGRHI 04) by the Water Resources Law for the 1994/95 biennium and given the environmental impacts caused by both agricultural, industrial and urban activities in the UGRHI 04 region and the need to preserve its water resources, riparian forests were granted to supply water suitable for consumption by the inhabitants of the region under study under Decree Number 58 771 of December 20, 2012, which approved and set the amounts to be charged for the use of water resources owned by the State of São Paulo in the Pardo Water Resources Management Unit, in accordance with Decree 50 667 of March 30, 2006, which regulated the provisions of Law 12 183, of 2005, which deals with the charge for the use of water resources in the domain of the State of São Paulo.

Therefore, given the importance of the water resource both for life and for economic and social development, in the current scenario of environmental degradation caused by agricultural, industrial and urban activities, a study on watersheds is justified, in this article, specifically the Pardo Watershed, where the main objective was to analyze the collection of funds for the conservation of the Pardo Watershed as of December 1, 2011, Decree 58 771 of December 20, 2012 and how it has been applied for its conservation.

2. Methodology

2.1 Classification of research

The present research is classified as applied, according to Lakatos and Marconi (2001), since it analyzes fundraising for the preservation of the Pardo Basin based on Decree Number 58 771 for its preservation. In addition, it is considered a formal study. The object of the study is considered descriptive, as it describes the current scenario of the management of fund raising and investment of financial resources in the Pardo Watershed. Regarding the time of the study, it is considered transversal, since the bibliographic and data collection took place at a single moment, and field research was carried out based on the comments obtained from each of the interviewees.

2.2 Data and collection instrument

The construction of the references was carried out through desk research, thanks to the documentary-bibliographic stage through the collection, reading and selection of articles published in print and digital form in the databases Scientific Electronic Library Online (SciELO), Web of Science and by the Integrated Water Resources Management System of the State of Paulo in the search for key words such as: Pardo River Basin; Sustainable Development and Sustainability.

2.3 Data analysis

With the information gathered during the bibliographic review, we proceeded to the application of the interpretative analysis of the data, which aims to expose the results and findings obtained in the different forms of production of the vital liquid and uses-abuses that are carried out on a daily basis through the various human activities both in the countryside and in the city (Caregnato & Mutti, 2006).

2.4 Water

The element water (H₂O), composed of two hydrogen molecules and one oxygen molecule, is used in practically all segments of humanity, being vital and indispensable for human survival, since it is an essential and considerable part of the formation of living beings (it is estimated that the human body is composed of more than 2/3 water), which is necessary for all forms of life.

This mineral chemical substance has the attributes of being odorless (without odor), tasteless (apparently without distinguishable taste) and colorless (without perceptible color).

It can be found in three physical states in the environment (biosphere): liquid (seas -salty- and rivers -sweet-), solid (snow and ice -sweet-) and gaseous (clouds and fog -sweet-) -water vapor-. Water remains in the same quantity on our planet (in great abundance), but it is mainly limited by population growth, which causes a reduction in the quantity per capita.

Despite its large proportion on the planet (flow of 41 000 km³ in a year), equivalent to more than seventy percent of the globe, little of it refers to fresh water (2.5%), as it is mainly found in the oceans, and of this small percentage, even less is available for human consumption (0.3%), when it is found on glaciers (4/5 at the poles) or in places of difficult access.

Access to potable water in the world (suitable for drinking) is unbalanced, being very limited in regions such as Africa, such as the Nile River basin, and Asia, such as the Middle East. The picture is bleaker when we have the information that research leads to the conclusion that more than half of the world's population will suffer from a lack of drinking water from 2025 onwards, which will make this resource increasingly relevant and a priority because of its scarcity, justifying its current title of "white gold".

The state of minimization of drinking water will increase the value of this good in the coming decades, in addition to serving as a pretext for the insurgence of a climate of belligerence, especially in places where scarcity will reach unbearable levels. Pollution and contamination factors are also important causes of drinking water scarcity, which calls for more effective public policies to combat them, on the part of governments, mainly because they involve the health of the population. Moreover, according to Sirvinskas (2005).

It should be noted, just as a curiosity, that since the Earth cooled many millennia ago (56 million years ago), the same amount of water remains, i.e., 1.4 billion cubic kilometers (salty and fresh). Only 90 million cubic kilometers (fresh) are ready for drinking, but not all of this stock is available in nature, and only renewable resources can be used through rainfall, reducing to 34 million cubic kilometers per year, corresponding to 0.002% of the planet's water. Currently, almost 70% of the world's water is used for agriculture, 22% for industry and 8% for housing.

2.4.1 Difference between the terms water and water resources

The element water can be called a water resource when it is used for economic purposes. According to Granjeiro, Pinheiro and Miranda (2020), the vision of the infinity of water for human enjoyment, which was common sense a little more than twenty years ago, has crumbled and, like any other mineral resource, increasingly demands payments from its users, and the image of a good with free access for all is fading. The Dublin Declaration on Water Resources and Development, signed in 1991, recognizes "freshwater as a finite and vulnerable resource, essential for sustaining life, development and the environment...all competing uses and should be recognized as an economic good" (Principle No. 4). Its indispensability stimulated the creation of a World Water Day, for which March 22nd of each year was chosen. Water resources are water with economic value, i.e., water that is no longer in the state of an environmental resource, which is found when it is no longer used by man.

The expression "water resources" was used in the Federal Constitution. Although this phrase does not always necessarily translate into the correct economic use of a natural resource. Although "water" and "water resource" are not absolutely identical concepts, we will use these terms without specific distinction, since the law did not use them with strict division (Machado, 2001).

Thus, to avoid further doctrinal delays on terminology and its correction, for didactic and facilitating purposes, in this presentation, specifically, we will no longer dissociate water from water resource in order not to have a deeper understanding of the concept, which is not a close objective of this study. Thus, water is the natural element, and the water resource is this, subway and surface, used in use or economic activity.

3. Results

Brazilian river basins, this is one of the foundations of the National Water Resources Policy (PNRH), which establishes that the River Basin is a "territorial unit for the implementation of the National Water Resources Policy and the implementation of the National Water Resources Management System", and its management is exercised by Committees.

Hydrographic basin is the "set of lands drained by a river and its tributaries. Thus, the basin comprises the main watercourses and their tributaries (main and tributary)" (Sirvinskis, 2005, p. 310). Therefore, it is a geological unit that possesses an aquifer of significant extension or "territorial unit for the execution of the PNRH and the operation of the National Water Resources Management System" (Article 1, Chapter V, PNRH). The River Basin Committees are made up of representatives of the Union, the State, and the Federal District whose territories are, even partially, in their respective areas of operation; of the Municipalities located, in whole or in part, in their area of operation; water users in their area of operation; and civil water resource entities with proven operations in the basin. Among the attributions of these Committees are: Propose to the National Council and the State Water Resources Councils the accumulations, derivations, catchments and releases of little expression, for purposes of exemption from the obligation to grant rights to use water resources, according to their domains; establish mechanisms for charging for the use of water resources and suggest the amounts to be charged; (Art. 38, Chapters: V and VI of the PNRH).

Water management, in a more complete, updated form and in accordance with the modern conception, is found in the PNRH, which created the National Water Resources Management System. The responsibility for implementing the PNRH fell on ANA, an autonomous federal entity created by Law Number 9,984/2000. According to the PNRH (Article 1), water is considered a public good (the state sector is responsible for regulating, controlling and charging for its use, as well as stimulating rational uses), endowed with economic value (due to its finite and limited nature), seeking more efficient water management in all its uses, as well as decentralization in the organization of the system with the effective participation of all stakeholders. The most important instruments of the PNRH are the granting of rights to use water resources and their collection (Sirvinskis, 2005, p. 310).

Public participation and stakeholder involvement is an extremely important tool, which contributes greatly to decision making and the reduction of conflicts inherent in the integrated water resources management process. Participation offers the community the opportunity to exercise its rights, as well as to recognize its responsibilities, an essentially ethical attribution (Gallo, 2007).

The granting of rights to use water resources is an administrative act by which the Granting Authority, whether of the Union or the State, allows the applicant to use the water resources for a determined period and under certain conditions. It is provided for in Article 12, PNRH, for certain activities, having the function of maintaining quantitative and qualitative control, and is granted for a maximum of thirty-five years, being extendable (Article 16, PNRH).

The concession is a right to use water, in order to control which and the amount of water resources in a given place, providing more accurate information to the State on the local water volume and consumption pressure (Demajorovic *et al.*, 2015). It is an instrument for implementing demand management systems and rational water use, regulating the type of activity to be implemented in the basin, contributing to the management of the territory (Almeida, *et al.*, 2016).

Due to its geographical location and natural characteristics, the Pardo River watershed constitutes an environment of great natural value; where human activities are conjugated that with the passage of time alter the natural heritage (Niño-Gutiérrez, 2017) which, substantially modifies the environment causing impacts at the local level and with this, progressive social repercussions are gestated. The area surrounding the study area is characterized by exuberant and dense plant growth and by the cracking of the lithological substrate, which, together with the existence of thin soils, produces a high infiltration coefficient. Surface runoff is relevant and is expressed through the supply of aquifers from some springs that, although they provide little flow, are constant and sufficient to maintain fluvial dynamics.

Citizen participation, as well as social actors are extremely important tools, which contribute greatly to decision making and the reduction of conflicts inherent to the process of integrated water resources management. Participation offers the community the opportunity to exercise its rights as well as to recognize its responsibilities, an essentially ethical attribution (Gallo, 2007).

It is important to note that the geological stability that prevails in the Pardo watershed plays a fundamental role in the regional climate, which has benefited from the presence of a large body of water that has increased the humidity in the atmosphere. The hydrogeological analysis of the basin is of particular importance, not only because it is necessary to adequately use the water for the satisfaction of human needs (although during its use the local inhabitants moderately modify the hydric dynamics of the subsoil and surface water), but also because of the natural conditions of stability of the materials of the Pardo River, all this, allows the area to be multifunctional since, environmental education activities, scientific research, monitoring of the elements of nature among others are carried out (Niño-Gutiérrez, 2014).

The granting of rights for the use of water resources, has the character of an administrative act from which the Granting Authority, based on the Union or the State, allows the applicant of the concession to use the water resources for a determined period and under certain conditions. It is provided for in Article 12, PNRH, for certain activities, having the function of maintaining quantitative and qualitative control, granted for a maximum of three to five years, being extendable (Article 16, PNRH).

The concession is a water use right, with the purpose of controlling the quantity and amount of water resources in a given place, providing more accurate information to the State on the local water volume and consumption pressure (Demajorovic *et al.*, 2015). It is an instrument for implementing demand management systems and rational water use, regulating the type of activity to be implemented in the river basin, contributing to the management of the territory (Almeida, *et al.*, 2016).

With the donation, the discharge of sewage and other waste is regulated and ordered, avoiding shortages at qualitative levels, in addition to ensuring that users can have access to the water resource. There are Brazilian states that have not effectively implemented this regime (Lisboa *et al.*, 2019), which is not the case in the State of São Paulo, where the concession process is processed by the DAEE, and in the case of rivers, before the ANA.

Charging for the use of water resources, has to do with the revolution in water management derives, mainly, from its scarcity in quantity and quality, stimulating its onerousness, since free use has been increasingly seen as dishonest, since it is not an individual good, but diffuse, of all. On the other hand, regardless of considering water as a scarce resource, it is necessary not to lose sight of the fact that its demand is increasing due to population growth and the different socioeconomic activities that are being developed with growing vigor. Although the PNRH already provides for charging for water use, it was with the commitment of the society and of the River Basin Committees that the user was induced to a rational use, seeking to balance availability and demand and, consequently, a harmonizing redistribution of the social costs resulting from its misuse. It should be noted that urban users until now paid for the distribution of water and not for the water itself.

Charging for water use is unprecedented, having been implemented on the European continent for decades. It gained momentum with ECO-92 and, in Brazil, its first implementation dates back to 2003, instituted by the Federal Government in the Paraíba do Sul river basin, covering municipalities in the states of São Paulo, Rio de Janeiro and Minas Gerais. In 2005, the São Paulo Legislative Assembly approved Bill No. 676/2000, which was sanctioned by the State Government, which provides for charging for the use of water resources owned by the State, setting the limit value at R\$ 0.01 (one cent of the Brazilian Real) to be charged per cubic meter of volume captured, extracted or derived, above the maximum limit of 10m³ to be charged to domestic, industrial and agricultural users (the latter with the benefit of having the right to four years to adapt to the new charge).

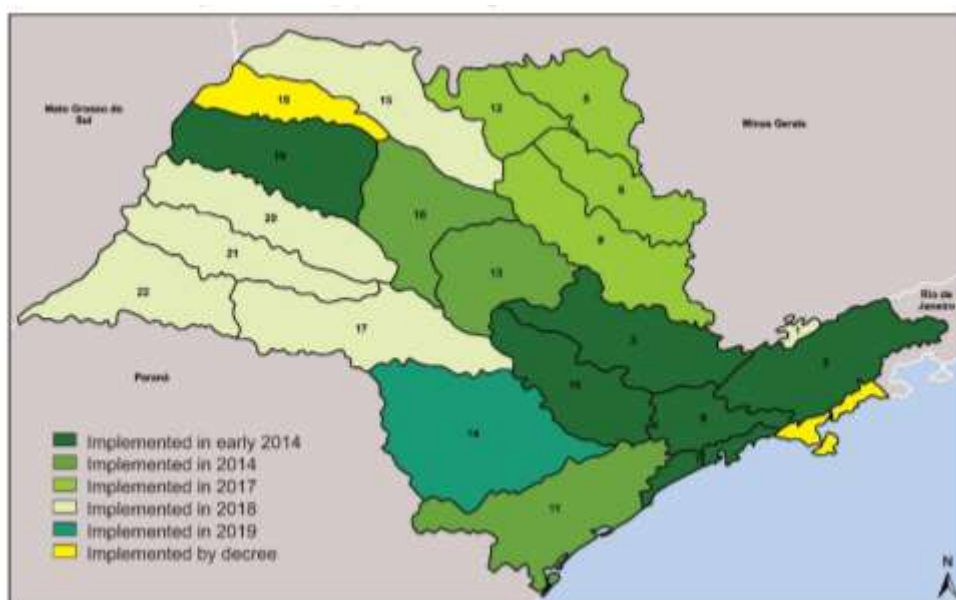
Charging for the use of water resources, more than an instrument to generate income, is an inductor of cultural changes, for the water economy, for the reduction of losses, for management with environmental justice, this because, it is charged from those who use and pollute, advancing towards a sustainable management of this precious good. It remains latent that water charges have a more moral and educational effect, aiming only at avoiding water wastage, since the amount foreseen for the charge is insignificant.

In the State of São Paulo, the Watershed Committees were responsible for planning and implementing the collection, as well as the power to define the collection methodology within their area of operation (Leite *et al.*, 2010), relying, for this purpose, on the prerogative of the Legislative Assembly to monitor and oversee the application of resources from water use charges. The amounts obtained from the collection should be invested, among others, in the creation of funds to invest in works for the recovery of rivers and other sources of water resources. The spirit of charging for water use is to economically attack the unimportant user who makes inappropriate use of this resource, based on the maxim "touch your pocket". Therefore, it is necessary to raise awareness and practice sustainable actions to guarantee the fundamental resources for our survival.

Charging for the use of water is part of a general principle of environmental law that imposes the payment of costs to those who will potentially profit from the use of environmental resources. The collection, therefore, is fully within the context of the most modern techniques of environmental law and is socially just. The charge for the use of water resources is not an end in itself, but, on the contrary, an instrument used to achieve specific ends. The charge is not in the nature of a tax. The purposes of water charges are: a) to recognize water as an economic good and to give the user an indication of its real value; b) to obtain financial resources to finance the programs and interactions contemplated in the water resources plans.

Charges for the use of water resources must be made based on the legal criteria established by law, given that their priority use must take place in the river basin that generated the economic resource. The application of the resources can be done on a non-repayable basis, i.e., the money returns to its origin with a view to financing projects and works that alter, in a manner considered beneficial to the community, the quality, quantity and flow regime of water bodies (Antunes, 2000). The payment is mandatory for those who collect water directly from rivers and lakes; use water from deep wells; and discharge sewage into rivers located in watersheds. Figure 1 shows the update in the regions that have already implemented the charge in the State of São Paulo.

Figure 1 Water Use Charge in the São Paulo State Watershed



Source: *Integrated Water Resources Management System of the State of São Paulo (2019)*

The purposes of the charge are: to indicate the real value of water; to encourage rational use; and to obtain financial resources for the Watersheds. In the State of São Paulo, the requirement is still restricted to urban industrial use (State Decree 50 667/2006). Recognizing water as an economic property is to make users aware of its real value, which will lead to rationalization in water use, as well as, eventually, to obtaining subsidies for investments in plans and programs, especially in places with high levels of water demand, including those with high population concentration as a result of migration from the countryside to the city, which encourages the growth of urbanization, sometimes industrialization or irrigated agriculture.

Charging contributes to environmental protection, as investment in sustainable watershed management can be significantly lower than the costs required to obtain new forms of water supply or treatment (Alencar *et al.*, 2018). It can be understood as a reaction to the constant degradation of watersheds, rationalizing water use, providing resources to finance investments in the watershed itself (Vera *et al.*, 2017).

The PNRH, among other concepts, consolidated sustainable planning and integrated management as a way of ratifying the impossibility of separating qualitative characteristics from quantitative ones, recognizing the economic value, charging for use, incentivizing the conscious use of the vital liquid for life with the idea of conserving and generating economic resources for the repair and maintenance of water availability (Oliveira *et al.*, 2017 and Niño-Gutiérrez, 2005). The uptake process still occurs gradually in the various Brazilian basins (Acselrad, Azevedo & Fomiga Johnsson, 2015), and not at the expected speed. For this culture to be strengthened, civil society would have to definitely commit to this barrier, so that public and political forces can walk this path in a greater number of basins (Santin *et al.*, 2013).

Something similar occurs in watersheds in other latitudes such as Mexico, where water use is combined with wildlife, given that watersheds are areas that serve as habitat for the diversity of plant and animal communities that exist there. Forested, humid and rainy areas allow the existence of rich fauna communities (Niño-Gutiérrez, 2015), since permanent vegetation provides safe shelter for many species. Among the animals that inhabit the area under study are mammals, birds, reptiles, batrachians and fish (Niño-Castillo *et al.*, 2020).

In addition to environmental recovery, charging for the use of water resources plays a prominent role in recovering the costs of public services to maintain their quality (Guimarães, 1993). It is not a tax, not even an express tax, but a public price derived from a patrimonial income of the Union or the States, which own the water, being economic instruments supported by the polluter pays and user pays principles, structured from the punitive point of view. or compensatory aspects to be incorporated in the production costs for water users (Assis *et al.*, 2018). Charging for the use of water resources will minimize adverse consequences on water quality for consumers, especially since it will require counterparts from those who use a designated public resource. These earned amounts should return to the basin of origin through investments defined in the basin plans approved by the water resources committees (Demajorovic *et al.*, 2015).

According to the National Water Agency (2015), the region covered by the Pardo Watershed is located in the Paraná Hydrographic Region, in which it has an approximate area of 879 873 km². According to Sampaio (2013), the Pardo River rises in the southern plateau of the state of Minas Gerais, in the municipality of Ipuíuna, where its waters continue after 550 km to the Grande River. The most spatially significant tributaries of the Pardo basin are the Canoas and Araraquara rivers, and the São Pedro, Floresta and Prata streams on the right bank, and the Tambaú, Verde and Fartura rivers and the Tamanduá stream on the left bank. The Pardo River has approximately 84% of its course in the State of São Paulo. The Pardo River Basin was instituted by São Paulo State Law Number 9 034, December 27, 1994, as Water Resources Management Unit 04-UGRHI 04.

For the Integrated Water Resources Management System of the State of São Paulo (2012), the Pardo River Basin comprises 23 municipalities, where the Basin's economy is based on the agricultural sector (agro-industry sucroalcohol, citrus and pastures), industry, commerce and services consolidated in the Ribeirão Preto region. In terms of water demand, the Basin is classified as "in the process of industrialization", with reasonable water availability compared to other basins in the state, and water quality varies from average to good.

According to the Secretariat of Sanitation and Water Resources of the State of São Paulo (2012), the Basin's economy is based on agriculture, industry, commerce, and services, mostly consolidated in the Ribeirão Preto region. In agriculture, sugarcane and citrus crops stand out, in addition to pastures, which occupy approximately 22% of the basin area (Ocelli Pinheiro *et al.*, 2022). As a result of sugarcane cultivation, the sugar-alcohol production chain is developed, and also in the secondary sector, the region is home to important "Local Productive Arrangements", such as the medical-hospital, dental and precision instrumentation and automation industries in the urban agglomeration of Ribeirão Preto.

For the Integrated Water Resources Management System of the State of São Paulo (2016), the Pardo River Basin Committee was installed on June 12, 1996. The Committee is composed of 27 municipalities, including Ribeirão Preto, which is the headquarters of the Executive Secretariat. These agglutinated cities are: Altinópolis, Águas da Prata, Brodowski, Caconde, Cajuru, Casa Branca, Cássia dos Coqueiros, Cravinhos, Divinolândia, Itobí, Jardinópolis, Mococa, Pontal, Sales de Oliveira, Santa Cruz da Esperança, Santa Rosa do Viterbo, Santo Antônio da Alegria, São José do Rio Pardo, São Sebastião da Gramma, São Simão, Serra Azul, Serrana, Sertãozinho, Tambaú, Tapiratiba and Vargem Grande do Sul. Its coverage has a drainage area of 8 993 km² and a population of 1 092 477 inhabitants.

On December 20, 2012, it was granted by Decree Number 58 771, which approved and set the values to be charged for the use of water resources in the domain of the State of São Paulo in the Pardo Water Resources Management Unit. In this sense, and in line with Decree Number 50 667, of March 30, 2006, which regulated the provisions of Law Number 12 183, of 2005, which deals with the charge for the use of water resources in the domain of the State of São Paulo.

In this sense, according to the deliberation of the Pardo River Basin Committee Number 278, on March 6, 2020, in which the guidelines and criteria for the distribution of FEHIDRO resources and the charge for the use of water destined for the CBH-Pardo area for 2020 were approved, they add up to the value of R\$ 1 636 076.95 of FEHIDRO participation and R\$ 606 163.83 of the charge for water use. Essentially, these resources are used for the execution of multi-year projects, in line with the ten-year plan for the Hydrographic Basin between 2016 and 2027.

According to the Integrated Water Resources Management System of the State of São Paulo (2019), they are in line with the actions prioritized by the River Basin Committee, classified and organized in accordance with the provisions of CRH Deliberation Number 190 of December 14, 2016. The prioritization of resources took into account the provisions of Article 2 chapter of CRH Deliberation Number 18 of November 8, 2016, endorsed on December 14, 2016, as can be seen in Table 1.

Table 1 Distribution of investments by PDC's (in R\$) for the year of 2020.

Description		Investment	%	Charge	%	Total	%
		Value		Value		Value	
Available resources		807 975.00	-	4 816 000.00	-	5 623 975.00	-
Total investment		807 975.00	-	4 816 000.00	-	5 623 975.00	-
PDC's	PDC1	0.00	0.0	290 292.73	6.0	290 292.73	5.2
	PDC2	0.00	0.0	59 614.09	1.2	59 614.09	1.1
	PDC3	0.00	0.0	2 722 003.90	56.5	2 722 003.90	48.4
	PDC4	0.00	0.0	623 091.44	12.9	623 091.44	11.1
	PDC5	807 975.00	100.0	277 452.18	5.8	1 085 427.18	19.3
	PDC6	0.00	0.0	322 816.20	6.7	322 816.20	5.7
	PDC7	0.00	0.0	0.00	0.0	0.00	0.0
	PDC8	0.00	0.0	520 729.46	10.8	520 729.46	9.3
Del. CRH 188/16, Art. 2°	Item I	0.00	-	349 906.82	7.3	349 906.82	6.2
	Item II	807 975.00	100.0	3 622 547.52	75.2	4 430 522.52	78.8
	Item III	0.00	-	843 545.66	17.5	843 545.66	15.0
+balance/deficit		0.00		0.00		0.00	

Source: Integrated Water Resources Management System in the State of São Paulo (2019).

As can be seen in Table 1, PDC 3 received the most investments, as it proposes to invest in sanitary sewerage from sanitary sewerage projects and works, in urbanized areas, solid waste from collection, treatment and final disposal system projects and works, or other solid waste management actions, river water drainage from urban storm drainage system projects and works, and actions aimed at promoting pollution containment, dissemination, prevention and control of erosive processes from projects, works and actions to prevent and control soil erosion or sedimentation of water bodies.

The investment in CDP 3 is substantially higher than in others given the urgency of waste management in large urban centers and the consequent prevention of both water pollution and disease prevention. In this sense, it is of superlative socio-environmental value and strategic for the sustainable development of cities. The second most important can be referred to JDP 5 related to the control of losses in water supply systems with projects, works and services for the control of losses in the supply systems of the different water user sectors, with emphasis on public supply networks.

This is the second most important CDP, given the importance of preserving water resources not only in river basins but also in large urban centers. The loss of this resource means not only an unacceptable waste, but also the loss of public resources from taxpayers, which causes a double damage to society. Moreover, in the field of public policies, it makes no sense to create a whole structure for the preservation of watersheds and their water resources if this is wasted in large consumption centers.

4. Conclusions

Since the elaboration of the famous Brundtland Report (Our Common Future, 1987) and its dissemination at the Earth Summit (Rio de Janeiro, 1992), it has been repeated and almost universally accepted that ecology is a fundamental value for human life and that sustainable development consists of implementing three types of solidarity simultaneously: within one's own community, with the rest of the world's inhabitants and with future generations. This solidarity-based veneer makes the concepts of ecology and sustainable development attractive to the mass media and to society as a whole, since they harbor ideas that are acceptable to all socioeconomic, political, cultural, religious and environmental actors.

Faced with worsening environmental problems on a global scale, nations have rethought the management of their natural resources with the aim of promoting sustainable development, as well as promoting economic growth, environmental preservation and social inclusion. Among these resources, water stands out. This precious resource for life and development has been used in a predatory manner by the productive system, particularly by agricultural, industrial and urban activities. On this point, even Brazil, being a privileged country in terms of water resources, has an unequal distribution in the geographic space, which requires responses from public authorities to this situation.

To this end, particularly in the State of São Paulo, river basin committees were created with the aim of making water resources more efficient and ensuring their sustainability and, subsequently, charging for the water resources consumed was authorized. Specifically in relation to the Pardo River Basin, this charge was allowed as of Decree No. 58,771 of December 20, 2012. The charge for the use of water destined for the CBH-Pardo area for the year 2020, add up to the value of R\$ 1,636,076.95 of the FEHIDRO quota portion and R\$ 4,606,163.83 of the charge for water use.

In this sense, the policy of charging for water resources aimed at their conservation and optimal use in the face of the danger of their scarcity due to their predatory and irresponsible consumption is perfectly justifiable, as long as the economic resources are used exclusively for the conservation and maintenance of this important natural resource, in addition, for greater reliability in the management of these resources, it is essential to maintain principles such as legality, morality, efficiency, publicity and impersonality.

With these resources, based on a ten-year plan, executed through a multi-year plan, it is possible to contract a strategic investment in the areas of sanitary sewage, solid waste, river water drainage and prevention and control of erosive processes. Therefore, the Pardo Basin Management Committee has worked and made strategic investments to ensure the sustainable management of water resources in the Pardo River Basin.

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Chapter 2 Sustainable development of the dairy goat under the influence of heritability and genetic improvement

Capítulo 2 Desarrollo sostenible de la cabra lechera bajo la influencia de la heredabilidad y el mejoramiento genético

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Abstract

The objective of this chapter is to characterize the goat farming system for the production and marketing of milk through the comprehensive management of the national and international market, including an analysis of its main indicators of genetic improvement, to understand how they affect the permanence of goat farming in Mexico, particularly in the livestock subsector. In this sense, an updated bibliographic synthesis on the production and commercialization of goat's milk was conducted, in order to understand the commercial context in which companies compete with each other. This paper also provides information on the bases of heritability, the obtaining and use of genotypes associated with productive and reproductive traits in goat farming, and molecular technologies in goat genetic improvement. This information will serve as support to any person dedicated to, or related to, the sustainable production of dairy goats.

Dairy goat, Goat milk, Genetic improvement

Introduction

In Mexico, goat milk production represents an important resource for various social strata (Maldonado *et al.*, 2018). A production of 163.59 million L of goat milk was reported for the year 2020 (Ministry of Agriculture and Rural Development, 2021), suggesting the common denominator of this sector is the scarce or non-existent technification in its production process (De Gea, 2006). Mexican goat production is mainly located in the northeastern and central-western regions (arid-semiarid zones), with limited production in their pastures, has shown a gradual increase in the national inventory, which reached 8.8 million goats in 2020 (Statistics Division of the Food and Agriculture Organization of the United Nations, 2020). In the planning and execution of genetic improvement programs for dairy goats, the increase in milk yield per animal should be the main objective for achieving sustained profit growth (Organization for Economic Cooperation and Development, 2020). In this sense, the correct application of a selection program would result in higher production income, lower feed costs, and greater permanence in the herd, thus leading to the sustainable development of the dairy goat production unit (Organization for Economic Cooperation and Development, 2020).

Based on the information provided in previous paragraphs, this paper reviews: i) International goat milk production; ii) domestic goat milk production; iii) dairy goat breeds; iv) generalities of heritability (h^2) in goat breeding; v) applications of heritability in goat herd selection and improvement; vi) molecular technologies in goat breeding; vii) uses and applications of molecular markers; and viii) marker-assisted selection -- information that will support anyone involved in, or related to, sustainable development in intensive dairy goat production.

References for acronyms and abbreviations

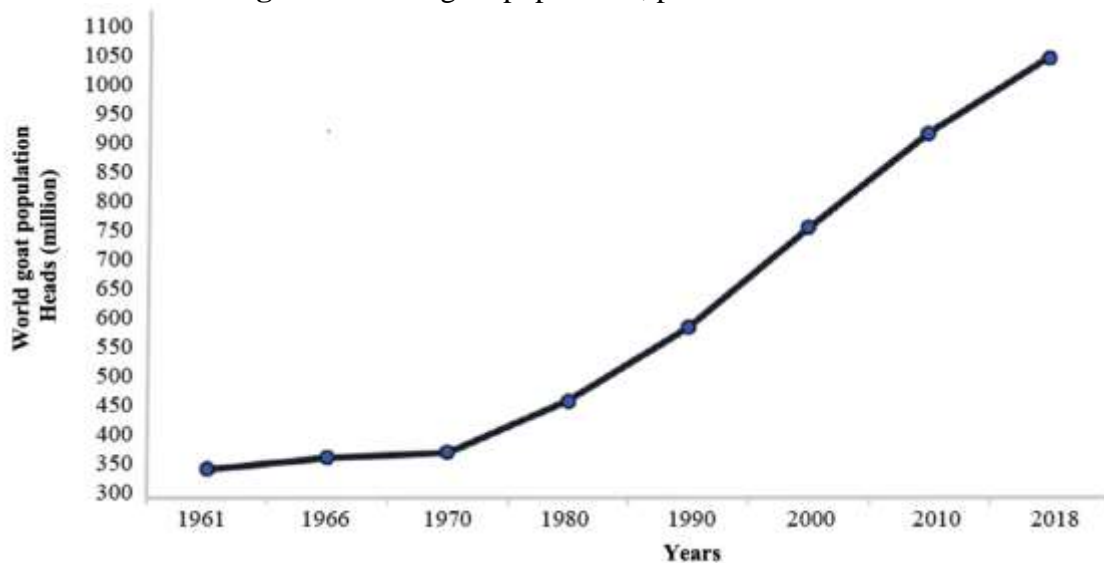
ADGA	American Dairy Goat Association
DNA	deoxyribonucleic acid
E_P	permanent environmental effects
E_T	temporary environmental effects
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics Division-Food and Agriculture Organization of the United Nations
G_A	additive genetic effects
GAS	genotyping assisted selection
G_D	dominance effects
G_E	epistatic effects
GWAS	genome-wide association study
h^2	heritability
IGA	International Goat Association
LM	Linked Markers
LPU	Livestock Production Units
MAS	marker-assisted selection
MST	Microbial Source Tracking
P	phenotype
PCR	polymerase chain reaction

SIAP	Agri-Food and Fisheries Information and Statistics Service
SNP	single nucleotide polymorphisms
USA	United States

1. International goat milk production

The world population currently stands at 7.9 billion people and is expected to show a 30% increase over the next 30 years, reaching approximately 10.2 billion people by 2050 (Wesley and Peterson, 2017). This demographic increase will be accompanied by economic growth, which will result in an increased demand for goat dairy products (cheeses, in particular) (Kubicová *et al.*, 2019). This increase in demand will be higher in developing countries, where growth is expected to be 103% (Kapaj and Deci, 2017). Faced with this trend, since 1982, the International Goat Association (IGA) has contributed to the expansion of knowledge, collaborative work policies, and the development of the goat sector in all corners of the world (International Goat Association, 2021). Within its platform, IGA notes that the domestication of goats (*Capra hircus*) occurred between 6,000 and 7,000 BC (Amills *et al.*, 2017). Initially, most goats developed in Southwest Asia (Zheng *et al.*, 2020), and by 2018, according to the database of the Food and Agriculture Organization of the United Nations (FAO), the world goat population reached 1.003 million head (Figure 1), equivalent to an increase of more than 30% since 2000 (Food and Agriculture Organization of the United Nations, 2020).

Figure 1 World goat population, period 1961-2018



Source of reference: (Food and Agriculture Organization of the United Nations, 2020)

Global goat milk production was estimated at 19.1 million t in 2019 (Food and Agriculture Organization of the United Nations, 2020). In Asia, governments and developmental agencies identified the dairy goat sector as a resilient alternative in the face of climate change and have invested in many projects over the last decade (Asian-Australasian Dairy Goat conference, 2018). Therefore, 55.4% of the world's goat inventory is located on the Asian continent (Table 1), with China, India, Sudan, Bangladesh, and Pakistan as its main livestock concentrating countries (Liang and Paengkoum, 2019). Asia also represents the highest production of goat milk (56.2% worldwide), with India producing 3,767,866 t, followed by Sudan with 1,104,620 t, Bangladesh with 1,051,493 t, and Pakistan with 824,098 t (Miller and Lu, 2019).

Table 1. Goat distribution in different areas of the world, 2018

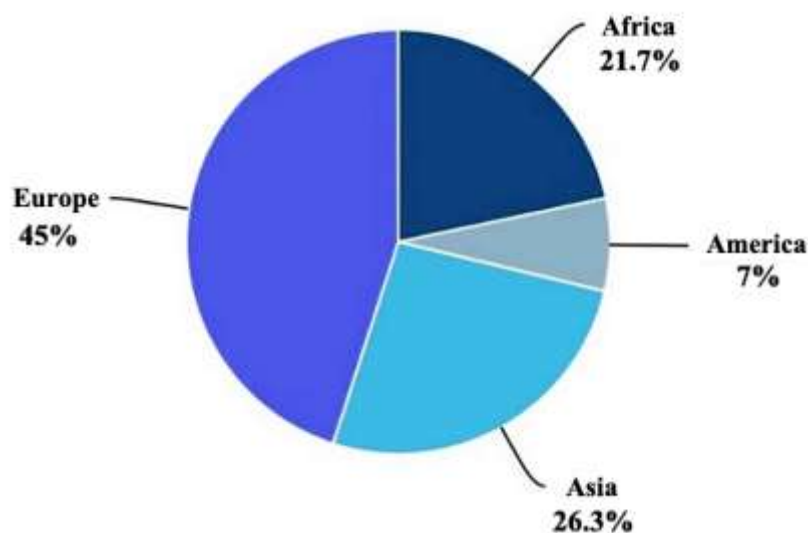
Continent	Heads (million)	Percentage (%)	Number of countries
Asia	556	55.4	48
Africa	388	38.7	59
Europe	17	1.7	42
Americas	38	3.8	47
Oceania	4	0.4	14
Total	1,003	100	201

Source of reference: (Statistics Division of the Food and Agriculture Organization of the United Nations, 2020)

Dairy goat farming in China has increased especially in the Shaanxi, Shandong, and Henan provinces, due to government recognition of the sector and its financial incentives (Liang and Paengkoum, 2019). However, Chinese production cannot meet the demand of its consumers; therefore, China is the world's largest importer of goat milk powder and whey for the manufacture of infant formula (Ribeiro and Ribeiro, 2010). Africa reached 38.7% of the world's goat inventory, despite the fact that its research, extension, and marketing plans, led by the African government, have prioritized cattle and overlooked small ruminants (Monau *et al.*, 2020).

Significant goat milk production is found in many African countries, including Nigeria, Sudan, Chad, Ethiopia, and Kenya (Kahi and Wasike, 2019). However, although most of the world's production and consumption of goat milk is found in Asia, the most organized market for its industrialization is in Europe, mainly in cheeses (Figure 2), where production reached 483 thousand t in 2019, with France as the main contributor at the European level, followed by Spain, Greece, Germany, Italy, and the Netherlands (Dubeuf, 2010). Thus, during 2018, Europe participated with 17 million goats, with Russia, Spain, Romania, Greece, and Italy representing the five countries with the largest goat populations (Ruiz *et al.*, 2019). Dairy goat production has a different origin in the Americas because goats are not indigenous to the Western Hemisphere (Ginja *et al.*, 2017). European breeds were introduced by the Spanish during the colonial period, and today they remain the most popular dairy breeds (Lu and Miller, 2019). Nubian goats from Egypt have also been introduced through England and Nigerian goats through Africa, but Swiss and other European breeds remain dominant (Sponenberg, 2020). With respect to its goat inventory, the Americas represented 3.8% of the world's goats (Table 1), while Brazil, Mexico, Argentina, Haiti, and Bolivia stood out with the largest goat population on this continent (Lu and Miller, 2019).

Figure 2. Goat cheese production and distribution worldwide, 2019



Source of reference: (Statistics Division of the Food and Agriculture Organization of the United Nations, 2020)

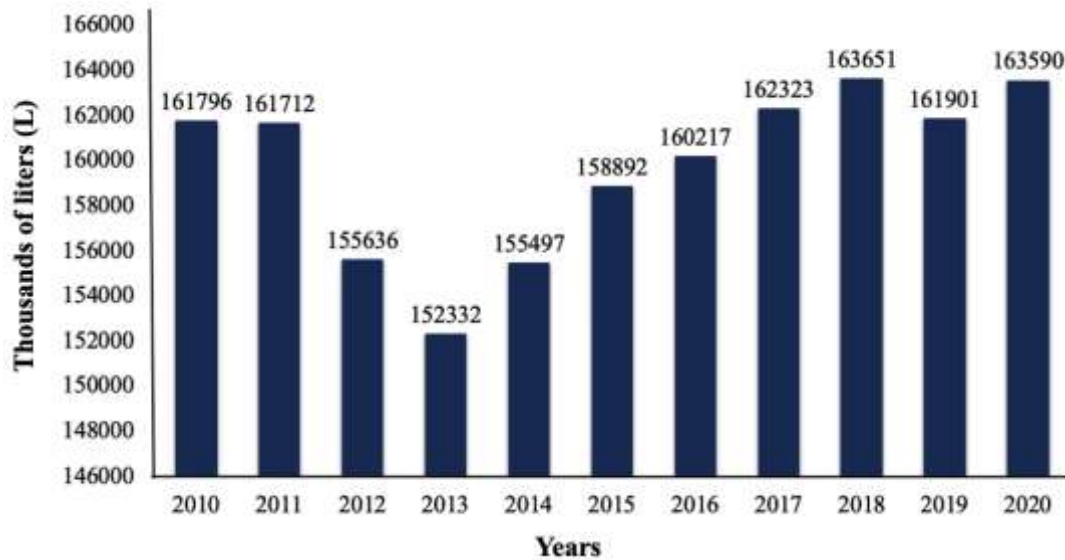
Finally, Oceania participated with 4 million goats, while Australia, Fiji, New Zealand, Vanuatu, and French Polynesia stood out as its main concentrating countries (Miller and Lu, 2019). Consequently, global goat milk production is concentrated in a few countries, mainly in Asia and Africa, with production systems located in tropical or arid regions. Goat milk is most likely consumed locally, while cow milk enters formal markets for processing (International Goat Association, 2021).

2. National production of goat milk

The national land area covers 1,964,375 km², of which 108.9 million hectares are used for livestock production, with the participation of 250,000 families whose primary or complementary productive activity is goat production (National Institute of Statistics and Geography, 2020). It represents 8.8 million goats (Statistics Division of the Food and Agriculture Organization of the United Nations, 2020), distributed across 494,000 Livestock Production Units (LPU), which, during 2020, reached a production of 163,590 L of goat milk (Figure 3), with a producer price of \$6.46/L (Agri-Food and Fisheries Information and Statistics Service, 2020), an annual per capita consumption of 1.3 L, and a share in national livestock production of 0.7% (Ministry of Agriculture and Rural Development, 2021).

Mexican goat farming represents 9 out of every 1,000 L of the world's total (Food and Agriculture Organization of the United Nations, 2020). It maintains a seasonal regime, due to the fact that goats are ruminants that present reproductive seasonality and multiple births (Maldonado *et al.*, 2018), as well as the availability of food during the rainy season and agricultural residues from seasonal crops (Clark and Mora, 2017).

Figure 3. Goat milk production in Mexico, 2010-2020 period



Source of reference: (Agri-Food and Fisheries Information and Statistics Service, 2020)

Production systems in the northeastern and central-western regions (arid-semiarid zones) of the states of Coahuila, Durango, Nuevo Leon, San Luis Potosi, and Zacatecas make up 64% of the total national goat inventory (Table 2). The remaining 36% is located in the central-temperate regions of the states of Guanajuato and Queretaro (Agri-Food and Fisheries Information and Statistics Service, 2021).

Table 2. Main goat milk producing states in Mexico, 2019

Ranking	Federal State	Thousands of liters (L)
1	Coahuila	45,065
2	Guanajuato	42,196
3	Durango	25,181
4	Jalisco	9,015
5	Chihuahua	7,341
6	Zacatecas	5,895
7	San Luis Potosi	4,769
8	Baja California Sur	4,123
9	Michoacan	4,036
10	Nuevo Leon	3,897
	Rest of Federal States	10,383
	Total	161,901

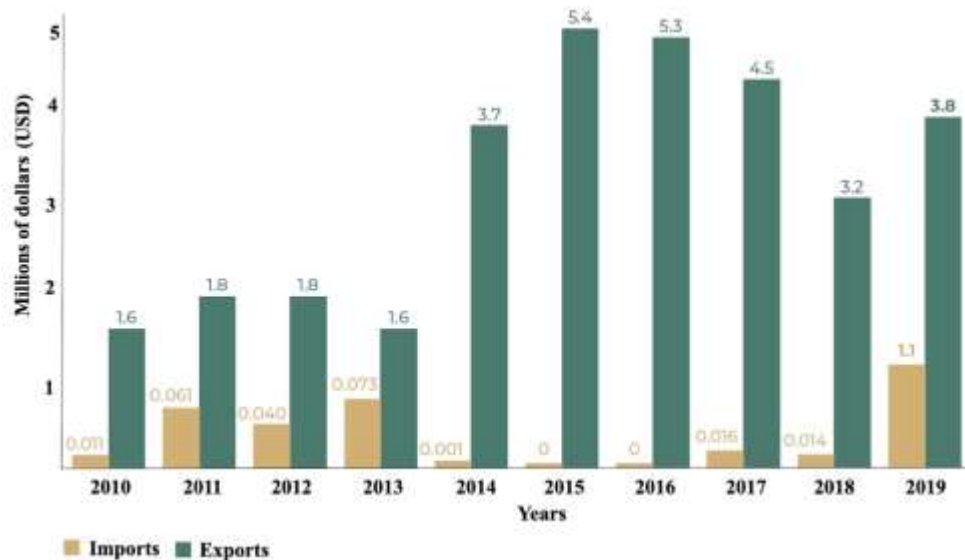
Source of reference: (Agri-Food and Fisheries Information and Statistics Service, 2020)

Coahuila and Guanajuato (Figure 4), are the largest producers of goat milk, together accounting for 53.9% of the country's production, equivalent to 87.259 million L (Ministry of Agriculture and Rural Development, 2021). Therefore, they contribute 52.2% of the total value of national production, equivalent to \$515.6 million (Agri-Food and Fisheries Information and Statistics Service, 2021). National production is maintained by animals without a defined phenotype; however, in the Comarca Lagunera region, there seems to be a predominance of the dairy genotype (e.g., Alpine, Saanen and Nubian breeds) (Maldonado *et al.*, 2018).

Figure 4. Main goat milk producing states in Mexico, 2019

Source of reference: (Agri-Food and Fisheries Information and Statistics Service, 2021)

Access of Mexican goat milk to cross-border trade circuits is mainly via dairy derivatives (e.g., curd and cheese) (Ministry of Agriculture and Rural Development, 2021). In this sense, Mexico exports only to the United States of America (USA), registering a flow of 3.8 million USD during 2019 (Figure 5). During the same year, imports reached 1.1 million USD, and came mainly from the USA, Spain, France, Portugal, and the Netherlands (Ministry of Economy, 2021).

Figure 5. International trade of goat milk derivatives in Mexico, period 2010-2019

Source of reference: (Ministry of Economy, 2021)

3. Dairy goat breeds

Alpine Breed

The Alpine is a French breed that is medium to large in size, with upright ears and a variety of colors. The hair is medium to short, and the face is straight.

Figure 6. Alpine breed specimen



Source of reference: (American Dairy Goat Association, 2020)

Alpine colors are described by using the following terms:

- **Cou Blanc (coo blanc):** “White neck” – white front quarters and black hindquarters, with back or gray markings on the head;
- **Cou Clair (coo clair):** “Clear neck” – front quarters are tan, saffron, off-white, or shading to gray with back hindquarters;
- **Cou Noir (coo nwah):** “Black neck” – black forequarters and white hindquarters;
- **Sundgau (sundgow):** “Black neck” – black front quarters and white hindquarters;
- **Pied:** Spotted or mottled;
- **Chamoisee (shamwahzay):** Brown or bay, distinctive markings are the black face and dorsal stripe; feet and legs sometimes with a martingale running along the withers and down to the chest;
- **Two-Tone Chamoisee:** Light front quarters with brown or gray hindquarters. This is not a *cou blanc* or *cou clair*, as these terms are reserved for animals with black hindquarters; and
- **Broken Chamoisee:** A solid chamoisee color, broken with another color by being banded or splashed. Any variation in the above patterns broken with white should be described as a broken pattern, such as a broken cou blanc (American Dairy Goat Association, 2020).

Alpine females are at least 76 cm tall and weigh 61 kg, while males are at least 81 cm tall and weigh 77 kg. They have upright ears and come in many colors and color combinations (Figure 6). The hair is medium to short, and the bridge of the nose is smooth. Alpines are known to be a hardy and adaptable animal that thrives in any climate while maintaining good health and excellent production (American Dairy Goat Association, 2020).

Florida Breed

The Florida goat is a dairy goat breed native to the Lower Guadalquivir Valley, Spain. Its origin dates back to the beginning of the 20th century, but it wasn't until 1997 when it became an official breed recognized by the Official Catalog of Livestock Breeds of Spain (American Dairy Goat Association, 2020). Its origin comes from the contribution of Nubian-type animals to the Alpine-Pyrenean stock native to the Guadalquivir Valley. It owes its name to the particular characteristics of its mottled red-on-white background or vice versa, so that it resembles a flowery field.

Florida goats are an attractive animal that embodies vigor, strength, and femininity, with a morphostructural conformation suitable for milk production (American Dairy Goat Association, 2020). It is a hypermetric, longilinear breed with a subconvex profile with arched and backward horns. The coat is mottled white on a red background or vice versa but mottled white on a black background is also acceptable (Figure 7).

Figure 7. Florida breed goats bred in Spain



Source of reference: (National Association of Florida Goat Breeders, 2012)

Both the presence and absence of mammarys is allowed (National Association of Florida Goat Breeders, 2012). The head is long with a convex or subconvex profile, with a not very broad forehead. The ears are large in size and set back, parallel in alertness and drooping at rest. The trunk should be long and deep, which determines a great respiratory and digestive capacity. Withers are fine and slightly prominent, chest broad at the base and manifest sternal keel. The flanks are deep, arched, and refined. The rump has a strong union with the back, being broad, strong, long, and slightly sloping. The tail is set slightly above the tip of the ischium (Figure 8).

Figure 8. Florida breed females bred in Spain



Source of reference: (National Association of Florida Goat Breeders, 2012)

The limbs are strong, well-separated, and conformed. The forelegs are straight and well-plumb, and the hind legs are parallel, well-separated, and almost perpendicular from the hock to the fetlock, when viewed from the side. The mammary system presents good capacity and a strong insertion, with a well-developed and well-implanted udder, but of medium depth and with well-positioned and defined teats. Males belonging to the Florida breed have a shorter head length and more accentuated convexity of the front, with a strong and developed neck, without losing length (Figure 9).

Figure 9. Florida stallions bred in Spain

Source of reference: (National Association of Florida Goat Breeders, 2012)

The Florida goat breed is mainly used for milk production and is characterized by high production, with high fat and protein content (Table 3).

Table 3. Milk production characteristics of the Florida breed

Number of births	No. lactations	Lactation duration (d)	Milk production (kg)	Fat (%)	Protein (%)
Primiparous	1086	256	496.08	5.08	3.64
Multiparous	2085	282	699.16	4.99	3.62
Mean	3171	273.48	629.61	5.02	3.63

Source of reference: (National Association of Florida Goat Breeders, 2012)

Another remarkable product of this breed is the suckling kid, where it shows a good productive potential. Due to the size of this breed, kids present an average birth weight of 3.2 kg, and an average daily gain of 180 g. The average slaughter weight of 8 and 9 kg is reached quickly between 25 and 30 days of life, with a carcass weight of 4.5 to 5 kg (International Goat Association, 2021).

Nubian breed

The Nubian breed descends from the crossbreeding of regional English, Irish, and Swiss goats (Saanen) with imported males from Egypt (Nubia Zaraibe), Ethiopia, Syria, Iran, and India (Jamna Pari) (De Gea, 2006).

Figure 10. Nubian breed specimen

Source of reference: (American Dairy Goat Association, 2020)

In 1910, the Anglo Nubian was recognized as a breed in Great Britain and registration began with 459 goats accepted as the nucleus of the Anglo Nubian section of the studbook (Stemmer *et al.*, 2009). The Nubian is relatively large and of Asian, African, and European origin. They are known for milk with high fat content. Females are at least 76 cm tall and weigh 61 kg, while males are at least 81 cm tall and weigh 77 kg (American Dairy Goat Association, 2020).

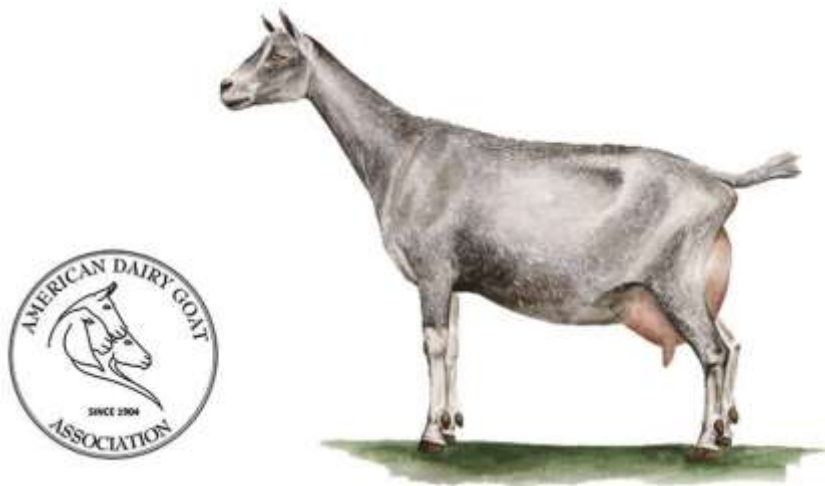
The head is the distinguishing feature of the breed, with the facial profile between the eyes and the muzzle being strongly convex, often referred to as the "Roman nose". The ears are long (extending at least an inch beyond the muzzle when held flat along the face), broad, and pendulous (Figure 10). They lie close to the head at the temple, flaring slightly and well-forward at the rounded tip, forming a "bell". The ears are not thick, with well-defined cartilage.

The hair is short, fine, and shiny. Any color or colors, solid or patterned, are acceptable. The breed standard accepts specimens of any color or combination of colors, although the predominant colors are tan (red), dark brown, overo and dark (black) (De Gea, 2006). It was introduced in the USA and Canada. Later, by means of selection, they began to specialize in milk production, and it was in the USA where the greatest emphasis was placed on genetic improvement, which led to better developed production.

Sable breed

This breed comes from pure Saanen animals that presented colors other than white and creamy white (Figure 11). Breeders in the USA selected and fixed the color coat characteristic by crossing between the animals that presented these "anomalies".

Figure 11. Sable breed specimen



Source of reference: (American Dairy Goat Association, 2020)

To differentiate it from the traditional Saanen, it has received the name Sable, given that the first animals selected had colored hairs between the white coat (as is the sable color in other animals), with these animals being of a grayish color (as if they were dirty), light brown, or black with markings of the Alpine and Toggenburg type (International Goat Association, 2021).

The phenotype (physical characteristics) in purebred or full-blood animals is virtually the same as traditional Saanen, with the exception of the coat color. However, because it is a relatively recent breed, it still has an open pedigree book, so there are different grades of Sable recognized by the American Dairy Goat Association (ADGA) (American Dairy Goat Association, 2020).

The Sable grades recognized by the ADGA are as follows:

- Purebred Sable;
- American Sable;
- Grade Sable; and
- Experimental Sable.

According to some Sable breeders, heat and humidity tolerance characteristics, as well as fertility and production in tropical areas, are superior to those shown by traditional, pure Saanen. In Mexico, it is believed that there is little presence of this breed; however, the influence of the lines carrying Saanen genetics is greater than what is thought. Therefore, even though it has not been recognized as an official breed in Mexico, the Sable is a great option for use in tropical dairy herds (American Dairy Goat Association, 2020).

Saanen breed

Saanen is a Swiss breed. It is medium to large in size and the bones are rough. However, females should be smooth and not coarse. Saanens are all white or light cream in color, white being preferred (Figure 12).

Figure 12. Saanen breed specimen



Source of reference: (American Dairy Goat Association, 2020)

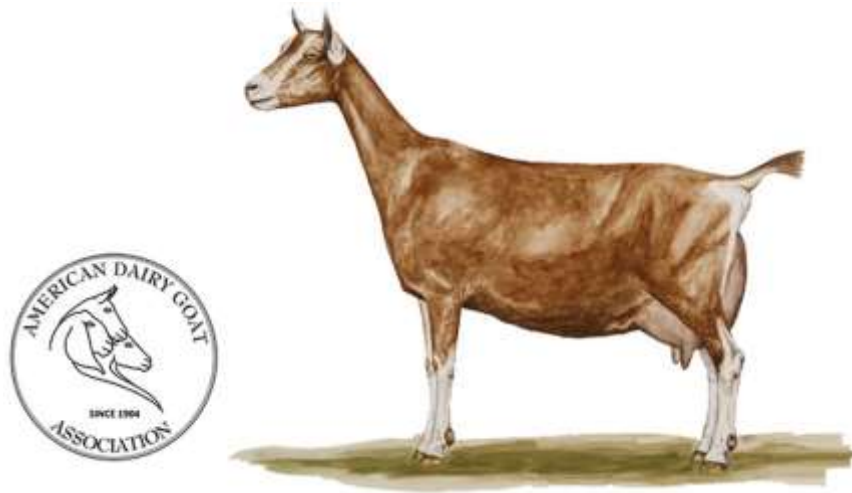
Its hair is short and fine, although a fringe over the spine and thighs is often present. The ears should be erect and carried attentively, preferably pointing forward. The face should be straight or domed. A “Roman nose” tendency is discriminated against (International Goat Association, 2021). Female goats are at least 76 cm tall and weigh 61 kg, while males are at least 81 cm tall and weigh 77 kg. The Saanen breed is distinguished by its solid white or light cream-colored hair. Skin patches may be present and a spot in the coat up to 3.8 cm wide is permitted. Saanen ears are erect and the bridge of the nose is straight or convex. The Saanen is a favorite for commercial dairies, due to its high milk production and calm temperament (American Dairy Goat Association, 2020).

Toggenburg breed

Toggenburg is a Swiss breed. This breed is of medium size. The hair is short to long, soft, and fine. Its color is solid, varying from light beige to dark chocolate with no preference for any shade (Figure 13). Distinctive white markings are as follows: White ears with a dark spot in the middle; two white stripes down the face from above each eye to the muzzle; white hind legs from the hocks to the hooves; white front legs from the knees down, with dark vertical stripes below the knee being acceptable; a white triangle on each side of the tail; white spots may be present at the root of the wattles or in that area, if no wattles are present (International Goat Association, 2021).

Varying degrees of cream markings, rather than pure white, are acceptable, but not desirable. Ears are erect and carried forward. Facial lines may be concave or straight, but never blunt. The bridge of the nose may be straight or convex (American Dairy Goat Association, 2020).

Figure 13. Toggenburg breed specimen



Source of reference: (American Dairy Goat Association, 2020)

Female Toggenburgs are at least 66 cm tall and weigh 54 kg, while males are at least 71 cm tall and weigh 68 kg. Toggenburgs were among the first purebred dairy goats imported into the USA and registered (American Dairy Goat Association, 2020).

4. Heritability (h^2) generalities in goat genetic improvement

The objective of breeding programs involves the identification and utilization of the best individuals within a herd, so that the next generation will show a better performance in the selected traits, with respect to the average of the previous generation (Biffani *et al.*, 2020). In that sense, the breeder needs information on the phenotype of the animals for the proper selection of parents, evaluation methods, selection methods, and mating systems (Scholtens *et al.*, 2020).

The phenotype of an individual is mainly influenced by a number of genetic and environmental factors, so that a specific quantitative trait not only describes the genetic differences between animals in a given population, but also the variability of the trait corresponding to the effect of the environment in which these animals develop (Schultz *et al.*, 2020). The genetic and environmental components of phenotype (P) can be divided into additive genetic effects (G_A), dominance effects (G_D), and epistatic effects (G_E), in addition to both permanent environmental effects (E_P) and temporary environmental effects (E_T) (Arnal *et al.*, 2020).

$$P = G_A + G_D + G_1 + E_P + E_T \quad (1)$$

In selection programs, permanent environmental effects present a disadvantage to the breeder, when the environmental influence of a mother has a significant impact on the behavior of her progeny (Scholtens *et al.*, 2020). For example, a young female develops mastitis and loses function in a certain environment, resulting in reduced weaning weights of subsequent offspring. In this regard, genetic evaluation methods implement contemporary groups to explain some of the environmental effects and adequately predict the additive genetic component (fraction heritable from parents to progeny) (from Araujo Neto *et al.*, 2018).

Several strategies have been developed to accurately characterize the proportion of variation in a trait in a population that can be attributed to heritable genetic factors (MacNeil *et al.*, 2021). Heritability is the specific concept that encompasses this proportion, defined as the average phenotypic differences or superiority that is likely to be genetically transmitted to the next generation and is calculated as follows (Kocevska *et al.*, 2021):

$$h^2 = \sigma^2_A / \sigma^2_P \quad (2)$$

Where:

h^2 = Heritability of a trait in a given population;

σ^2_A = Genetic variance (genetic potential of an animal that can be transmitted to its progeny); and

σ^2_P = Phenotypic variance of a trait in that population (variability of phenotypes in the population).

The heritability estimate ranges from 0 to 1; it is often expressed as a percentage (Ginja *et al.*, 2017). A number close to 1 indicates that a trait is highly heritable in a population. This aspect gives it great importance in selective breeding and behavioral genetics (Kocevska *et al.*, 2021).

Heritability plays an important role in the selection of polygenic traits, especially those related to animal production and behavior (Chen *et al.*, 2020). It may also increase if genetic variation increases, causing individuals to show more phenotypic variation, such as showing different levels of maternal production (Schmid *et al.*, 2021). Furthermore, heritability may also increase if environmental variation decreases, causing herd individuals to show less phenotypic variation, such as similar maternal characteristics among females in the herd (Asadi-Fozi *et al.*, 2020).

5. Applications of heritability in the selection and improvement of goat herds

Heritability indicates to the breeder how much confidence to place in the phenotypic behavior of an animal when choosing breeding parents for the next generation (Schmid *et al.*, 2021). Some of the traits reported in the literature for meat and dairy goats are presented in Tables 4, 5, and 6. In highly-heritable traits, where h^2 exceeds 0.40, the animal's phenotype is a good indicator of genetic merit or breeding value (Martin *et al.*, 2016). On the other hand, traits where the h^2 is less than 0.15, the performance value of an animal is much less useful for identifying individuals with the best genes for the trait of interest (Garcia-Peniche *et al.*, 2012).

Table 4. Heritability values for productive and reproductive traits in dairy goats

Trait	h^2	Breeds	Source of reference
Supernumerary nipples	0.40 0.44	Alpine Saanen	Martin <i>et al.</i> (2016)
Age at first birth (days)	0.22 0.28 0.32 0.61 0.16 0.32	Alpine Lamancha Nubian Oberhasli Saanen Toggenburg	Garcia-Peniche <i>et al.</i> (2012)
Interval between births (days)	0.06 0.04 0.02 0.02 0.06 0.08	Alpine Lamancha Nubian Oberhasli Saanen Toggenburg	Garcia-Peniche <i>et al.</i> (2012)

When the trait is highly heritable, selection is more important than crossbreeding and handling, but when the trait is low in heritability, selection is not appropriate, in lieu of crossbreeding and handling (Ginja *et al.*, 2017). In other words, having this knowledge provides an idea of the possibilities of achieving genetic improvement through selection (Schmid *et al.*, 2021).

Table 5. Heritability values for productive and reproductive traits in dairy and dual purpose goats

Trait	h ²	Breeds	Source of reference
Milk production (kg)	0.36	Alpine	Garcia-Peniche <i>et al.</i> (2012) Kahi and Wasike (2019)
	0.48	Lamancha	
	0.44	Nubian	
	0.61	Oberhasli	
	0.36	Saanen	
	0.47	Toggenburg	
	0.29	Aradi	
	0.45	Damascus	
Fat production (kg)	0.36	Alpine	Garcia-Peniche <i>et al.</i> (2012)
	0.43	Lamancha	
	0.40	Nubian	
	0.60	Oberhasli	
	0.34	Saanen	
	0.44	Toggenburg	
Protein production (kg)	0.36	Alpine	Garcia-Peniche <i>et al.</i> (2012)
	0.54	Lamancha	
	0.45	Nubian	
	0.59	Oberhasli	
	0.38	Saanen	
	0.49	Toggenburg	
Fat production (%)	0.51	Alpine	Garcia-Peniche <i>et al.</i> (2012) Kahi and Wasike (2019)
	0.50	Lamancha	
	0.56	Nubian	
	0.42	Oberhasli	
	0.46	Saanen	
	0.59	Toggenburg	
	0.23	Aradi	
	0.22	Damascus	
Protein production (%)	0.46	Alpine	Garcia-Peniche <i>et al.</i> (2012)
	0.66	Lamancha	
	0.57	Nubian	
	0.46	Oberhasli	
	0.43	Saanen	
	0.57	Toggenburg	

Research conducted by Ginja *et al.* (2017) indicated that heritability estimates are lower in extensive handling systems, given the scarcity of dietary energy for the expression of genetic variation under extensive handling conditions; therefore, the breeder should take into account the origin of these heritability estimates. However, the absence of a significant difference between the different handling levels in the present finding could be due to the fact that most of the heritability estimates for the intensive handling levels were estimated using an animal model, and most of the heritability estimates in extensive and semi-intensive handling were calculated using the parent-offspring relationship (Garcia-Peniche *et al.*, 2012; Kahi and Wasike, 2019).

Table 6. Heritability values for reproductive traits in meat and dual purpose goats

Trait	h ²	Breeds	Source of reference
Birth weight	0.15	Ardi	Mohammed <i>et al.</i> (2018) Menezes <i>et al.</i> (2016)
	0.41	Damascus	
	0.08 - 0.18	Boer	
Weaning weight	0.26	Ardi	Mohammed <i>et al.</i> (2018) Menezes <i>et al.</i> (2016)
	0.35	Damascus	
	0.23	Boer	
Weight at 180 days	0.45	Ardi	Mohammed <i>et al.</i> (2018)
	0.18	Damascus	
Daily weight gain	0.17	Criolla goat	Menezes <i>et al.</i> (2016) Josiane <i>et al.</i> (2020)
	0.31	Boer	
Body length	0.14	Boer	Zhang <i>et al.</i> (2008)
Litter weight at birth	0.05	Boer	Menezes <i>et al.</i> (2016)
Child survival	0.02	Criolla goat	Josiane <i>et al.</i> (2020)
Interval between births	0.10	Boer	Menezes <i>et al.</i> (2016)

Breeders should rely on heritability values from herds that have handling, genetic, and environmental similarities; otherwise, one needs to keep in mind that this value will act more as a partial guideline on which to base decisions to select and improve the herd (Ginja *et al.*, 2017).

6. Molecular technologies in goat genetic improvement

Until the mid-1960s, markers used in genetics and animal breeding were controlled by genes associated with polymorphic traits, generally easy to identify visually (Mukherjee *et al.*, 2019). Only a small number of morphological markers and phenotypic characteristics of easy visual identification allowed finding significant associations between these and economically important characteristics (Mukherjee *et al.*, 2019). However, due to their limitations, isoenzymatic markers emerged – biochemical markers that distinguish homozygous from heterozygous genotypes – becoming accessible to a greater number of species, consequently providing better results in the differentiation of individuals (Ramesh *et al.*, 2020).

The application of molecular techniques as an additional support for the selection of animals has gained importance, since it is possible to identify genes with favorable effects for productive characteristics, as well as detrimental alleles for the productive behavior of carrier animals (Arnal *et al.*, 2020). In this sense, the development of different techniques for the realization of such identification has allowed its application in various areas of livestock production, and different molecular markers have been developed for this purpose (Biffani *et al.*, 2020).

Molecular markers are defined as fragments of deoxyribonucleic acid (DNA), with specific, identifiable locations, which inheritance can be traced at the genomic level and correspond to expressed or unexpressed regions of the genome (Zonaed Siddiki *et al.*, 2020). Currently, the molecular markers most commonly used in the livestock sector are classified into two groups: i) Microbial Source Tracking (MST), and ii) direct markers, also known as linked markers (LM) (Wakchaure *et al.*, 2015). MSTs are short sequences of one to four nucleotides repeated 10 to 50 times throughout the genome of the species and flanked by highly conserved regions (Ramesh *et al.*, 2020).

The most well-known MSTs are randomly amplified DNA polymorphisms, restriction fragment length polymorphisms, amplified fragment length polymorphisms, and simple, repeated sequences, better known as microsatellites (Xia *et al.*, 2018). Microsatellites are mostly used in breed conservation studies, being a fundamental tool in understanding the genetic structure of Criolla goat populations, as part of the improvement of national programs aimed at the rescue, conservation, and use of any breed (Asroush *et al.*, 2018).

LM are specific loci along the genome of the species in charge of encoding genes corresponding to certain well-defined characteristics. Baumung *et al.* (2004) indicate the presence of about three million LM; a little more than 700,000 have been validated in humans and cattle. For these markers, variants of the polymerase chain reaction (PCR) technique have been developed, based on different physicochemical properties of DNA (Biffani *et al.*, 2020).

The development of DNA sequencing led to the discovery of single nucleotide polymorphisms (SNP) (Eck *et al.*, 2009), considered the most widely used trait-linked markers of livestock interest today. The abundant presence in the genome, genetic stability, and high capacity for inclusion in automated analyses make SNPs a useful tool in genotyping (Asroush *et al.*, 2018), genome-wide association study (GWAS), and genomic evaluations (Biffani *et al.*, 2020).

7. Uses and applications of molecular markers

Techniques based on molecular markers have been widely used in several animal species, obtaining important results for the development of crossbreeding schemes, breed conservation, and the application of this knowledge in genomic preventive medicine (Al-Samarai and Al-Kazaz, 2015). Commercially, the most widely used chip in animal genotyping is the 50k chip with 54,609 SNP-type markers (Chhotaray *et al.*, 2020).

The continuous advance and development of techniques based on molecular markers, as well as their increasingly routine application, have allowed the costs of such tests to become more and more affordable (Bouwman *et al.*, 2018). Thus, applications in livestock today include paternity testing, with exclusion probabilities > 90%, validation of pedigree records, measurement of genomic response to selection, identification of individuals carrying (or free of) genetic diseases, as well as disease-resistant animals, marker-assisted selection, and introgression (Sudrajad *et al.*, 2020).

Pedigree verification is an important aspect of the use of molecular markers in several programs (Eck *et al.*, 2009), as they provide substantial opportunities to increase the accuracy of estimated genetic values and gain (Ginja *et al.*, 2017). Likewise, the identification of possible carriers of lethal or detrimental genes allows the breeder to include only healthy animals, with ideal genetic profiles, in accordance with the established selection objectives (Vargas *et al.*, 2018).

Several goat breeder associations worldwide have implemented, to a greater or lesser extent, DNA testing to validate their reproductive animals and establish genetic fingerprints that allow, in the medium term, to increase the accuracy of the genetic values of their animals. For example, the American Dairy Goat Association (2020) has, since 2015, implemented mandatory DNA testing to obtain genetic profiles of all registered and unregistered males before the offspring are eligible for registration.

Paternity testing is also offered as part of this service. In addition, tests performed include: Carrier identification for G6 sulfatase deficiency, scrapie (transmissible, spongiform encephalopathy), and alpha S1 casein type, in addition to genetic fingerprinting and paternity testing (American Dairy Goat Association, 2020). This has allowed the global implementation of genetic improvement strategies in production, reproduction, and health.

The differences in the scopes and reports of the DNA tests of the different associations depend on their correct interpretation during decision making at the time of selection, generating, to a greater or lesser extent, the need for training of both the team of technicians and the breeders themselves (Table 7).

Table 7. Interpretation of DNA test data

Code	Meaning	Interpretation
SQ	DNA-qualified stallion	Suitable male qualified by DNA, third generation
DQ	DNA-qualified womb	Suitable female qualified by DNA, third generation
PQ	Qualified sires	Suitable male or female qualified by DNA, second generation
OT	Original DNA proof	Suitable male or female qualified by DNA, first generation
SE	Stallion excluded by DNA	Male not suitable for breeding, qualified by DNA
DE	Womb excluded by DNA	Female not suitable for breeding, qualified by DNA
DNA	With DNA test	Animal with genetic fingerprint and paternity test available
N/N	Normal	G6S free
N/G	Carrier	G6S carrier
G/G	Affected	G6S affected
NN QQ	Affected	No resistance to classical scrapie
NN QK	Highly-susceptible carrier	One copy of protective variant K222, increased resistance to classical scrapie
NN KK	Moderately-susceptible carrier	Two copies of protective variant K222, increased resistance to classical scrapie
NS QQ	Highly-susceptible carrier	One copy of protective variant S146, increased resistance to classical scrapie
SS QQ	Moderately-susceptible carrier	Two copies of protective variant S146, increased resistance to classical scrapie
NS QK	Very low-susceptible carrier	One copy each of protective variant S146 and K22, increased resistance to classical scrapie
A, B	High alpha S1 casein production (CSN1S1)	Any combination is associated with high volumes of CSN1S1 production
E, F, N	Low production of alpha S1 casein (CSN1S1)	Any combination is associated with high production volumes of CSN1S1
O1	No production of alpha S1 casein (CSN1S1)	No production of CSN1S1
A, B, E, F, N	Medium production of alpha s1 casein (CSN1S1)	Any combination is associated with medium CSN1S1 production volumes

Source of reference: (American Dairy Goat Association, 2020)

8. Marker-assisted selection

Marker-assisted selection (MAS) is an auxiliary tool for genetic evaluations in cattle herds, as it allows greater genetic progress, in combination with conventional methods (Zheng *et al.*, 2021). The use of genetic identification techniques for MAS of high-quality animals has gained importance in the identification of genes related to productive characteristics, as well as genes with detrimental effects on the productive behavior of carrier animals (Petrović *et al.*, 2018).

MAS is used in several countries to determine polymorphisms in the alleles that make up the genotypes of milk proteins, which have direct effects on the composition and technological properties of milk (Al-Samarai and Al-Kazaz, 2015) – a fact that Amills *et al.* (2017) demonstrated by reporting the influence of genetic characteristics of animals on the physicochemical behavior of milk. Asroush *et al.* (2018) and Zonaed Siddiki *et al.* (2020) established the theoretical basis for animal selection based on genomic evaluations, gaining popularity in animal production. Such evaluations are based on considering the parts of the genome that animals inherited from their parents.

The concept behind marker-assisted selection is that there may be genes with significant effects that can be specifically targeted in selection (Martin *et al.*, 2016). Some traits are controlled by single genes (e.g., hair color), but most economically important traits are quantitative traits that are usually controlled by a fairly large number of genes (Ginja *et al.*, 2017). However, some of these genes may have a major effect, and can be referred to as major effect genes, located in QTL (Al-Samarai and Al-Kazaz, 2015). Although the term QTL is strictly applied to genes of any effect, in practice, it refers only to major genes, since only these will be large enough to be detected and mapped in the genome (Ramesh *et al.*, 2020).

When making selection decisions based on marker genotypes, it is important to know what information can be inferred from the marker genotypes (Menezes *et al.*, 2016). The use of direct markers is straightforward, as the marker genotype provides a direct indication of the QTL genotype (Ginja *et al.*, 2017). The problem is how to base decisions on indirect markers. When there is a direct marker (DNA test) for a QTL, we can use direct marker-assisted selection, sometimes known as Genotyping Assisted Selection (**GAS**) (Isik and Bilgen, 2019). Where only linked markers exist for a QTL, we must use indirect MAS-assisted selection. In either case, the goal is to determine QTL genotypes to aid selection (Menezes *et al.*, 2016).

The value of this depends on several factors: i) When heritability is low, the value of individual QTL information tends to be higher, because the precision of the genetic values increase by a relatively larger amount (Al-Samarai and Al-Kazaz, 2015); ii) when the traits of interest cannot be measured in a gender, the marker information provides a basis for classifying animals of that gender (Xia *et al.*, 2018); iii) if the trait cannot be measured prior to sexual maturity, the marker information can be used to select at a juvenile stage (Chhotaray *et al.*, 2020); and iv) if a trait is difficult to measure or requires sacrifice (as is the case with many corpse traits), the information from the marker can be used (Asroush *et al.*, 2018).

Conclusions

Some considerations regarding the goat livestock system for milk production and commercialization were reviewed through the lens of integral management of the national and international market, including an analysis of its main genetic improvement indicators. It is considered that the evaluation of dairy goats by heritability in selection, assisted by molecular markers, is a methodology that interprets the interests of the producer. In addition, the use of DNA tests provided by genetic evaluation services should be accompanied by breeding values for individual traits, thus facilitating breeders who wish to apply their own weighting criteria to achieve sustainable development of the dairy goat.

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Chapter 3 Sustainability and new rurality: Colombian territory and peace process

Capítulo 3 Sustentabilidad y nueva ruralidad: Territorio colombiano y proceso de Paz

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Abstract

The new rurality explains a large part of the population, economic, social and environmental problems that are currently developing in emerging countries such as Colombia. The objectives were: a) to explain the most characteristic features of agriculture and the rural environment in Colombia and b) to synthesize the peace process in the Country. The methodology included office and field work to collect primary and secondary data.

The results reached were: 1) land ownership in Colombia is highly concentrated and 2) chronic inequality and secular poverty constitute the socioeconomic reality of a large part of the peasant and rural population. Conclusions: a) ecology is a fundamental value for human life and that sustainable development consists of starting three types of solidarity simultaneously: within the community itself, with the rest of the world's inhabitants and with generations and b) the lack of regulations has created the ideal conditions for the rural conflict with its two components: agrarian and armed.

The protagonists of the first are the peasants with their struggle for land (among themselves and with landowners and investors), for well-being and for political inclusion. The protagonists of the second have been the guerrillas, the paramilitaries and the drug traffickers, who want to control the territories, the corridors and the population.

Keywords: Colombia, geography, peace process, rurality, sustainable

1 Introduction

Ecologist E. Leff (1998) indicated that current environmental problems appeared during the last decades of the 20th century as a crisis of civilization where the dominant economic rationality and technology are questioned. The progressive environmental deterioration (Niño-Gutiérrez, 2014) and the increasing destruction of natural resources on a planetary scale constitute clear evidence of what a model based exclusively on economic growth and obtaining immediate benefits is capable of generating, but they are also an eloquent sign of the very limits presented by capitalism.

The capitalist system has demonstrated for several centuries an enormous capacity for self-transformation that has allowed it to adapt to the times and to its needs and interests. Given the unquestionable incapacity that the market economy has shown to avoid ecological destruction, to shorten the gap that separates the rich from the poor (Athanasiou, 1996; Boff, 1997) and for this reason, neoliberalism is no longer well received in many parts of the world and among different social groups. This assertion, in the face of the danger of a more than probable environmental collapse in the medium term, reflects the urgency that the capitalist system has to transform itself again, if possible by offering a friendly "ecological" and "sustainable" face, a strategy that it has been developing for several decades with notable success.

In spite of the new sustainable and ecological image it is trying to spread, the market continues to rule everywhere and all that remains to be seen is what definitive form it will take and what subterfuges it will use to ward off criticism and continue to fulfill its inherent objectives: the accumulation and reproduction of capital. However, it is often forgotten, perhaps out of ignorance, perhaps out of cynicism, that the capitalist system has clear limits because just as it is not reformable to the point of renouncing the exploitation of labor or dependent countries, neither could it ever suppress the depredation of natural resources (fig. 1) and ecological destruction (Niño-Gutiérrez, 2017).

Figure 1. Depredation of the natural landscape in Guerrero, Mexico.



Source: Niño-Castillo, et al., 2020

Moreover, it is difficult for the globalization of the economy, trade liberalization and the omnipresent market to ensure a harmonious balance between material production and nature conservation. Such a balance is simply incompatible with a world economy and a growth model based on unlimited profit-making by companies that by definition pursue this goal and compete with each other in a global free market.

Capitalism should not only be understood as a simple mode of production, but also as a culture with great power to numb consciences and promote the profusion of ideas that block the response capacity of societies, especially in rich countries. This capitalist culture, derived in reality from its mode of production, exalts the value of the individual over the collective, guarantees the private appropriation of the wealth obtained with the work of all, seeks to maximize profits with the minimum possible investment, places as the cornerstone of its dynamic behavior the competition of all against all, seeks to transform everything into merchandise to always have profits, is based on the constant creation of artificial needs and establishes the market (globalized, at present) as the main mechanism that articulates the totality of the processes of production, competition, distribution and consumption.

Historical capitalism has demonstrated an unparalleled capacity to create enormous quantities of material goods, but it is no less true that it has also entailed an enormous polarization of the wealth generated. Many individuals have benefited greatly, although there are legions who have seen a very substantial reduction in their real income, the quality of their lives and the progressive deterioration of the resources necessary for their subsistence. In the space-time covered by historical capitalism, the incessant accumulation of capital has meant the continuous widening of the real distance between social classes and between countries.

The logic of the capitalist mode of production is the accumulation of capital with the aim of accumulating more capital, in a system that is not very "natural" and rather absurd, as I. Wallerstein described it in 1988. Wallerstein in 1988, whose immanent essence lies in the creation of "necessary" contradictions and imbalances between areas (center-periphery), countries (developed-underdeveloped), habitats (countryside-city), economic activities (agriculture-industry and services), relations of production (capital-labor), people (rich-poor) and social classes (exploited and exploiters). In any case, the capitalist logic, both in its mode of production and cultural aspects, is to produce accumulation through the exploitation of people's labor power, the domination of some social classes by others, the subjugation of peoples and the depredation of the world's natural resources. Likewise, capitalism imposes an absolutely dilapidating model in the management of natural resources, whose main characteristics are the extreme productive and extractive mentalities, null consideration of biotic regenerative cycles and abiotic processes and total indifference towards the interests and needs of the majority of the population.

For these reasons, if anyone seeks solidarity with nature and with individuals, respect for all that is different and diverse, dignity for human beings and respect for life in any of its manifestations, he or she should certainly not look to the logic and culture of capital. Capitalism threatens all democratic social values and jeopardizes the future of human societies. Both as a mode of production and in terms of its cultural dimension, capitalism makes environmental and social ecology unviable. Faced with these approaches, a clear dichotomy arises: either capitalism triumphs by occupying all physical and mental spaces, as it claims, or ecology triumphs. If capitalism triumphs, it destroys ecology and puts the Earth-system at risk, but if ecology wins, it destroys capitalism or subjects it to transformations that do not allow it to be recognized as such, according to the Brazilian liberation theologian L. Boff (1997 and 2006). In any case, there is no possibility of agreement, conciliation or harmonious coexistence.

For all these reasons, the market economy constitutes a compulsive system that, if allowed to operate according to the designs of the so-called "invisible hand", leads inexorably to natural and social disaster. Given that in the sacrosanct market economy the only thing that is untouchable is competition, it is easy to deduce that it drives social and environmental destruction. Hence, the market and sustainability can be considered antagonistic concepts.

In this same line, R. González Sousa (2001), raises the existing incompatibility between the processes of capitalist globalization and sustainability in underdeveloped countries, places where pollution and environmental destruction are especially serious and where environmental ecology and social ecology are inextricably linked. The global strategies applied in these nations stimulate activities linked to the external sector, increase food dependence, prioritize export crops, concentrate land ownership, generate marginalization, unemployment and poverty, cause serious ecological problems and distance any sustainable and socially fair use or in the best of cases concrete actions are undertaken for the protection and conservation of the natural landscape (Niño-Gutiérrez, 2021).

Therefore, capitalism not only intends to dominate nature, but also to plunder and deplete it, if it were to assume the ecological and environmental discourse it would be due to three fundamental reasons: to spiritualize it and, in this way, empty it of content and of any truly sustainable claim, to obtain profits or to make it impossible and, consequently, destroy it for being uncomfortable and dangerous for its accumulation purposes.

In these times when there is so much talk in the academic world about rural development, local development or sustainability, the truth is that not much emphasis is placed on the close link that exists in undeveloped countries, as is the case in Colombia, between the development of rural areas and injustice in the distribution of land. There can be no rural development without profoundly altering an agricultural property structure characterized by chronic peasant uprooting, rural poverty and the concentration of land in very few hands. This circumstance, together with the omnipresent power of the agroindustrial sector and the preference for an agriculture oriented to international markets and not to the consumption of the population, constitutes the embryo of the armed conflict that devastated the country for more than five decades. The success of the peace process and of the agrorural guidelines emanating from it to overcome the bleeding rural poverty inevitably depends on modifying the structure of land ownership, putting an end to idle or unprofitable latifundia and producing for the domestic market, thus safeguarding the country's food sovereignty.

Colombia has advanced into the 21st century without definitively resolving the structural problems of its agriculture. This hinders farmers' access to productive resources, with the consequent delay in the development of the agricultural and livestock sector. For several decades, attempts have been made to complete various agrarian reforms that have always proved insufficient, have been poorly directed and have even been inoperative for the development of the land market and the improvement of the living conditions of farmers and rural inhabitants. This situation, very common in the Latin American region as a whole (Guereña, 2016), is revealed to be especially problematic and violent in Colombia, a nation that happens to be one of the most solid democracies in Latin America, with only a short dictatorship in the 1950s of the last century. Nevertheless, Colombians have lived through an armed conflict, the oldest in the continent, which has left an endless trail of murdered and disappeared people and chronic socioeconomic inequity.

The road to peace and democracy goes through recovering agrarian life and ensuring integral rural development, since the countryside has been at the center of the armed conflict from the beginning. Millions of people have been forced to abandon their land to escape the violence. In certain strategic areas, displacement has affected entire rural communities. They lost their livelihoods, their culture and the roots that linked them to the traditional wisdom and farming practices that have always represented their identity, the guarantee of a living rural environment and the food sovereignty of the people.

The main objective of this contribution is to explain the most characteristic features of agriculture and the rural milieu in Colombia, which are precisely those that have contributed most intensely to the widespread poverty existing in the country's non-urban areas and whose secular permanence constitutes the origin and continuity of the bloody armed conflict that has plagued this nation for decades. At present, faced with a new opportunity provided by history to achieve a definitive peace in the country, one cannot be completely optimistic about the fulfillment of all the initiatives that are intended to be implemented to repair the victims of the conflict, restitute the dispossessed lands, achieve an integral rural development and modernize the countryside by helping the productivity and profitability of small peasant farms. There have been many frustrated attempts in this direction for a century. This may be yet another failed attempt, which for a time will occupy politicians and social agents, drafting documents and enacting laws, and then remain a mere wet paper. The guerrillas, paramilitaries, the army and drug traffickers may cease their hostilities, but if the structure of land ownership is not modified, if the large landowners do not pay taxes or make their unproductive haciendas profitable, if the peasantry is not expressly supported and financed, and if the historical collusion between the large estates, agro-industry and political power is not ended, Colombia's agrarian problem will always be latent. These aspects constitute the starting hypothesis of this text.

2. Methodology

The methodology used was of a mixed nature, since qualitative techniques were used at the beginning and later complemented with quantitative techniques, through the information gathered in the field. Thus, the qualitative technique applied during the documentary research involved the review of relevant publications in the form of articles, books and book chapters, in printed or digital form, so that after their compilation, they were read, analyzed and selected according to the variables under study, on topics related to: Colombia, new rurality, multifunctionality, peace process and sustainability. For this purpose, reference digital databases were consulted, such as: Latindex, Redalyc, SciELO, Google Scholar, among others. The methodology used is dialectical, because apart from the fact that all the factors that contribute to rural poverty in Colombia and that intervene in the attempt to achieve lasting and democratic peace are intimately interrelated and subject to constant transformation, the interests of the main actors are antagonistic and subject to permanent conflict.

In the theoretical-conceptual framework (Arias, 2006), sustainable development has become an all-purpose concept that is recited as a kind of mantra by all types of economic, social, political, cultural and environmental agents, even by those who contribute most with their actions, strategies or policies to environmental deterioration and the destruction of ecosystems around the world. Even the World Trade Organization (WTO) tries to convince public opinion of its excellence by insisting that it is not an anti-environmental organization because its regulations contain several references to the environment and the need for sustainable development.

The preamble to the Marrakesh Agreement (1994) states that its purpose is to enhance the production of and trade in goods and services, while allowing for the optimal use of the world's natural resources in accordance with the objective of achieving sustainable development. Of course, it is true that the WTO aims to increase production and international trade in goods and services free of customs barriers, since this is its *raison d'être*, a legal instrument at the service of capital, but it is not true that its aims include sustainable development with the optimal use of resources (WTO, 1994).

Trade liberalization on a planetary scale, sponsored by the WTO, is an incentive for the large transnational corporations of the rich countries and the oligarchies of the poor countries to produce more and at lower costs and, therefore, to increase exports. The increase in production and trade and the search for cheap labor and raw materials in order to reduce production costs are representing a renewed cycle of overexploitation of natural resources and greater environmental aggression for the already hard-hit ecosystems of the underdeveloped countries.

Moreover, capitalist trade is characterized by "externalizing" the ecological costs of its activities to society as a whole instead of reflecting them in the prices consumers pay for the goods and services they purchase.

In fact, transnational corporations and local companies, mainly those involved in agriculture and agro-industry, do not consider the protection of the environment and natural resources as fundamental factors for sustainable and environmentally friendly development, but rather as an obstacle to trade, similar to a non-tariff barrier that undermines the competitiveness of many important products or markets and harms commercial exchanges. Hence the limited success of proposals advocating the introduction of ecological clauses in international trade agreements, except when they serve as non-tariff barriers for rich countries against imports from poor countries or are used as an instrument by the powers that be to continue controlling the economy of the underdeveloped world under the cynical banner of ecology or sustainable development, which in reality is what matters least to them.

Even the recent interest of the European Union (EU) in sustainable development and agrorural multifunctionality is also closely related to the demands of international trade organizations, such as the WTO. After several decades of extreme productivism, with the consequent cost to the environment, the EU's rural (not exclusively agricultural), sustainable and environmental vocation would have taken longer to manifest itself had it not been for these international pressures, the chronic generation of surpluses and the unsustainable budgetary expenses represented by its agricultural policies. In other words, necessity has made a virtue. In any case, despite budget cuts and the predominance of official discourses of an environmental, sustainable and multifunctional nature, the Common Agricultural Policy (CAP) continues to defend an agricultural model of high productivity in order to maintain the economic efficiency of its agriculture and competitiveness in world markets. At the same time, the CAP also continues to maintain a high degree of agricultural protection, albeit under a new rhetoric of sustainability, multifunctionality and peasant pluriactivity.

Further proof of the fallacy of sustainable development is provided by the three fundamental problems generated by capitalism, among others: the depletion and extinction of natural resources (fertile land, water, energy sources, forests and jungles, animal and plant biodiversity), the precarious balance of the Earth system (nuclear weapons, fossil fuels, climate change, the greenhouse effect) and social injustice in the world (inequality, inequity, divergence, imbalance).

As L. Boff (2006) points out, this social and environmental cataclysm is neither innocent nor natural, since it appears as the direct result of a type of development that does not measure the consequences of its actions on nature and social relations. For this reason, the so-called sustainable development is a trap of the capitalist system, which evidences a contradiction in its very name. Proof of this is that the term development is taken from the market economy, while the notion of sustainability comes from the ecological and biological sciences. Capitalist development, although it would be more appropriate to say growth, is unequal and unbalanced, since it accumulates for a minimal part of the world's population at the expense of the majority of its inhabitants, who are harmed and excluded. This growth is intended to be linear and ever-increasing. Sustainability, on the other hand, is related to the capacity of an ecosystem to include everyone, to maintain a dynamic equilibrium that allows the subsistence of the greatest possible biodiversity, without exploiting, oppressing or excluding.

In this sense, capitalist development and sustainability deny each other, since they do not combine the interests of human beings with those of ecological conservation. Rather, the opposite is true because they deny and destroy each other. What is needed is a sustainable society that grants itself a development that satisfies the needs of all and of the environment, so that the planet is sustainable and can maintain its dynamic equilibrium, rebuild its losses and remain open to further forms of development.

Likewise, J. Martínez Alier (1991, 1992 and 2005) indicates that the Brundtland Report (1987) sees poverty as a cause of environmental deterioration and, therefore, preaches the convenience of striving to achieve an economic development that is sustainable from the ecological point of view and that simultaneously eliminates poverty and improves the environment. This author accepts that poverty can be a cause of environmental degradation, but rejects the belief that poverty can be eliminated by general economic growth rather than by redistribution of wealth. This faith in the goodness of steady, upward economic growth is counterproductive to ecological integrity.

It is curious, on the other hand, that everyone, from ordinary individuals to governments and representatives of international organizations (including those of an economic and financial nature), agrees that poverty must be eradicated from the earth as unjust and unworthy. However, this discourse and these good intentions do not go hand in hand with the necessary reasoning and deliberations on wealth, when both situations are dialectically interrelated. The aim is to end poverty through a policy of minimums (minimum wage, minimum income, minimum calorie consumption, minimum access to resources) with the intention that the majority of the world's population will rise above the line of a certain threshold of consumption. The claim of spreading wealth implies the erroneous idea of living on an infinite planet, with infinite resources, with an all-powerful technology and full of good will, where people would achieve high levels in all types of consumption.

This pretension of generalized enrichment, in order for the market economy to continue functioning at full capacity, is not admissible in a practically saturated world, where its carrying capacity has long since been exceeded, the food sovereignty of the majority of its population is not assured, basic resources such as water and unpolluted air are scarce and the survival of future generations is in question. Faced with this unquestionable reality, it is obvious that poverty can never be eradicated unless the unbridled consumption of the rich countries, their plundering of the resources of the poor and the systematic destruction of their ecosystems are limited. But how can these issues be limited in a mode of production that does not have and cannot have limits, that is horrified by any kind of regulation, especially of consumption, and that sacralizes the omnipresence of the competitive market?

3. Results

Despite the abundant existing legislative apparatus, the practical inhibition of Latin American governments in agricultural matters, the search for economies of scale by the agroindustrial complexes through increased productivity, yields and the physical size of farms, as well as the dimensional needs of the agrarian base of the agroexport model, are factors that encourage the concentration of land ownership. The "rural megalomania" of the oligarchies (Stédile, 1997), which have always identified social projection and political prestige with the possession of large tracts of land, even though this is not their main source of income and they are not too concerned about its economic exploitation, is not unrelated to this situation in Colombia and other Latin American countries, whereby a few accumulate a lot of land and a legion of small and medium farmers barely have enough land to survive.

It is a cruel logic that those who own a lot of land, and do not depend on it for their survival, care very little about making it produce, using it mainly for speculation, as a store of value or as a simple instrument of power. This, undoubtedly, is anachronistic, paradoxical and contradictory in these countries where there are also important contingents of landless farmers, unemployed rural workers and even small producers underemployed in their own smallholdings, who in the end are pushed to occupy marginal lands or forced to emigrate, either to metropolitan areas or abroad.

Land ownership in Colombia is highly concentrated. In 2014, properties smaller than 10 hectares represent 78.03% of the total and account for only 5.95% of the country's entire agricultural, agricultural, livestock, livestock, forestry and agro-industrial land area. Eighty percent of the country's small farmers have less than one Family Agricultural Unit (UAF), i.e., they are micro-founders. In contrast, properties larger than 1,000 hectares represent only 0.19% and account for 53.97% of all land. However, what is most striking is that the 275 properties larger than 10 000 hectares in the country account for 0.02% of the total and absorb no less than 40.89% of the land. As Eduardo Sarmiento (2015) indicates, the concentration of the agricultural sector is alarming because the structure of land ownership has not changed at all in two centuries. This sector constitutes a way of hoarding wealth, isolating it from the economy and obtaining large valorization benefits (Sarmiento, 2015).

The process of land concentration has not ceased during the last decades. It should be noted that latifundios larger than 1,000 hectares owned 26.6% of the country's agricultural land in 1992, while minifundios, i.e., with dimensions smaller than 10 hectares, exercised dominion over 8.8% of the land on the same date. At the end of the same decade, the Geographic Institute "Agustín Codazzi" presented a new distribution of land ownership in Colombia: 67% of the owners (2.3 million people) each owned a farm of less than five hectares, that is, only 3% of the surface area.

On the other hand, 2,055 large landowners, owners of farms larger than 2,000 hectares, which represent a ridiculous 0.06% of all landowners in the country, owned 51.5% of Colombia's agricultural land. Although the number of large landowners has decreased, land has been concentrated in fewer hands. That is to say, fewer large estates, but with larger surface dimensions. This cruel contrast is what has explained the long persistence of violence in rural areas of the country, according to Jaime Vásquez (2003).

This clear process of land re-concentration has not only been carried out by large landowners, but from the eighties and nineties of the last century onwards, a new actor entered the scene and accumulated a large amount of land in a short period of time: drug traffickers. The National Planning Department (DNP) estimated that drug traffickers had bought land in 37% of the country's municipalities between 1980 and 1995.

This situation led to an increase in the concentration of agricultural property, the displacement of peasants from the colonization fronts to the cities, an increase in the price of land, the financing of paramilitaries and the reorientation of the most fertile soils towards extensive cattle ranching, to the detriment of agriculture and forests (Segrelles and Vásquez, 2012). In this regard, it is estimated that 6.6 million hectares were dispossessed by the violence of the last two decades, i.e. 15% of the country's agricultural land.

According to data prepared by the Agricultural Rural Planning Unit-UPRA (2015), the Gini index for the country as a whole is 0.73, although there are sensitive differences between its departments, as some, such as Atlántico or Vaupés, are below 0.30, while the majority exceed the value of 0.70, with particular intensity in Sucre (0.92), Vichada (0.91), Cauca (0.89), Nariño (0.85), Huila (0.83), Santander (0.82) or Guaviare (0.81). However, other studies estimate that the Gini index of land concentration is 0.89 in 2011, when in 2005 it was 0.86 (Asistencia Técnica Internacional del Tercer Laboratorio de Paz, 2011).

For his part, Germán Escobar (2016) maintains that this index was 0.88 in 2014, a figure that Arantxa Guereña (2016) agrees with for 2011. Be that as it may, and regardless of the specific data, what is evident is that Colombia's agrarian structure is one of the most inequitable in the world, only surpassed in Latin America by Paraguay (0.93) and Chile (0.91) (Guereña, 2016).

The unbalanced distribution of land ownership constitutes a traditional phenomenon already entrenched in rural life in Colombia and that continues to worsen with the implementation of neoliberal policies. Under the protection of the weakness of the State, almost always hostage of the central powers, the international financial organizations and the local landed oligarchy, the large properties continue to expand their extension through the absorption of smaller properties, a phenomenon that J. Graziano da Silva (1979) once called "rural phagocytosis".

Faced with the age-old problem of land concentration in Colombia, the country's first important agrarian reform took place in 1936, preceding Law 136 of 1961, or Agrarian Reform Law, promoted by the now dissolved Colombian Institute of Agrarian Reform (INCORA), after carrying out the first national agricultural census in the years 1960-1961. Before promoting the relevant distributive measures, it was necessary to analyze the structure of land ownership. Given the high concentration of land in the hands of a few, a second census was carried out ten years later as a way of balancing the distribution of land, although little progress was made and in some areas there were even setbacks and agricultural property became even more concentrated. Attempts were made to solve its limitations and deficiencies with new laws, such as Law 4 of 1973, of the Government of Misael Pastrana Borrero, and Law 6 of 1975 on Sharecropping, of the Government of Alfonso López Michelsen.

The latter led to the so-called Chicoral Agreement, established by the previous government, which was nothing more than the beginning of the agrarian counter-reform, since measures were taken that primarily favored large landowners. Other legislative initiatives for agrarian reform in Colombia were those promoted by President Belisario Betancur in his Ceasefire, Truce and Peace negotiations with the FARC guerrillas in 1982, Law 30 of 1988, by President Virgilio Barco, and Law 160 of 1994, on subsidies for land acquisition, by President César Gaviria, within the framework of World Bank recommendations (Segrelles and Vásquez, 2012).

Several laws have also been promoted recently with different agrorural objectives: land acquisition for the population affected by forced displacements, adjudication of vacant lands, socioeconomic reactivation of rural areas affected by natural disasters, administration of assets seized from drug trafficking, organization of productive chains in the forestry and agricultural sectors, support for rural women, forestry management and control, consolidation and promotion of rural development (Ibidem, 2012).

Despite all these attempts to achieve a democratic agrarian reform, undertake rural development and alleviate the existing imbalance in the Colombian agrarian structure, the process of land ownership concentration has continued to intensify, which represents a burden for the productivity of its agriculture, a marked uprooting of peasants, deficient rural development and a harsh aggression against the country's environment and natural resources (Bonatti *et al.*, 2022).

According to Elisa Wiener, quoted by Germán Escobar (2016), four processes of concentration of land ownership can be distinguished, taking into account the purpose of exploitation: concentration for agricultural purposes, i.e. food production by agribusiness; concentration for agrofuel production; concentration for the development of extractive industries; and concentration for forestry purposes (Escobar, 2016). This means, in short, that land use and land concentration feed each other. Certain uses stimulate the concentration of agrarian property in a few hands, while large monoculture estates require extensive areas to meet their commercial and productivity objectives. In any case, the result is the dispossession of small and medium farmers, environmental deterioration and loss of food sovereignty.

The simple evolution of the population census between 1990 and 2018 already reflects a reality that once again refers to the concentration of land ownership, the prevailing inequality in Colombian society and the continued and constant process of dispossession and uprooting of small farmers. The rural population, estimated at 9,508,270 inhabitants in 2018, decreased by 10%, between the dates indicated, a reduction due to the strong displacement that has taken place in the Colombian countryside during the last decades. In 1990, the rural population was 10 566 000 inhabitants. This rural exodus has been directed with priority towards metropolitan areas (Bogota, Medellin, Santiago de Cali, Cartagena de Indias, Barranquilla) that have almost exceeded their absorption capacity, as the urban population exceeds 49 million inhabitants, with a growth of 75.7% between 1990 and 2018. Peasants fleeing poverty or being expelled from their lands go where they believe it is easier to find employment and a decent way of life for themselves and their families, although in many cases they survive by practicing informal employment and even committing crime, begging or prostitution.

On the other hand, while the rural population in Colombia is estimated at just over 9.5 million inhabitants in 2018, the peasant population is estimated at seven million people, a number not much different from fifty years ago and which currently produces the food for all the country's inhabitants (almost 49.6 million). According to Aimo Baribbi and Piet Spijkers (2011), this means that while fifty years ago the ratio between producer and consumer was two to one, today it is almost one to six. It is predicted that by the year 2030 this ratio may be one to ten. Demographic projections estimate, with an annual growth of 1.7%, that in 2030 the total population of Colombia will be 70 million inhabitants. The rural population will be no more than ten million, while the peasant population will only be between five and six million producers (Baribbi and Spijkers, 2011).

In any case, and according to the 2014 Agricultural Census, prepared by the National Administrative Department of Statistics (DANE, 2015), the abandonment of the countryside by young people represents a progressive aging of the rural population, a fact that generates a vicious circle that is difficult to solve. Young people do not find in the countryside any possibility of a future because their expectations are almost null and the living conditions in this area are not as attractive as they would like. 72.6% of the population between 17 and 24 years old cannot access education and 20% of those between 5 and 16 years old do not attend school (DANE, 2015). All this is due to the fact that the level of capitalization in rural areas is very low, 83% of producers do not have agricultural machinery, a similar percentage do not have any agricultural infrastructure, credits are hardly used and technical assistance is conspicuous by its absence in the vast majority of farms. Without credit, capital and technical assistance, it is impossible for agriculture to be competitive, productive, profitable and efficient. In the absence of rural development, there is no training or retention of young people in the countryside, and without this non-aging population, initiatives aimed at the development of agricultural activities and the rural milieu cannot be carried out.

The percentage of people living in poverty and indigence in rural Colombia has decreased between 2002 and 2018, although its values are always higher than those of urban areas and the country as a whole. Despite this reduction, the fact that there are still intolerable figures of poverty (4 992 620 people) and indigence (2 239 680 people) in the Colombian countryside cannot be ignored. The sum of indigent and poor people reaches 7 232 300 individuals, people who survive on less than two dollars a day, who have no housing (11%) or have it in poor condition (16%), who lack sewerage (85%), who are illiterate (18.5%), who do not have access to drinking water (60%) or who are under the subsidized health regime (83%). In addition, 60% of rural employment is informal, 90% of peasants have never received technical assistance and the rural Gross Domestic Product (GDP) has only grown 2.8% in the last decade, according to a report by the Bogotá magazine *Semana*.

As is the case with the abandonment of the countryside by the young population, rural poverty in Colombia is also immersed in a vicious circle of complicated resolution. It is evident that the rural poor do not have any capital to improve their production, their educational level is elementary or non-existent, they have no housing or it is in very poor conditions, and they cannot access health services, among other deficiencies. It is difficult to get out of poverty without these premises, but being poor it is impossible to have the resources to achieve these objectives. For this reason, Rafael Isidro Parra-Peña (2013), referring to the Colombian rural environment, states that "although in recent decades the level of poverty has decreased slightly, everything seems to indicate that this is a structural phenomenon" (Parra-Peña, 2013). Indeed, there is a set of structural factors that prevent the rural population from overcoming the barriers that limit the generation of sufficient and sustainable income. In this context, any possibility of improvement for the rural poor population is lost without remission despite the economic growth that the country has experienced since the early years of the 21st century.

In this regard, Santiago Perry (2010) states that these structural factors, in addition to the difficulties in accessing land and other productive assets (livestock, water, technology, financing), are centered on the precarious socioeconomic development of rural areas that prevents the generation of sufficient income, the lack of road infrastructure (especially serious in the most peripheral areas) and the lack of agrifood marketing, the scarce coverage of social and public services, as well as institutional weaknesses that lead to fragile coordination between social policies and agricultural policies, since there are many public programs that barely reach the rural poor because their primary objective is not to generate in the rural poor the productive capacities that would allow them to become small rural entrepreneurs in the medium term and to manage their own development processes. Nor have the various government agencies involved in this issue been able to support the programs and processes promoted by civil society to accompany their economic development and put an end to rural poverty.

Given this situation, it should come as no surprise that former Colombian President Juan Manuel Santos himself, in a statement published in *Semana* magazine, said that there was still much to be done in the countryside, adding that it was necessary to accelerate comprehensive rural reform. Likewise, in the peace negotiations in Havana between the Government of the Republic and representatives of the FARC guerrillas, the need to implement a public goods policy that would help narrow the gap that currently still separates rural and urban areas in all economic, social, demographic, cultural and political indicators was also seen. Moreover, chronic inequality and secular poverty constitute the socioeconomic reality of a large part of the rural and peasant population. The situation of poverty or destitution in which most rural households in Colombia live, which translates into marginality, discrimination, inequity, injustice and inequality, is one of the factors that has contributed most to the country's violent political history (Howland, 2022).

Karen Tatiana Álvarez Riascos (2016) does not hesitate to state that post-conflict planning in Colombia involves adopting a perspective that includes a local type of development in rural populations, which would be managed through the integrated action of the State, the rural communities themselves and private enterprise. Local development implies the promotion of local entrepreneurial capacity to add value to both traditional resources (agriculture, livestock, handicrafts) and non-traditional ones (environmental protection and natural resources, renewable energies, rural tourism, conservation of cultural heritage). In a post-conflict scenario, local development emerges as a complementary tool to nationwide peace policies. In this way, through territorial planning, the space and its inhabitants would be recovered, thus activating mechanisms that would contribute to poverty reduction, with their own endogenous resources and with capitalization and exogenous support.

Thus there would be an increase in social cohesion and the local economy would be integrated with the regional and national economies (Álvarez Riascos, 2016).

According to the National Human Development Report Colombia 2011, prepared by the United Nations Development Program-UNDP (2011), this country will not be able to modernize as it intends if it acts with its back to the peasant population that bets on its happiness and future in urban centers. As already mentioned, a simple agrarian reform is not enough, and even less so if it remains a dead letter, as has happened with so many other initiatives of this type in Colombia's recent history. It will be necessary to change the structure of land tenure, which has been concentrated for centuries. This implies not only elaborating an agrarian census and updating the cadastre, but also imposing high taxes on the owners of a lot of land and penalizing unproductive properties, in order to discourage concentration. It should be the central government and not the municipal authorities, manipulated by the local elites, who should be in charge of enforcing these measures. The idea would be to invest the money in welfare for the rural population with the most precarious living conditions, i.e., peasants living from basic agriculture or a related activity, women, Afro-descendants and indigenous people.

4. Conclusion

Since the elaboration of the famous Brundtland Report (Our Common Future, 1987) and its dissemination at the Earth Summit (Rio de Janeiro, 1992), it has been repeated and almost universally assumed that ecology is a fundamental value for human life and that sustainable development consists of implementing three types of solidarity simultaneously: within one's own community, with the rest of the world's inhabitants and with future generations. This veneer of solidarity makes the concepts of ecology and sustainable development attractive to the mass media and to society as a whole, since they harbor ideas that are acceptable to all socio-economic, political, cultural, religious and environmental actors.

Such notions have been self-servingly magnified while being integrated into the well-oiled machinery of marketing and advertising. Therefore, it has become a matter of good taste, typical of committed and progressive citizens to speak of ecology, sustainable development, integral rural development, endogenous local development, sustainable growth, ecotourism or environmental resources at the slightest opportunity, without thinking that these concepts contain in themselves an insurmountable contradiction with the immanent essence of the capitalist mode of production, since this generates antagonisms that make it unsustainable, to the point of having sufficient ideological, cultural, technical and economic-political power to destroy the planet. It is evident, then, that the market economy and any of the above-mentioned concepts mutually deny each other.

For its part, the capitalist mode of production also has insurmountable limitations because it can in no way renounce the exploitation of labor or the abusive use of natural resources, a fact that constantly endangers the viability of ecosystems and generates growth that is anything but sustainable. The need for accumulation and constantly high profits "forces" it to resort systematically to the conquest of new sources of production and consumption, which in the end results in a massive and irrational use of new natural resources and a dangerous approach to a definitive environmental collapse.

The policies imposed on underdeveloped countries by various international trade and financial organizations, such as the IMF, the World Bank and the WTO, are a clear proof of this assertion. The structural adjustment programs, the reduction of social investments and the promotion of export economies that neoliberalism demands of these countries through its legal instruments, constitute a major tool for plundering natural resources and categorically degrading the environment. And all with the aim of obtaining foreign currency in foreign trade to be able to satisfy the interests of their bulky foreign debts, which are also a direct consequence of the strategies of the developed world and its transnational corporations to continue maintaining most of the countries of the planet in economic, financial, technological and cultural dependence.

However, as has already been stated in other works (Segrelles, 2001, 2002, 2004 and 2015), the achievement of a lasting balance between the needs of the population, the resources consumed and the environmental consequences of all this is not only a scientific-technical problem, but fundamentally a socio-political and ethical one.

The use of natural resources should be subject to moral and social justice requirements. The 1998 Nobel Laureate in Economics, Amartya Sen, argued that policies aimed at achieving sustainable development capable of ensuring ecological balance and the well-being of present and future societies should not be designed by the markets, as is often the case, but that the role of the public authorities in this matter should be decisive. Given that development (better, growth) and sustainability are incompatible in a capitalist system, the debate should be much broader and go beyond the one raised by this Indian economist and question the prevailing mode of production and its inherent logic.

Therefore, it is useless, because ineffective, to talk, write, give classes and lectures and worry about the destruction of ecosystems, the growing environmental pollution, the persistent poverty of underdeveloped countries or the cultural uprooting of peoples if we do not criticize the immanent logic that encourages the entire capitalist system, as a mode of production and as a culture, which is very similar to what happens in southern Mexico (Niño-Gutiérrez, *et al.*, 2022).

Given that large landowners have a strong influence on public policies, or are represented in them, and consequently benefit from very low taxes, it is necessary to consider the possibility of ceding the logistics and design of tax collection to the central administration. It would also be advisable to set up a central government oversight mechanism, thus consolidating a cadastral information system so that those who have more pay more and, at the same time, make the land market supply more flexible.

In order to deepen democracy in rural areas and reduce the existing gap between the different regions of the country, agrarian reform policies and access to rural property, as assumed by the land restitution policy, should have the spatial dimension as a priority parameter. It is well known that there are regional centers with higher rates of property concentration due to reasons of domination and speculation. It would be convenient, then, to study the possibility of giving priority to these areas to apply public policies where gender should be heard and allow support in concrete actions for peace (Myrntinen & Castañeda, 2022).

This same author argues that the Colombian rural environment has been the scene of a long conflict based on a serious injustice: land dispossession. Land restitution policies, as well as technical and financial assistance for victims, should have greater importance in public policy. Apart from representing a social and political debt owed by the Colombian State and the armed actors (guerrillas, paramilitaries, drug traffickers), this would be an unbeatable opportunity to boost small and medium production. This would reactivate the agricultural sector and would not only formalize the tenure of land that has been dispossessed in order to leave it in the hands of the market.

It is to be hoped that the legal initiatives taken on land and its restitution as a result of the signing of the peace accords will not be the same as on previous occasions. Still fresh in the memory are those legislative measures of the government of former President Álvaro Uribe that ultimately made it possible to legalize the usurpation of land by paramilitary groups and to allocate state funds to finance productive projects on these lands. Many of these properties are now in the hands of individuals who exploit them economically. Likewise, Álvaro Uribe's agrarian policies consolidate in some way the dispossession of land ownership from peasants. State financing has been used as an instrument for this purpose under the argument of strengthening agro-industrial production.

This in fact prevents the restitution of their land to the victims of usurpation. Uribe's legal initiatives are framed within the National Development Plan (2002-2006), which was later extended to the 2007-2010 period and which privileges what it considers to be primary agricultural products, i.e., those corresponding to crops that require large capital and are of late yield, as indicated by Bersarión Gómez Hernández (2011).

It can be said that in Colombia there has been more territory than State. The lack of regulations has created the ideal conditions for the rural conflict with its two components: agrarian and armed. The protagonists of the first are the peasants with their struggle for land (among themselves and with landowners and investors), for welfare and for political inclusion. The protagonists of the second have been the guerrillas, paramilitaries and drug traffickers, who want to control the territories, corridors and population. To overcome the rural conflict, the UNDP proposes another controversial point: "more State in society and less market in the State" (UNDP, 2011).

Since the market has not promoted rural development, it is imperative that the State intervene for the benefit of the rural milieu and Colombian society as a whole.

For these reasons, it is urgent to organize a comprehensive land policy. Restitution and formalization are a very important part, but it is necessary to go further, towards a policy that dares to intervene in the agrarian structure and modify the high inequality in land ownership. This includes, of course, the implementation of water and environmental policies. Land speculation must also be eliminated, to stop having agrarian properties simply to increase their value, without making them produce efficiently and profitably.

In the words of Viviana Ayd e Vargas Rivera (2007), the clearest demands of peasant organizations in Colombia are the following: redistribute the latifundia, close the agricultural frontier, give a technical use to the soil, relocate settlers settled in fragile areas, put an end to illicit crops, encourage and protect the peasant and agricultural economy in accordance with the interests of the nation, achieve a clean production of chemical products and increase the social and business organization of rural communities to achieve true participation, demanding together with all this a political solution to the armed conflict and respect for all their constitutional rights.

The peasants also demand the establishment of hundreds of so-called Peasant Reserve Zones (ZRC), areas of colonization in which peasant economies are encouraged and stabilized in order to control the expansion of the agricultural frontier and achieve greater participation of rural communities. It should not be forgotten that when agriculture is barely able to survive, the agricultural frontier expands, occupying environmentally fragile areas for agriculture and extensive livestock raising and with a high risk of natural disasters, as has occurred in other latitudes such as Mexico (Ni o-Guti rrez, *et al.*, 2011).

For their part, the powerful elites have fought against the tax on land ownership through their influence on municipal authorities. A dialectical relationship arises in which, through a social and armed conflict that has lasted for more than fifty years, the elite defend their economic and political power by putting at risk the fundamental economic, social, cultural and environmental rights of the peasants.

The State should expropriate those unproductive lands, alleging their misuse, as this harms the common good, society as a whole. The question is whether Colombia is willing to do so. Or rather, the more accurate question would be to know if the traditional powers that be are going to allow Colombia to do so. The new Victims and Land Restitution Law is limited and rather incomplete and, in addition, it does not seem easy for the State to have the capacity to respond to the demands of its actual implementation, among other reasons because some political parties and part of the Colombian society are reluctant to accept a profound change in the agricultural structure, to alter what they call the right to legitimate ownership of land or a significant increase in the taxes that large landowners would have to pay. This is proven in the document Bases for a National Peace Accord presented on October 12, 2016 by the Democratic Center, conservative and liberal party of former President  lvaro Uribe.

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Chapter 4 The bioeconomic approach for the management of public policies against climate changes in the agricultural sector

Capítulo 4 Enfoque bioeconómico para la gestión de políticas públicas frente al cambio climático en el sector agrícola

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Abstract

The contemporary market is based on an economic system whose objective is economic growth as an indicator of well-being, however, it has been shown to fail for achieving the satisfaction of the most basic needs of the human population. Present study describes the historical conception of the causes that originated the ecological economy, as well as the social motivations that led to considering it as a sustainable development alternative based on the understanding and application of energy, flows from the perspective of the laws of thermodynamics that saw their conception in sciences such as physics and chemistry. This approach to economic development based on the understanding of the need to value natural resources and the environmental effects of the economic process represents the evolution of the assumptions established by contemporary neoclassical economics. Along with the main objectives of traditional economy of satisfying human needs, present study shows the bioeconomy as an alternative to study the satisfaction of both economic and environmental objectives for a sustainable agricultural and livestock production.

Bioeconomy, Agriculture practices, Sustainability

Introduction

The economy is assumed by a group of individuals under different undergrounds looking for the satisfaction of a human need, for this reason, among its outstanding characteristics is that it is a component of a socio and political facts, by the opposite environmental characteristics cannot be studied into the social sciences. If the needs were not existing or the ways for satisfying the needs were limited or unlimited, then the economy would lack in consistency, since it would only might solve phenomena with un-lacking resources, then, economy would not solve dilemmas between the consumption agents.

As a science, the economy includes specific research methods to understand and explain part of the components of the systems to promote a favorable social development that can be modified by economic factors. However, since from the capitalist point of view, the existence of living species are the promoters and the reasons of the economy phenomena, therefore the accumulation of wealth is part of the primordial purpose of the production. In fact, for the capitalism, the plural concentration of wealth and the satisfaction of the the needs derived from economic models can be possible by the joining of the science and technology to reach the accumulation and satisfaction objectives, without any comprehension or consideration for the natural resources used to maintain the production (Barberá, 2007).

Despite of the releasing of the greenhouse gases (GHG), the increment of the temperatures, the changes of the precipitation reduce the potential availability and yield of crops (Medina-Cuéllar *et al.*, 2018a, 2018b; Ibarola-Rivas *et al.*, 2019) attempts against the security of living species. Then the production focused exclusively in generate and satisfy novel needs, and in the wealth, accumulation proposed by the actual economy is not sustainable. Then, considering factors as the efficient usage of the resources will play a fundamental role in the future economical development.

The bioeconomy emerges as an alternative to satisfy both economic and environmental objectives for a sustainable agricultural and livestock production (Medina-Cuéllar *et al.*, 2021). The priority of the bioeconomy should be the economic growth of traditional and novel industries based on the natural resources availability, through the creation of value chains that would increase the value-added of market products.

Since the objective of the bioeconomy is the insertion of the economical activities in the natural and human ecosystems, and their long-time sustainability, models applied to agronomical activities have been derived to obtain present effect-causes associations that can be holistically explained by the variables that affect the yields (Goudrian and Van Laar, 1994; Van Straten, 1999; Van Straten, 2008) and to generate short and long-time predictions under different environmental sceneries (Jones and Kiniry, 1986; Medina-Cuéllar *et al.*, 2014, 2018, 2021). Some agricultural products and yields can be used as bioeconomic indexes, therefore bioeconomic models have been derived to associate the yields with the availability of the environmental resources (Medina-Cuéllar *et al.*, 2018a, b, 2021).

Present study describes the historical conception of the causes that originated the ecological economy, and the bioeconomy, as well as the social motivations that led to considering it as a sustainable development alternative based on the understanding and application of energy, flows from the perspective of the laws of thermodynamics that saw their conception in sciences such as physics and chemistry.

References for acronyms and abbreviations

BLUES	Best Unbiased Estimators
BLUPS	Best Unbiased Predictors
CO ₂	Carbon dioxide
CH ₄	Methane
GHG	Greenhouse gases
H	Hydrogen
N	Nitrogen
NDF	Neutral Detergent Fiber
SUCROS	Simple and Universal Crop Growth Simulator
USA	United States of America

1. Economy as a science

The economy is a science, although it comes from an empirical law, implies facts that size into a theory and that can be applied on the specific methodology made for the economic research (Tamayo, 2004). The possibility of an holistic the understanding of the economic phenomena among the present and past observed variables, requires of the selection of a sample of events from a considerable number of possible events that should be significant for the established theory, the selected observations most be according to concepts that depend on hypotheses and follow the scientific method. The experimental sciences can be isolated to the components of a system, to explain reality from them, however, is difficulty the isolation of the components, due to the process of socialization through every social phenomenon generate a biological and economic dependence, then, some social phenomena are part of economic science.

The application of economics as a science, as part of a whole, can promote a favorable socioeconomic development, when the mixture of these two groups are included in a cooperative process. On the other hand, triggering a disruptive investigation between the science and the distinctive patterns of the economy, coupled with the obligation of reach the satisfaction of needs, would make a difference from the studies that takes into account the practical and the mobile of the human's activities based in an economic that depend of the origin of new social needs and their relation with the social well-being (Ávila, 2004).

When science is reinforced with research, the resulting development generates a proportion of wealth that can origin a dispute between economic agents monitored by the economy (Vienney, 1983). The approaches and research provided when the economy and the science are separated might release many important factors without an appropriate analysis, then science should be a system immersed inside the economy.

Additionally, public policies have resulting from the study of economic factors that have been broadly attributed and immersed in finances and the activities of the civil services. Analysis from an economic point of view is also viable, on issues such as organized crime (Friedman, 2007), the educational system, the legal framework, public choice, religion (Laurence, 1998), and science.

The problems of intentionality in the study of the behavior of economic agents are the emergence of new parameters that show the complexity of identifying frequent consumption patterns and their choice alternatives in the nature of the economy. The rhythm is gradually marked by the spatial configuration of the economy and the blocks between nations, and by the interrelations among the novel communication relations, and economic, environmental, social, and cultural factors (Dabat, 1998).

This rhythm falls on assumptions of compulsive consumption patterns and production systems that neither considers the prevention or long-range proposals, nor approach a wide range of activities which might allow to all species to maintain a dignified life. Associated with the consumption characteristics that now tend about a capitalist system, it is necessary to create remarkable alternatives that consider a perspective natural and friendly with the environment, without negative effects on the factors involved in production and future incomes.

Despite of the current modification of the exchange mechanisms and what is intended to be offered in a market, there have been diverse cultures that mean to be in total dependence with the environment.

2. The origin of the bioeconomy

Despite of the identification of diverse economic orders that have derived from an exhaustive socioeconomic research which could help to increase the social and academic development, there are many Universities and Institutions with the proposal of include the bioeconomy as a research field (Fairlie, 2017).

Bioeconomy was described by the European Commission (2011) as the integration of the production paradigms that depend on biological processes and with natural ecosystems, use of natural inputs, that could have required the minimum energy and wastes. Nowadays, economy considers that the inputs of processes can be reused in the ecosystem towards a sustainable development (Georgescu-Roegen, 2003). The current ideology of sustainability in economy is directed by some economists who have adverse opinions of the neoliberal approaches, since it must be interpreted in a way that is immersed in the capitalist system.

The bioeconomy also analyzes the topics inherent to capitalism, accordingly, there is an assumption of the errors in neoclassical economics, since a rational management of ecosystems sometimes in not considered in classical economy. In this scenario, it is necessary carrying out economic activities concerning that could reduce the negative environmental impacts with the emphasis of offering services to human-beings and promoting the development of the community.

The neoliberal economy is conceived like the actions the carried out to mechanize and rationalize the regulation of the production processes considering the environment, despite of the preeminence of financial power, to reach it, the system becomes in the creator but also participates in its historical conditions to allow its spatio-temporal existence (Aglietta, 1999). The neoliberal approach is born from the interest in sustainability whose methods are validated by public policies. Since 1972, the land has been considered as a natural resource that should be rationalized utilized, and based on contemporary approaches, land is part of the metabolism of cities, and their anabolism and catabolism, before land was considered as a human property (Hodgson, 1995).

Economic ecology represents scientific models of sustainable management and the valuation of the unsustainable, integrated by comprehensive and inclusive production models that consider environmental and social variables. Therefore, environmental economics focus on study of the preservation of the natural resources, including many analytical tools to help finding the economic decisions with minimum negative impact on the environment. Considering that environment is a provider of ecological and natural resources, and services, this kind of economy should work with other sciences, looking forward a transdisciplinary research field (Carpintero, 2005).

The bioeconomic particularity depend on other economy branches, as the ecological economy needs the environmental economy concepts. Therefore, bioeconomy is supported by the governments and citizens, research organizations, academics, and companies whose integral participation might achieve a sustainable development. Optimal management of the bioeconomic indicators would support the solidification of innovation systems (Pavone, 2012).

3. Bioeconomic imperatives and governmental role

To obtain novel markets and boost the economic growth, the bioeconomy considers as priorities: 1) the facilitation of bio inventions developed through multidisciplinary research; 2) the development of rules and laws focused on reducing obstacles; 3) the speeding up in the regulation processes; and 4) the reduction of environmental costs and risks to human health. In addition, bioeconomy identifies and promotes the opportunities for the development of alliances between public and private sectors, where competitors contribute with resources, knowledges, and experience to reach successes and/or failures.

Consequently, the multisectoral sector can be improved, considering agriculture, the health sector, the obtention of energy, the environmental impacts, and the public administration (Maxon and Robinson, 2012). As an example, the inclusion of biological materials can be sustainable substitutes of prime materials, specially of hydrocarbons applied in industries and manufacturing processes. Then, innovation is necessary to obtain an sustainable growing and to generate novel economic opportunities, and public policies should include it to promote the productivity, novel markets, and strategies that might reduce the social and environmental negative impacts (Reinoso, 2017).

The foregoing intervenes in the way of governing societies, in addition, political concerns are attributed to it, meanwhile transitions are reinforced by acts and promulgations provided by government regulations and public policies. This is defined by Hecló and Wildasvsky (1974) as the government action directed to obtain external objectives, then, government systems are legitimately legal in proportion to the opportunities and social benefits that they achieve for the population (Reyes, 2007). However, many public policies generated under empirical and pragmatismal concepts to support the governmental actions have been mobilized and instrumentalized to benefit the pluralist ideas, neo Marxists and neo corporativists (Muller, 2004).

Although there is the interest of increase the environmental sustainability, the governmental actions seem to be so far from the bioeconomy principles. The governmental instruments are those promulgated by the Stockholm and Millennium Declarations that have been importantly contributed to the design of public policies with incentives to a pro-bio environmental management.

In the United States of America (USA) the public policies are oriented towards a bioeconomy based on agriculture to move away from energy dependence and reinforce the greener economy (Eaglesham, 2006). According to the Service of Economic Research (2000) public policies are the result of some agricultural policies based on the market, focused on the proportion of large payments to farmers as a compensatory measure between low purchase prices and high production costs, the technical mismanagement and the contamination of crops due to the penetration of polluting gases emitted by factories lacking gas emission control.

Before to implement any mitigation or change measure, it is important to consider the changes of the available economic indicators. For example, the "Big Mac" index, which works based on the theory of purchasing potential, and the idea that exchange rates should move towards an equal rate and weight through the different countries (The Economist, 2017), bioeconomy is based in the research of indicators is an starting point to find solutions.

In USA, the first main indicators were low prices and production costs and after their application both improved by 13%, in addition, the policy called "bioeconomic based on agricultural mass" had economic benefits in the formation of social capital and a greater profitability in the production space which derived in an increase of 14% in quality standards. North American government is interested in investment and created the «National Bioeconomy Blueprint», published in 2012 to reinforce its activities related to the bioeconomic and biological-based products (Maxton and Robinson, 2012).

Another latent example was presented in the middle of the year two thousand, entering the topic of conversation in European political spheres (European Commission, Staff Working Document on Innovating for Sustainable Growth, 2012). However, the foundations for the bioeconomic originated strategic objectives in the European Commission that highlighted the non-physical investments but based on knowledge and the role of biotechnology in the innovation and development (European Commission, 1993).

Nowadays, the bioeconomic technology platform (2011) shows that the bioeconomy has a market size of more than 2 trillion euros and offers 22 million jobs in various sectors, including agriculture, forestry, food chemicals, and bioenergy, and it is attributed to a optimal government management and successful proposal of public policies.

A proposal for the retribution of the land that has been transformed to promote the reduction of damage of it, the novel vision is that land can make a friendly contribution to satisfy the need of production of a service and/or a material good. The centralization of bioeconomic objectives with the greatest boom is being presented with the initiative of biorefineries to produce biofuels (Jong, 2013) whose might solve the problem of the increasing of fossil resources prices, the uncertain availability of those, and the environmental damages derived from GHG emissions, considering that the manufacture of biofuels implies the substitution of petroleum by biomasses as a raw material to produce chemicals and fuels (Cherubini, 2010).

China and its model of four bioindustries, and its forecast of a transition towards the bioeconomy through the development of biofuel, biohydrogen, among others, is an example of the interesting option of the technological driving force for the transformation of chemicals (Lee, 2016); similarly, Italy has a total of 12 biorefineries that employ 1,600 people directly for the creation of biomolecules and biomaterials (Philp, 2012).

In terms of a development perspective, it is a challenge to join the environmental with the policies issues, and the union of both represents the necessity of the joint work among researchers and members of the public function, and there are some theories that look forward the best environmental performance.

Apart from the bioeconomy variables and foreign countries' advances, bioeconomy actions should affect the socioeconomic development, since to reach an effective change of any economic process it is necessary the supporting dynamics contributed by primarily and secondary actors along the value chains and socio-political contexts. Organisms with a bioeconomic approach must promote the biological-based and circular economy that requires the construction of new value chains involved in the production process, and in consequence novel alliances among participants are required. In addition, the development of novel networks is important. Consumers also play a very important role at the moment of decision, as they try to avoid perceived risks or limitations of products and materials, then it should be honest advertisements about the implications of an circular base economy (Venkata *et al.*, 2016).

Mexico has had approaches for a bioeconomy approach, since in economy the energy pattern is defined by the type of sources of energy mostly used in processes, and in Mexico as in other countries the energy pattern is primarily from fossil energy, although it is looking forward the development of solar, wind, and geothermal sources of energy.

4. Environmental policies

The state government can be a tool to reach bioeconomic objectives since it can contribute to the creation of effective policies. There are environmental policies, that aware or not of environmental responsibility, are promoted by institutions look forward the environmental preservation and care. However, the development of environmental policies falls during their design since the scientific research is not always useful for their development. Then, it is necessary to translocate the scientific reports and the abundant information in a minimum useful parameters and derived conclusions.

An effective environmental policy requires to integrate sectoral policies, by knowing the relationship among the environmental conditions and the pressure of its exploitation promoted by the sectors; the environmental conditions most be evaluated by either the usage of natural resources and the polluting emissions.

Environmental policies in the different countries have tended to gradually increase the supply of renewable energy, for example, in 2008, European Union make a long-term projection to reach in 2020, the substitution of the 20% of its energy supplies with renewables sources, and reduce the GHG emissions (Clean, 2008).

In addition to the policy-action implementation proposal, the bioeconomic approach represents a challenge, intended to be carried out in a sustainable scenario: satisfying the needs of the present without compromising the ability of future generations to satisfy their own needs (Moreno, 2007; Martínez and Roca, 2013). Sustainability is a long-term principle and with a wide range of management strategies to allow the human-being ensure both the present and future survival. In the globalizing context, the sustainable principles are the emerging limits and the reorientation of the civilizational process of humanity, thus as a normative criterion for the reconstruction of economic order as a condition for human survival (Leff, 1998).

Management systems should continuously change to allow them to be productive and self-sufficient, without losing their functionality, they would complement to policies that promote the increasing of yields, innovation, and new markets while include strategies to reduce the negative social and environmental effects (Reinoso, 2017).

The combination of policies and their commitment to current environmental challenges may be attracted to generate educational organizations that could join efforts to perform projects and develop strategies to reduce the global future concerns by the application of precautionary measures to mitigate the impact of ecosystems. The integrated public policies to actions would bring novel production paradigms and the organization of systems that consider the dynamics of the biological cycles to promote an integrated economic dynamics with the primary sector (Medina-Cuéllar and Portillo, 2017).

5. Development of bioeconomy

The application of bioeconomy as a model to overcome the economic paradigms most be useful for the environmental conservation and the fulfillment of global coverage, despite the wide range of primary activities that take place in the environment. In this sense, the primarily objective is the rational usage and exploitation of the biomass and obtention of wealth from the earth resources, as the millions of plants, animals, and microorganisms species, the genetical diversity, and the intricate interactions that constitute the ecosystems that build the environment affected by the resources abundance, rates of production, habitat productivity, climate variability, spatio-temporal adaptations, evolutionary history, etc.

6. Bioeconomy under a scenery of climatic changes

In addition to the high rates of deforestation and the loss of hydrological services of ecosystems, the abatement of the water availability is considered one of the most important environmental challenges intended to be solved with the novel approach of bioeconomy (Manson, 2004). In the hydrological sector itself, proposals aimed at economic optics are already emerging, marine plants that generally live on rocks or other hard substrates in coastal areas called algae, have received much interest and attention in applications related to energy, food, biosensors, and pharmaceutical applications (Venkatesan *et al.*, 2016).

Earth planet has important differences of the concentration of gases in the atmosphere: Oxidizing (oxygen (O₂), carbon dioxide (CO₂)), reducing (methane (CH₄), hydrogen (H)), and inert (nitrogen (N)) that allow the life. These gases are into the atmosphere, primarily composed by nitrogen (78.3%), but balanced with other gases present in smaller quantities. On other planets, these gases concentrations vary and reduce the probability to the support life, additionally not all planets have an atmosphere to regulate the internal temperature to support the life (Newell *et al.*, 1975).

The greenhouse effect is due to an unbalance of those gases, the reduction of some of them allow a greater solar radiation that penetrates the surface of the planet (although part of the infrared radiation is absorbed and remitted to outer space). Resources such as water, CO₂, CH₄, and nitrous oxide (NO₂) are natural components of the atmosphere, and the components manifest in gaseous form and have the property of absorbing part of the incoming radiation, however when those gases excessively increase, the radiation that escapes is less and the current temperature increases, the phenomenon that has occurred is called greenhouse gases (Rodhe, 1990).

Increasing the concentration of GHG increases the temperature of Earth and affects many biological processes. As an example, the greenhouse effect has altered the proportion of pollinators like the bee (*Apis mellifera*), bees' flight is linearly related to temperatures in the range of 14-22° C (Reyes and Cano, 2000).

Different comprehensive approaches of the climatological variation have been studied by authorities, but some of them do not consider the climatic changes as priority. For example, USA has withdrawn from the Paris agreement, minimizing the effects of climate changes considering it as Chinese's strategy to destabilize the global economy (El Financiero, 2017). The Intergovernmental Panel on Climate Change (2017) defined this thinking model as a "fantastic" misinterpreting of the statistics of the climate through the long periods. However, the environmental degradation, in part, is attributed to human activities.

Humans pollute and cause environmental changes because of the economic activities, and those are regulated and promoted by Institutions that lead decisions that damage the environment. This means that pollution is the cheapest way to solve a common practical problem: Satisfying a need of any type at any environmental cost. Therefore, individuals decide to produce and consume within a listed range of economic and social institutions (Field, 1997).

7. Modeling the climate changes and the bioeconomy

How climate changes affect the environment is sometimes undetectable and might have a favorable or unfavorable sensation depending on subjective criteria. The excessive CO₂ emissions mainly promoted by the combustion of fossil hydrocarbons and that increased since the beginning of the industrial period contribute to global warming. Although CH₄ emissions are less than CO₂, the CH₄ has more potential to global warm than CO₂.

Global warming not only refers to the temperature increasing but also to changes of other climatic variables that affect the life survival and the productive activities (for example: The precipitation, wind, radiation, and humidity) (Stainforth *et al.*, 2005).

The detection of the global warming is important to quantify the effects on the value chains, the production potential, or even on the obtention of the desired utilities. Global climate changes can negatively affect the production and the consumption patterns, and the monetary capacity to sustain the production. Environmental and economic costs are factors that increase over time and can decrease or increase production. However, the maximum potential warming promoted by anthropic activity is attributed to Industries, and the minimum to the agricultural and livestock sectors, and to the deficient management of wastes and by-products. The intention to seriously mitigate warming must begin with policies focused to reduce the burning of fossil fuels (Barros, 2005).

Agricultural systems encompass both agricultural production and marketing systems. They are rich in complexity and diversity. Generally, all systems include economic considerations. Understanding how such systems are structured and function requires the use of mathematical modelling frameworks that represent their key features. Models have been developed to investigate specific issues to reach different objectives as to relate causes and effects, to obtain novel hypothesis, to simulate or predict future trends, and even to control some systems.

Bioeconomy is supported by the modeling processes and can include both deterministic and stochastic models. Although, modeling is not performed exclusively by economists, explanations and economical applications of models that depending on climatic variables are useful to design both management strategies during the production processes and to obtain public policies.

Many models to associate environmental conditions with the productive potential have been developed and validated since 1980. Deterministic and dynamic models are directly applied to control theory which could be the special difference among traditional econometric models primarily based on statistics and deterministic and theoretical models (Van Straten, 2008). Many agricultural and bio-resource sciences work with models have been using to automatize some agricultural or biotechnological processes performed in greenhouses or bioreactors.

As an example of this kind of models applied to theory control and thereby useful for the automatization of processes, is the development of the Universal crop growth simulator (Simple and Universal Crop Growth Simulator (SUCROS)), generated around 1980 to relate the physiological process of plant's growth with the biomass yield: The model associates the CO₂ caption and respiration with the environmental fluctuations. This model have been evaluated and validated along the time, and although the prediction is not the main objective of SUCROS, it has been useful to understand the effects of the environmental on crop yields and to generate novel hypothesis (Goudrian and Van Laar, 1994).

Bioeconomy is primarily supported by models to predict the potential effects of climate change on crop yields requires models that relate the weather and crop yields. Statistical models belong to stochastic group, with a diverse modeling tools as time of series, linear models (applied to continuous or/and discrete variables), non-linear models (orthogonal polynomial, non-linear regressions), etc., additionally, stochastic models can integrate random and/or fixed effects variables to obtain best unbiased estimators (BLUES) or even best unbiased predictors that consider different spatio-temporal evaluations (BLUPS). Therefore, stochastic models allow to reach some control on production systems since they can have enough accuracy to relate climate changes with production fluctuations, and therefore to simulate and predict future responses under different climatic sceneries. although this kind of models are not necessarily useful to automatize can allow the optimal decisions around investments and incomes and might be useful to design novel public policies around the environmental conservation and exploitation.

CERES-Maize model was generated in 1986 by Jones and Kiniry and have represented a useful to predict maize future yields, predict even in crops evaluated in different times or spaces. The model was performed using different methods: 1) Single model of time-series; 2) Single model using panel data; 3) single model using cross-section site average weather and yield data. CERES-Maize model has been evaluated and validated in different space and temporal environments (Jones and Kiniry, 1986; Hodges *et al.*, 1987; Tojo *et al.*, 2007), finding that future maize yields are primarily affected by temperature and precipitation changes ($R^2= 0.54$ to 0.69) (Lobell and Burke, 2010). Lobell and Burke (2010), applied CERES-maize model to simulate crop yields under the future scenery - if temperature increased 2° C and precipitation reduced 20%- produced by global warm. Although statistical models have limits, models are useful to take correct decisions.

Applying this modeling tools and considering the honey production as a possible index of the natural resources availability, Medina-Cuéllar *et al.* (2014; 2018a) also used different modeling tools to relate the honey bee production with the climate changes in a semi-arid region of Central-North Mexico. Honey bee yield data from 2000 to 2014 were included to obtain Cobb-Douglas models, best model showed a relation among environmental factors and honey bee yield of 70% ($R^2= 0.70$), and showed that the conservation of natural scrubs, traditional systems of agriculture and the minimum temperature primarily affected the yield. On the other hand, two future sceneries considering the increases from 0.6 to 2.5° C of the minimum temperature would considerably negative affect the honey-bee yield, even if precipitation would not change. Additionally, that study shows how honey-bee yield could be a bioeconomic index to assign a monetary value to natural resources conservation.

Although, it is not well known in agro-modeling if linearization followed by evaluation of eigenvalues and eigenvectors of the system matrix is useful to obtain dominant time constants and dominant directions in state space, and offers opportunities for science-based model reduction. The continuous state space description is also useful in deriving truly equivalent discrete time models, and clearly shows that parameters obtained with discrete models must be interpreted with care when transferred to another model code environment (Van Straten, 2008).

Medina-Cuéllar *et al.*, (2018b), also obtained deterministic models to relate environmental variables with honey-bee production. Multifractal Detrended Fluctuation Analysis (MDF) can be an alternative to identify correlations in time series. The derived models showed that it is possible to make long-term predictions for honey-bee production that firstly depend on the climate classification, and secondly of the land usage; derived results could be design novel sustainable management strategies. This information could be useful to generate public policies about the usage of fertilizers and about the wild flora, forests, and scrubs conservation (Wratten *et al.*, 2012; Benelli *et al.*, 2014).

To protect ecosystems it is necessary to quantify the impact of productive activities and planning strategies to maintain or restore the natural covers (Menz *et al.*, 2011; Wratten *et al.*, 2012; Benelli *et al.*, 2014). Deforestation and intensive production contribute to global greenhouse gases emission, to desertification process, soil impoverishment, and negative impact the water quality (Menz *et al.*, 2011; Wratten *et al.*, 2012). Consequently, the modeling of honey production can associate climatic changes, availability of predominant nectar sources, and the phenological development of the bees (Lobell and Burke, 2010; Zoccali *et al.*, 2017), and calculate these environmental services in local incomes.

Control plays an important part in agricultural and bio-systems-engineering, but practical control options are restricted to alleviating growth limiting conditions, rather than true crop control. Then, the most important to reduce the uncertainty (Van Straten, 2008). Even, other statistical tools, as the orthogonal polynomial (trend analysis models) analysis allow to obtain the inflection points to optimize the resources invested in production and reduce the pollution of the fertilizers usage in agricultural practices or grain inclusion in livestock (Portillo-Vázquez *et al.*, 2014; Tirado-Estrada *et al.*, 2020). Tendency models are useful to describe dose–response phenomena; in biological processes, quadratic and cubic models can find the inflection points of optimal values and discriminate between the sub or over-doses (Medina-Cuéllar *et al.*, 2021).

For example, the excessive application of N fertilizer has negative effects on crops, greatly reduces N-use efficiency, and causes significant nitrate leaching losses, contributing to GHG since it is the major source of N₂O (Martins *et al.*, 2015). Therefore, N must be applied at rates that satisfy both economic and environmental objectives and is critical for sustainable agriculture (Zhou *et al.*, 2014).

8. Activities related to the agricultural sector

Agricultural activities belonging to the primary sector comprise a set of actions that transform the natural environment, to make it more suitable for the growth of crops. Its beginning originates in the Neolithic period, when the economy evolved from harvesting to livestock, thus allowing greater availability of food and a field with the characteristics to be manipulated again to be able to improve the technique and seek care. of his environment; It is one of the pillars when talking conceptually about self-sufficiency (Saez, 2009).

The primary sector includes almost exclusively extractive productive activity, which is why it is also called the extractive sector. It covers the activities that mean extraction from nature, without more transformations than those carried out by it. Activities related to agriculture, livestock, forestry, hunting, fishing, and mining are included in this sector. This sector has been characterized by its average progress. Primarily conditioned by the land factor; It is made up of the natural resources provided by nature in fixed amounts, hence it is also known as the nature factor, which cannot be increased or consumed (Barsky, 2001). Broadening the concept, it is the set of elements that nature makes available to man, soil, air, light, etc. The agricultural sector itself, in its combination of factors of production, is called the primary factor; since its supply is decisively isolated from the economic system itself.

The agricultural sector has remarkable characteristics that generate an inclusion, concerning the other productive sectors, that is, those of transformation and the tertiary sector. Although the agricultural essence, distinguishes the extraction work, there is another correlation, and it is the proportionality of essential foods for the subsistence of the species, and its permission for the development of vegetable crops, among others.

9. Designing sustainable management alternatives for the agricultural sector

The third sector is distinguished by the proportionality of urban, industrial, and recreational services (Ruoco, 2002) that could promote the land preservation culture. David McGrath (2012) mentioned that the energy used for the agriculture should be quantified by including within the incomes the human work, and the impact on primary or secondary ecosystems that are damaged to increase the spaces for crops and livestock.

Agriculture is complicit in a large part of carbon dioxide emissions, through deforestation and biomass burning, and also through the burning of fuels of non-renewable origin in the development of these activities, as mentioned before, human beings can modify and find alternatives to improve production or be more efficient, but nothing makes sense if it is not done under a scheme of joint responsibility between producers and the economic and political systems that govern them, without their intervention in the responsible production, it is impossible to improve the state of the ecosystem.

Modern agriculture systems are very intensive in the usage of fossil fuels, since tilling the land would present complications if there was no option for better performance of the crop with previous land preparation. Bioeconomy integrates the agricultural knowledge (quantifying the effects of the overexploitation of natural resources and their regenerative potential) to develop the technology capable of facing the environmental challenges. Although, most GHG emissions are released by transports, industries, and natural phenomena, the contribution of the GHG emissions by agriculture and livestock activities must be analyzed and reduced. Grains used for human and animal feed is that the agricultural processes to produce large volumes of grain such as deforestation, land preparation, and fertilizer application contribute high volumes of greenhouse gases emissions (Beauchemin *et al.*, 2008; Knapp *et al.*, 2014).

Crops and livestock production can be optimized to reduce their environmental impact by improving their systems' efficiency, but researchers, producers, economists, and political systems responsibility of generating and applying optimal production methods.

Emissions of gases from livestock sector contribute to global environmental greenhouse gases. Livestock contribute 18% of global anthropogenic greenhouse gas emissions (FAO, 2006). When broken down to individual gases, livestock contribute 1.35%, 15%, and 19% of total CO₂, N₂O, and CH₄ anthropogenic emissions, respectively (Knapp *et al.*, 2014). Ruminants reared on tropical pastures contribute the most enteric methane emissions due to the lower quality of feed and the longer time it takes for these animals to reach slaughter weight.

The composition of fermentable fraction in ruminal environment can affect not only the livestock production but also the environmental impact because of the GHG emissions attributed to meat and milk production. The proportion of soluble carbohydrates can improve the milk yield (Miller *et al.*, 1999) since it affects the ruminal ecosystem, the fiber degradability, and the amino acids absorbed in small bowel of ruminants (Lee *et al.*, 2012). Additionally, the proportion of soluble carbohydrates and structural carbohydrates (quantified as Neutral Detergent Fiber (NDF)) affect the fermentation kinetics and the amount of methane produced in ruminal that would contribute to GHG emissions. Then, strategies to mitigate enteric CH₄ production include increasing the quality of ruminant diets through the increasing of grains proportion in ruminant diets (Beauchemin *et al.*, 2008).

Increasing the grain and stover individual yields and quality, and on the other side, the improvement of the starch:cell wall (neutral detergent fiber (NDF)) ratio of whole maize plants would be an alternative to use higher amounts of forage in ruminant diets (Khan *et al.*, 2015; Tirado-Estrada *et al.*, 2018). World food security depends on reaching crop and livestock-feeding efficiency. Improving the forage yield and quality is an alternative to reduce the costs of livestock feedstuffs' environmental and economic costs (Oba and Allen, 1999; 2000a, b).

An alternative is the usage of agricultural by-products to feed ruminants that might reduce economic and environmental costs (Liang *et al.*, 2015; Tirado-Estrada *et al.*, 2018, 2021). Most grains used in animal diets can also be directly used by humans as food thus creating competition between man and animals, raising demand for grains on the world market and driving prices beyond the reach of the common man. Maximizing the forage and fibrous by-products in ruminant's nutrition could reduce the usage of grains for livestock production (Beauchemin *et al.*, 2008; Knapp *et al.*, 2014). In addition, it could reduce the oxidants of milk and meat (Lazalde *et al.*, 2021) and improve the animal welfare (Lee *et al.*, 2013; Saleem *et al.*, 2013).

Many biotechnological products that can be evaluated to improve the production and reduce the potential livestock-derived pollution (Tirado-Estrada *et al.*, 2016; Tirado-González *et al.*, 2018, 2021; Carrillo-Díaz *et al.*, 2022).

Knowing the real effects of climate changes is useful to develop solutions as reforestation, developing “clean” energy, improving energy production systems, investing resources to study and improve the ecosystems efficiency, etc., however, those solutions must be promoted by public policies. Deforestation, desertification, the abatement of available water, the reduction of flora and fauna diversity and therefore the genes diversity reduce the possible adaptation and survival of life in Earth (Márquez, 2015).

In Baja California Sur, Mexico, a study was conducted to relate the yield obtained from fishing and the climate, to find strategies to improve the natural resources sustainability, the results indicated that the fishing season can be reduced from eight to four months, that would contribute to a bioeconomic process for the marine species management (Canedo *et al.*, 1999), in addition to the initiation of the operation of eleven biofertilizer production centers, and so on. support the initiative to reduce greenhouse gases (Martínez and Roca, 2013). Despite the deterioration in natural ecosystems and the negative effects on the quality of life of both human beings and flora and fauna, in Mexico, the application of public policies had not been essential in the country, although there is already a comprehensive vision of restoration and in favor of bioeconomic management (Carabias *et al.*, 2007).

In addition to the importance of algae as food in its original form, its high carbohydrate content has promoted the industrial use of algae species as a source of hydrocolloids, such as alginate, microbiology, and medicine, as well as in the plastics industry (Khalil *et al.*, 2017). As for the fishing work, it has a double intervention on the bioeconomic on the one hand, it contributes to the emission of greenhouse gas produced by the use of fuels; and on the other, it modifies marine ecosystems, the basis of fishery resources, so that fishing could mitigate its carbon footprint by reducing its consumption of fossil fuels, and therefore its contribution to greenhouse gas emissions. Optimum fisheries management coupled with a bioeconomic approach is essential for maintaining lasting fisheries that limit catches of weakened and endangered species. For this reason, it is necessary to integrate appropriate mitigation measures to protect the environment systems and help to ensure the productive ecosystems under a scenery of climate changes (Perez, 2004).

Conclusions

The activities of human populations are immersed in the public function must visualize the range of options for social and economic development in favor of the governed sphere. Once there is prior knowledge about the indicators and the importance of each one of them, it is necessary to take active measures to reduce risk or increase a benefit.

A clear example is that in the bioeconomic situation, the order is inappropriate for a design methodology where the government initiative stands out, in this case, it was first the theoretical part and the superimposed concepts of other currents to generate a combined approach of the previous attributes. and to obtain resources with effective technical management so that similar conditions are maintained or away from the deplorable synthesized by scholars.

When the problem of climatological conditions emerges and it is emphasized that the first affected sector is agriculture, evidently due to its dependence on the environment, the bioeconomic fits perfectly with the presented context and it is the approach and the alternatives that appear as a possible agent. mitigating and that would benefit in the same way, that is, without trying to counteract any productive work (except those that generate environmental damage).

To maintain the praxis from generation to generation, it is for this and other remarkable facts that it must be taken into account for the creation of public policies in favor of this sector, without delimiting the others, but with a fundamental approach, as well Likewise, the measures that are taken into account to reduce environmental fluctuations will be another key and sustainable factor for activities of any kind, belonging to sectors other than agriculture. The tonality of preserving the means with which profits are obtained is the adaptive bioeconomic approach in public policies in the face of climate change in the agricultural sector.

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Chapter 5 Rurality and multifunctionality in the “El Veladero” National Park, Acapulco, Mexico

Capítulo 5 Ruralidad y multifuncionalidad en el Parque Nacional “El Veladero”, Acapulco, México

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Abstract

Multifunctionality and the new rurality explain a large part of the population, economic, social and environmental problems that are currently developing in emerging countries in Africa, Asia, Latin America and peri-urban areas of developed countries in Europe, Oceania and North America. Hence the importance of synthesizing the characteristics contemplated by the Sustainable Development Goals at a global level. In the case of the countries of the global south such as Mexico, and particularly the southern state of Guerrero, it is urgent to contribute with physical-geographical and economic-social information that allows decision-making by the current municipal management of Acapulco de Juárez, Guerrero, Mexico. The central objective was to elaborate the socioeconomic and environmental synthesis in three human settlements in the "El Veladero" National Park. The methodology is of a mixed nature since qualitative techniques were used at the beginning and later complemented with quantitative techniques of information collected in the field. The main results are: 1) population pillar is made up of 1,028 inhabitants grouped in three towns within the park 2) economic pillar focused on the development of economic activities such as agriculture, livestock, shearing and hunting; 3) social pillar the population has minimal basic municipal services as a result of the irregularity of the terrain 4) environmental pillar the deciduous forest vegetation of greatest scenic beauty is reduced to the core area of the "El Veladero" National Park. Conclusions: a) the rural multifunctionality is a modern strategy that allows options for the development of places and population that wishes to progress and b) an updated analysis of the population, economic, social and environmental variables was carried out where the multifunctionality and the new rurality are viable strategies for reorient the development of sites located in emerging countries.

Biodiversity, Geographical, Multifunctionality, Rurality, Tourism

1. Introduction

At the global level, the European school of thought coined the term "agrarian multifunctionality" in the 1990s and in parallel in Latin America the construct called "new rurality" was developed (Flores et. al., 2022). Within this context, in Mexico there is a bibliography published in printed and digital form on the characterization and application of these theoretical-methodological concepts by various authors (Niño-Gutiérrez & Segrelles, 2013); (Sandoval et. al., 2021).

In this order of ideas, rurality in the study area is approached by taking up and sustaining the conventional indicators of rurality such as: total population, economically active population, economically inactive population, the size of the locality, where primary activities play a fundamental role. All of the above refers to a complex analysis that allows linking rurality, multifunctionality and religious tourism, which is grounded in Praderas de Guadalupe, municipality of Acapulco, Guerrero, Mexico. This enclave is located in the upper part of "El Veladero" National Park, located in the north-central portion of Santa Lucía Bay (Castellanos et. al., 2021). This enclave is of interest because, according to Art. 44 of the General Law of Ecological Balance and Environmental Protection (LGEEPA), Natural Protected Areas (NPA) are areas of the national territory over which the Nation exercises sovereignty and jurisdiction, in which the original environments have not been significantly altered by human activity, or whose ecosystems and integral functions require preservation and restoration. Therefore, these would be subject to the regime established in the LGEEPA and other applicable regulations (CONANP, 2021a).

Another important aspect to highlight is the religious aspect, since the Catholic religion in Mexico was conceived after the conquest, which is why it would dictate the norms and values of the majority of Mexicans at the time. For its consolidation, the crown in charge of the country imposed Catholicism through war, economic and political power, this religion was the predominant one even after the independence of Mexico, which is confirmed by the Constitution of 1824, where it is indicated as the only one in the country, without tolerating any other, which limited the emergence of other religions or ideologies (Rosas, 2012). According to data from the last population and housing census conducted by INEGI in 2020, there was a decrease of five percentage points in those who claim to be Catholics, which went from 82.7 to 77.7 percent with respect to the 2010 census, so it can be said that Catholicism remains the predominant religion in the country (Rodriguez, 2022).

Table 1 History of the protection of National Parks in Mexico

Epoch or period of Mexican history	Event related to the history of the conservation of natural areas in Mexico.
Pre-Columbian Period	Botanical gardens and public parks created under the order of King Nezahualcoyotl of Texcoco (1402-1472).
Colonial Period	The Spanish Crown decreed laws in favor of the conservation of timber resources (1679).
Period after the Independence of Mexico	Benito Juárez established the first laws for the protection of Mexican flora and fauna, among them the Forestry Law (1870). The first natural area for conservation and public recreation, El Desierto de los Leones was decreed under the order of Lerdo de Tejada (1876) (SEMARNAT, 2018).
Porfiriato	Porfirio Díaz decreed the Monte Vedado del Mineral del Chico National Forest (1898).
Mexican Revolution and post-revolutionary period	The Department of Forests was created (1910). Venustiano Carranza decreed the Desierto de Los Leones as a National Park (1917). Guadalupe Island was decreed as a Reserved Zone for Hunting and Fishing of animal and plant species by Plutarco Elfas Calles (1928).
Government of Lázaro Cárdenas	During this period, Miguel Angel de Quevedo sponsored the creation of 39 National Parks (1935).
Government of Miguel de la Madrid (1982-1988)	The Secretariat of Urban Development and Ecology (SEDUE) and the National System of Natural Protected Areas (SINANP) were created. More than three million hectares of ecosystems were protected and the General Law for Ecological Balance and Environmental Protection (Ley General del Equilibrio Ecológico y la Protección del Ambiente, LGEEPA) was enacted (1988).
Government of Carlos Salinas de Gortari (1988-1994)	The National Commission for the Knowledge and Use of Biodiversity (CONABIO) was created. Ten Biosphere Reserves, two National Marine Parks and 11 other reserves were opened (1992).
Ernesto Zedillo Ponce de León (1994-2000)	During his term, the LGEEPA was amended to strengthen the National System of Natural Protected Areas (SINANP).
Vicente Fox Quesada (2000-2006)	The islands of La Pajarera, Cocinas, Mamut, Colorada, San Pedro, San Agustín, San Andrés and Negrita and the islets of Los Anegados, Novillas, Mosca and Submarino, located in Chamela Bay, Municipality of La Huerta, State of Jalisco, with an area of 1,981,439.2 ha, were declared a protected natural area (ANP) with the category of Sanctuary.
Felipe Calderón Hinojosa (2006-2012)	It declared the area known as Balandra in the state of Baja California Sur as an ANP with the category of Flora and Fauna Protection Area, given that it is a coastal wetland, making these ecosystems unique at the national level.
Enrique Peña Nieto (2012-2018)	Declared the Revillagigedo Archipelago as an ANP with the category of National Park on November 24, 2017, making it the largest in North America.
Andrés Manuel López Obrador (2018-2024)	On March 22, 2022, the Ecological Park of Lake Texcoco in the State of Mexico was declared a NPA with the category of Natural Resources Protection Area.

Source: Prepared by the authors based on CONANP, 2022.

To address the issue of protection of natural spaces in Mexico, it is important to know that it is a fairly broad topic historically speaking, since since the time of the Mesoamerican cultures there was already an awareness towards the care and preservation of natural spaces. This can be seen through some important cultures that were part of pre-Hispanic Mexico, such as the Maya and Mexica civilizations, which as part of their worldview incorporated the worship of nature and paid tribute to elements such as rain, the sun, plants and animals; many of these elements had a deity that the population associated with each one and were represented in different ways, such as in sculptures made from different materials, of which there are several vestiges today (González, 2001).

In pre-Hispanic Mexico, society was involved with nature, so much so that they venerated multiple aspects of it, since they felt part of it and not superior. From this period it is also known that the indigenous people took walks for recreational purposes in areas of natural spaces (Soto, 2016), it is even known that one of the rulers, King Nezahualcoyotl of Texcoco ordered several ahuehetes plantations in order to carry out recreational activities and landscape appreciation (Castañeda, 2006). Therefore, similar to what happened in the United States, the conservation of natural areas occurred through the search for recreational activities, at least in Mexico's pre-Hispanic era.

Officially, the government of Mexico starts from the 1996 law, regarding the Natural Protected Areas SEMARNAP (1996), where it seeks to promote the conservation of endemic species of the country along with the conservation of its ecosystems, so it is essential to promote environmental education so that each citizen acquires a responsible environmental behavior, together with the government participating with the private sector in matters of protection so that the NPAs can be managed based on specific and effective programs and management plans (Niño-Gutiérrez, 2017).

With the above, it is possible to glimpse the notable difference regarding the basis on which the NPAs were conceived, which initially sought only to conserve primary natural resources for their subsequent exploitation and use for recreation, and then to move towards something more complex such as a generalized environmental education of its population.

In the particular case of Mexico, the Secretariat of Tourism (SECTUR) defines rural tourism as "trips that are made with the purpose of witnessing activities of coexistence and interactions with rural communities, all the social, cultural and daily production expressions of the same". According to the Secretary of Tourism (SECTUR, 2002), activities that could be carried out in rural tourism include artisan workshops, mystical experiences, dialect learning, ethno-tourism, eco-archeology, agro-tourism, rural photography, gastronomic workshops, and preparation and use of traditional medicine.

As a result of the effects of COVID-19 in Mexico, several rating agencies have downgraded the annual growth forecast from 1 to 0.9%, while the economic contraction should be approximately 1.5%. In this sense, the Economic Commission for Latin America and the Caribbean estimates that the GDP will be close to 10% by the end of the year. At the national level, estimates were made by INEGI, where in 2019 there were 1.8 million companies under five years old. This newly created business sector was the most vulnerable during the pandemic (ECLAC, 2020). As a result of the aforementioned, there was a sharp drop in employment, especially in the industrial and services sector between March and April, in contrast to the agricultural sector, which showed resilience. For its part, the Bank of Mexico estimated that around 1.7 million official jobs would be lost by 2020 as a result of the pandemic in the country. The International Monetary Fund made a projection forecasting that Mexico will suffer a 10.5% drop in GDP, where 2 million formal jobs could be lost and up to 17 million informal jobs by 2020, according to Enoch Castellanos, president of the National Chamber of the Transformation Industry (Agencia Reforma, 25/06/2020), which would also have a negative impact on the tourism sector.

Within the National Park "El Veladero" there have been several attempts made by different municipal administrations to induce a religious eco-tourism, since this is not yet recognized by much of the population of Acapulco or by tourists, which is sought through the construction of a landmark similar to the Corcovado Christ in Brazil, which measures 38 meters high. For the particular case of the area under study, the monument to be built would be called "Cristo Rey de la Paz" (Christ King of Peace), which would be approximately 80 meters high, which would be of greater proportions with respect to the reference monument. This project would be located northwest of the park's western polygon, which is approximately 700 meters above sea level (INEGI, 2020c). There is information that the genesis of this project has been in consolidation since 2000 and is still being considered (Ramírez, 2021).

Table 2 Local fauna in danger of extinction

Common name	Scientific Name	Protection category
Boa	<i>Boa constrictor imperator</i>	Threatened
Garrobo	<i>Ctenosaura pectinata</i>	Threatened
Iguana verde	<i>Iguana iguana</i>	Special protection
Gavilán pescador	<i>Pandion haliaetus</i>	Out of risk
Escorpión	<i>Heloderma horridum</i>	Threatened
Cojolite	<i>Penelope purpurascens</i>	Threatened

Source: Mexican Official Standard NOM-059-SEMARNAT-2010.

The municipal presidency has sought to detonate a local tourism development in the community of Praderas de Guadalupe by taking up factors such as the rural landscape along with the climate, flora and fauna species, to promote an improvement in living conditions in this locality, parallel to the development of the municipality of Acapulco. Some authors that reinforce these ideas are Niño-Castillo & Niño-Castillo (2018) in Latin America, as well as Niño-Gutiérrez (2014 and 2020), CONANP (2021b) and Niño-Gutiérrez *et al* (2015) in Ibero-America.

The study is important because it offers: a) a synthesis of the population-environmental pillar and b) interrelates the economic-social pillar. This contributes to a current global vision of the socio-territorial, economic and environmental dynamics in the upper part of Acapulco Bay.

This is in order to lay the foundations for the formulation of concrete actions aimed at improving infrastructure and accessibility to the site under study, in addition to formulating in the medium term a religious tourism program specifically in Praderas de Guadalupe located in the northern polygon of the National Park. The added value of this study lies in the provision of updated statistical information so that the appropriate and pertinent municipal authorities have reliable information to make timely decisions regarding this geographic enclave.

The techniques on which the study was based included: i) conceptual mapping, ii) thematic mapping and iii) documentary research within the INEGI platform (Digital Map of Mexico, Mexico in Figures and DENUE). The above was complemented with field work where we resorted to: a) in-depth interview technique and b) participant observation. In order to contribute to fill the information gap, comprehensive information is provided in the hope that the managers on duty will have data, figures and evidence that will allow them to contribute to the preservation and care of the green lung located in the highest part of the city of Acapulco. The guiding question of the study was: what is the current situation of rurality and multifunctionality in El Veladero National Park? This document is integrated by the following sections: introduction, methodology, results, acknowledgements, conclusions and references.

2. Methodology

The methodology used was of a mixed nature, since qualitative techniques were used at the beginning and later complemented with quantitative techniques, through the information gathered in the field. In such a way that the qualitative technique applied during the documentary research involved the review of relevant publications in the form of articles, books and book chapters, in printed or digital format, so that after their compilation, they were read, analyzed and selected according to the variables under study, on topics related to: rurality, multifunctionality, tourism, geography, biodiversity. For this purpose, reference digital databases were consulted, such as: Latindex, Redalyc, SciELO, Google Scholar, among others, together with the consultation of printed thematic cartographic material and digital satellite images from INEGI, which are updated to 2021 on the area under study.

The use of quantitative variables enriched the case study, which was also complemented with field work carried out between April 22 and May 17, 2022, where we had the opportunity to interview nine key informants, who accompanied the authors on three tours of the area under study; six semi-structured interviews were also conducted, in which the use of the field logbook and participant observation was important. It was also possible to take 66 photographs showing the population, economic, social and environmental dimensions in order to establish the interrelation with the objectives of sustainable development from a local level with a global perspective.

During the fieldwork phase in the study area, we visited the three rural towns located within the "El Veladero" National Park, which are: Praderas de Guadalupe, Pueblo Nuevo, Pueblo Nuevo and El Veladero: Praderas de Guadalupe, Pueblo Nuevo and Vista Hermosa. A visit was made to each of the settlements within the study area, where a specific day was dedicated to each of the settlements listed above for a detailed reconnaissance tour. The first visit was carried out on April 22, 2022 in the town of Praderas de Guadalupe, in this place a tour was carried out and several evidences were collected from notes in a notebook, taking photographs and interviews with the help of three people who are inhabitants of the town, who collaborated voluntarily, in addition interviews were conducted to corroborate data obtained. The second visit was carried out on May 5, 2022 in Pueblo Nuevo, where evidence was collected with the help of photographs and interviews with two villagers. The third visit was carried out on May 17, 2022 in the town of Vista Hermosa and a survey of evidence was carried out in the same way, through photographs and interviews with the inhabitants of the town. The main objective was to prepare a socioeconomic and environmental synthesis of El Veladero National Park.

Conceptual framework, the author Arias (2006), who defines data collection techniques "as the set of procedures and methods used during the research process, with the purpose of obtaining information relevant to the objectives formulated in a research" (p. 376).

The data collection technique made possible: (a) documentation, through which the consultation of documentary databases in analog and digital format was carried out, in order to use the information obtained, by following a method to establish an order on the information obtained; b) observation, which was supported by field work, where data were collected through notes in a field notebook, to later be captured in tables, in addition to the collection of evidence in photographic format; c) conceptual mapping, where the "concept maps and diagrams" were taken up again, later in the Latin American context Tobón coined the term conceptual mapping.

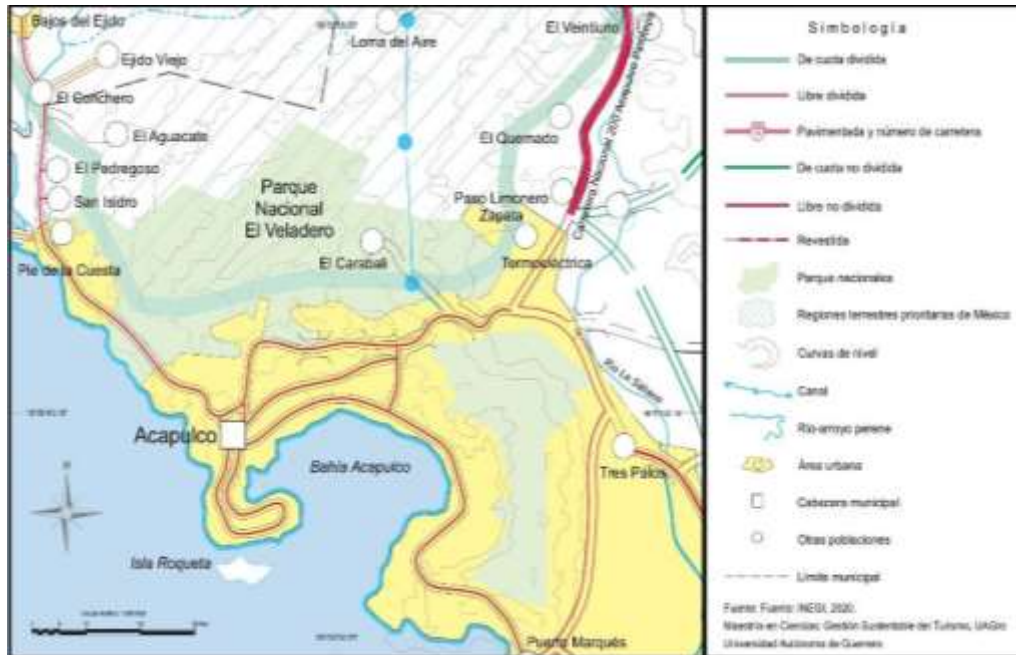
This is conceived as a methodological tool driven by socio-training (Niño, 2020). In Latin America, Sergio Tobón is considered the father of conceptual mapping since 1996. This technique was useful for the analysis and systematization of concepts such as what is intended to be done in this research. At the same time, it becomes a qualitative research strategy. According to Rodríguez (2020), "conceptual mapping seeks to systematize, organize, analyze, construct, communicate and learn concepts and theories, orienting the analysis from different perspectives within the research context" (p. 2).

In this sense, concept mapping can be useful to foster concepts and theories. This technique is made up of eight axes, which are: exemplification, notion, category, characterization, differentiation, subdivision, linkage and methodology, each of which is composed of specific questions that make it possible to systematize the information on a given topic (Tobón, 2013). Thus, concept mapping can work together with other tools, such as information and communication technologies. The use of this technique has become a novel and essential way to work with the challenges that new research scenarios may pose, to structure and systematize knowledge. This modern tool connects the complex relationships between concepts and helps to structure or improve the state of the art, analyzes the relationships of each definition between a single concept and at the same time analyzes the definitions individually and their relationship with others (Moreno & García, 2010) and d) Thematic mapping to characterize the research context graphically, which constitutes an instrument capable of being used to obtain real information of the study area at any time and place where it is required. These maps contain information on the environmental, social and economic characteristics of the study area.

Characterization of the study area, was carried out under what was proposed by Niño and Melo in the Niño Sociogeographic Model (MSNiño) for Natural Protected Areas of Mexico (1992-2014) with adaptations to achieve a tourism diagnosis of the study area in question (Niño, 2015). In this model, the guidelines are detailed step by step so that, in a manner attached to the structure of sustainable development, they are applied to comprehensively analyze the geographic enclave in which the research is developed through indicators: social, environmental and economic relevant to sustainable tourism analysis. Therefore, the indicators proposed by the aforementioned model and once applied to the case study, were detailed as follows: Geographic location of "El Veladero" National Park is located south of the municipality of Acapulco, divided into two polygons, one in the western part of the municipality and another of smaller dimensions, in the eastern part. This in turn, by its disposition of the National Commission of Natural Protected Areas (CONANP), is located in the physiographic region known as the Neovolcanic Axis also known as Sierra Volcanic Transversal, along with the Sierra Madre del Sur (CONANP, 2016).

El Veladero National Park is located between 99°49'28" and 99°56'58" west longitude and 16°49'03" and 16°54'51" north latitude with respect to Greenwich (Figure 1). The park's cartographic map was created by the National Institute of Statistics, Geography, and Informatics (INEGI) and is called "Acapulco" at a scale of 1:50,000.

Figure 1 Geographic location of "El Veladero" National Park



Source: INEGI, 2020c.

El Veladero National Park is located in the south of the state of Guerrero, within the territory that corresponds to the municipality of Acapulco (Avilez, 2014). It is distributed in two polygons, the western polygon has an area of 27 379 358 m², while the eastern polygon has an area of 8 785 584.39 m² (DOF, 2000). It was decreed as a National Park on July 22, 1980 under the following criteria: "It is the Federal Executive's authority to establish national parks for public use on lands that, because of their location, topographic configuration, exceptional beauty, scientific, educational or recreational value, or when they contribute to the improvement of the community's living conditions and well-being or contribute to tourism development; as well as to carry out the necessary works for their development and organization" (DOF, 1980).

The park under study is in a critical situation due to the growing problem of environmental contamination caused by burning garbage within the natural resource protection area. In addition, there is a severe problem of human encroachment that threatens the western polygon of "El Veladero" to disappear. The efforts of the agencies in charge of protecting the ANP have been insufficient to stop urban expansion. The vertical structure of the ANP includes the biotic and abiotic aspects, which are found within the environmental pillar of Sustainable Development (SD) to obtain more precise data for the research work (Niño-Gutiérrez, 2008).

The horizontal structure of the landscape that makes up "El Veladero" National Park is related to the social pillar that includes in situ characteristics of the population and economic characteristics, which are also part of the sustainable system and have to do with the balance of the municipality of Acapulco. The indicators were approached from a qualitative perspective based on what was originally proposed by the Modelo Sociogeográfico Niño (MSNiño) for Natural Protected Areas of Mexico (1992-2014). The characterization was carried out through pointed questions (see Table 3).

Table 3 Evaluation of indicators

Environmental		Social			Economics	
Fauna	Flora	Hydrology	Soils	Population	Infrastructure	Economic activities
Are there endemic, threatened or endangered species within the study area? How to take advantage of the existence of fauna for environmental-tourism education?	Are there endemic, threatened or endangered species? What is the relevance of the flora for tourism?	Are there any bodies of water within the study area? Does the study area have any hydrological significance within the municipality of Acapulco?	What is the importance of soils within the study area?	What is the ratio of EAP to EIP in the study area? What is the health affiliation situation? What is the education situation? What is the housing situation?	What is the infrastructure like within the study area? Are there basic services?	What are the economic activities within the study area? Do these activities generate any type of impact on "El Veladero"?

Source: Prepared by the Company

3. Results

The municipality of Acapulco has a total population of 600,000 inhabitants (INEGI, 2020a), which is directly linked to the social pillar of sustainable development, where the population tends to settle in steep slopes on cliffs, hills, hillsides and natural reserves, as in the case of "El Veladero", where there are three human settlements: Pueblo Nuevo, Vista Hermosa and Praderas de Guadalupe. According to INEGI, 68 Basic Geostatistical Areas (AGEBs) have been identified (INEGI, 2021), where there are 65 colonies with 1,028 inhabitants, of which 15 are located in Pueblo Nuevo, 532 in Vista Hermosa and 481 in Praderas de Guadalupe.

Pueblo Nuevo is a rural town located within the territory of El Veladero National Park, in the western polygon. It is located at longitude 99° 54' 47" west and latitude 16° 53' 24" north, with an altitude of 574 meters above sea level (masl). It is a hamlet town. The primary economic activities in the town include raising and exploiting livestock and agriculture, the main product of which is corn. Water is supplied through hoses and water is obtained by drilling artesian wells (Op. Cit., 2021).

Figure 2 Western polygon of El Veladero National Park.



Source: Niño-Castillo, et al., 2020

Praderas de Guadalupe is a rural town located within the territory that corresponds to "El Veladero" National Park, in the western polygon. It is located at the coordinates Greenwich West Longitude 99° 51' 51" and North Latitude 16° 53' 31" with an altitude of 342 masl, the type of locality has characteristics of the last century. There is a Diconsa store and a grocery store where the villagers stock up on basic necessities. The primary economic activities include agriculture, livestock raising and farming, and livestock grazing. The main product of livestock raising and farming is pork. The town's water supply comes from artesian wells. There is public lighting in the town; however, it is present in less than half of the town. There are paved streets in less than half of the town, and garbage is collected and deposited in an open community dump to be buried or burned. Transportation in the town is provided by microbus, combi, individual or collective cabs, and pickup trucks (INEGI, 2021). Of the total of 575 inhabitants, only 488 work in an activity for which they receive a salary. Therefore, they are the ones who sustain the local economy, based on activities such as seasonal agriculture, backyard cattle ranching, poaching and extraction of stone materials for self-construction. Accessibility to this area is rudimentary, consisting mainly of roads, trails and paths (INEGI, 2020b).

Vista Hermosa is a rural town located within the territory of El Veladero National Park, in the eastern polygon. It is located at the coordinates West Longitude 99° 50' 20", North Latitude 16° 51' 35" with respect to Greenwich, with an altitude of 299 meters above sea level. It is a town whose characteristics are from the last century, where there is minimal telecommunications. There is a grocery store in the town that supplies residents with basic necessities such as corn, beans, rice, powdered corn flour, among others. Water is supplied through hoses and is obtained by pumping or artesian wells. Most of the town has electricity; at least half of the town of Vista Hermosa's streets are covered with gravel. A community sports field was observed in the field. In terms of transportation, there is a cab feeder route that connects Vista Hermosa with downtown Acapulco, which provides service from 5:00 am to 9:00 pm (INEGI, 2021).

Figure 3 Eastern polygon of "El Veladero" National Park



Source: Niño-Castillo, et al., 2020

In the economic pillar of sustainable development, of the 1,028 inhabitants are under 12 years of age or are housewives, which is why they do not receive economic compensation for the functions they perform (INEGI, 2021). Housewives and students are considered a vulnerable group because, since they do not have an economic income, it is difficult for them to have access to the social security services to which they are entitled by law. There are a total of 345 dwellings, of which 289 are inhabited and 56 are not permanently inhabited, but we were told in the field that these are occupied on long weekends, year-end vacations and Christmas. Ninety percent of the houses are self-built, so they hardly have good ventilation, lighting and the necessary spatial distribution to accommodate more than four family members (INEGI, 2020b).

Among the basic municipal services, it was observed in the field that less than 50% of the streets are paved. Therefore, it is common to find cobblestone or rustic streets and roads. In part, there is no potable water supply, so the water distributed among the settled population comes from hoses connected to springs, and in the dry season, water is supplied by public and private pipes. Drinking water is obtained from three springs, whose names and locations are omitted so as not to overexploit them. There is no sewage service in the upper part of "El Veladero," so sewage runs by gravity into the bay. Public transportation service is irregular, although there is private access through private automobiles and public-private service concessions (INEGI, 2020c).

In terms of health, the population affiliated with municipal, state and federal health services is 715 inhabitants (Op. Cit., 2020c). This represents 50% of the total population within El Veladero National Park. The unaffiliated population is 312 inhabitants, which represents 25% of the total population living in the study area. The health services observed in the field include a health center in each of the towns, a nurse and a doctor, as well as basic utensils for ambulatory care in case of emergencies, since those who need specialized care are transferred to the center of Acapulco, where there are more specialized public and private health services (INEGI, 2021).

The infrastructure within El Veladero National Park is rural, with access routes in and out of the study area, in the form of roads and trails established by the inhabitants since 1980 (DOF, 1980). Currently, the delimitation of the area that corresponds to the National Park's territory is deficient, because there are areas where there is cyclone netting, and in others there is no delimitation at all because it borders directly with ravines and cliffs that are a natural protection. On the outside, in the middle of 2022, there are no National Park signs indicating the border of the reserve, nor is there an official entrance to access the territory, because the entrance in Carabalí indicates that it goes to "Cerro Encinal", so there is no official entrance to "El Veladero". There is also a sign at the entrance that refers to religious tourism, but there is no other information. The national park is protected by federal authorities (Navy), who patrol the towns surrounding the oak forest. This protected area is marginalized from local sustainable tourism development because there is no map of routes or any type of signage to help follow the main route through the reserve, so it is easy to get lost in "El Veladero".

This park has had several attempts at resurgence, one of which has been through the inclusion of religious eco-tourism, through the construction of a statue of a "Christ King of Peace" (Ramírez, 2021). Religious tourism (Figure 4) refers to religious travel similar to conventional tourism, where trips are made to places considered sacred, without depending on the motivation of visitors (Torres et. al., 2017), while religious eco-tourism represents an industry where a large number of people travel around the world, for economic, religious, cultural and environmental issues (Gómez, 2022).

Figure 4 Local tourism signage



Source: Taken in the field by the authors

Various government agencies such as SEMARNAT, CONANP (2021c), and the federal, state, and municipal governments recognize the existence and territory of El Veladero. At the entrance to the park, near Carabalí, you can see the ejido office where the commissariat is located, along with a Diconsa store, which is abandoned. Within this territory, the inhabitants are digging in the subsoil in order to build artesian wells to obtain water and satisfy their basic needs.

The economic pillar has to do with the primary economic activities in the rural part of the municipality of Acapulco, including agriculture, cattle ranching, shearing, hunting and extraction of stone materials. The inhabitants practice agriculture for subsistence, which is done in a rustic way to plant corn (*Sea mayz*) with an occupied surface of 118.4 hectares (ha), squash (*Cucurbita pepo*), fruit species such as mango (*Mangifera indica*) comprising 13.3 ha, lemon (*Citrus limon*), papaya (*Carica papaya*), beans (*Phaseolus vulgaris*) with 36.01 ha, and even cleared for cultivation inside the national park, which causes both wind and water erosion. In most cases, agriculture is for self-consumption because the edible products are stored for the local population. Most of the fields used for planting and harvesting corn, mango and beans are located in the central southern part of the western polygon of "El Veladero" National Park near the town of Praderas de Guadalupe.

Livestock farming includes raising various species of animals for self-consumption, such as cattle, goats, pigs, poultry, horses and donkeys. INEGI (2019) reports exclusively cattle grazing in an area of 4.28 ha. Specimens of the aforementioned type of livestock are mostly fed through natural vegetation within the area, so it is common to find them in various locations within the study area, this type of feeding has caused the loss of leafy vegetation cover. Livestock activities in the study area are not regulated, but rather are activities for self-consumption and small businesses that are not commercially registered, so in the field it was observed that there are poultry, pig and cattle farms, which are located in rural areas and in rustic facilities. However, songbirds (Table 4) with colorful plumage and different songs can also be observed with the naked eye.

Table 4 Bird species and their types of local uses

Common name	Scientific name	Use	
		Edible	Medicinal Medicinal
Paloma morada	<i>Patagioenas flavirostris</i>	X	
Chachalaca	<i>Ortalis poliocephala</i>	X	X
Zopilote	<i>Coragyps atratus</i>	X	
Cucucha	<i>Columbina picui</i>		X
Zanate	<i>Quiscalus mexicanus</i>		X
Calandria dorso amarillo	<i>Icterus chrysater</i>	X	
Codorniz	<i>Coturnix coturnix</i>	X	

Source: Own Elaboration

Within the area that corresponds to "El Veladero" there is a field for cattle raising and exploitation in the town of Praderas de Guadalupe. Due to the increasing invasion and use of the land for agricultural and livestock activities, especially in areas without vegetative cover, this has caused severe erosion, which can be seen in several areas of the land within El Veladero.

Logging is a common activity in the area. Villagers begin by cutting down areas of the forest using tools such as machetes and axes; large tree trunks are used for construction and firewood because many villagers do not have gas stoves. Later, the smaller vegetation is burned and removed to use the space for planting. Most of the planting is done during the rainy season, because most of the year the climate and soil conditions do not allow for the development of plant species.

Within the study area, as it is a natural area, there are animal species such as: raccoon (*Procyon lotor*), badger (*Nasua narica*), rabbit (*Sylvilagus cunicularius*), hare (*Lepus flavigularis*), squirrel (*Sciurus aureogaster*), green iguana (*Iguana iguana*), black iguana (*Ctenosaura pectinata*), masacuata (*Boa constrictor*), rattlesnake (*Crotalus durissus*), coralillo (*Lampropeltis triangulum*) (SEMARNAT, 2016), some are used in edible form or medicinal use that are prone to be hunted and inhabit the ecosystem normally; however, the various human settlements have displaced the species and at the same time have engaged in poaching activities.

These hunting activities are almost entirely for self-consumption; however, there are indications that some species are being sold, such as iguanas and parakeets, which is a serious situation because these species are under special categories of protection. These activities as a whole within the municipality of Acapulco contribute 0.99% of the municipal economy, which indicates that in general terms they are activities dedicated to self-exploitation by the inhabitants of the study area.

Tertiary economic activities are of vital importance for the subsistence of the inhabitants; retail trade represents 45.5% of the municipality's total economy, making it an important source of income. The inhabitants have to travel during the day to get to the places where they work in commerce, either as business managers or as workers in tourist activities and informal commerce. Some of the inhabitants came to the municipality of Acapulco from other parts of the state of Guerrero, due to the economic boom caused by tourist activities. This caused a large part of the population of tourist service providers to migrate to the port of Acapulco, and some parts of "El Veladero" National Park were invaded by these people, who still live there today. Acapulco stands out in terms of tourism; temporary lodging services and food and beverage preparation represent 18.7% of the municipal economic activity. Other activities: health and social assistance services (3.49%), real estate services (1.02%), recreational services (0.94%), educational services (0.89%) (INEGI, 2020c).

The environmental pillar of sustainable development refers to the biotic and abiotic aspects that support economic activities such as tourism and environmental education in order to contribute to local sustainable tourism development. The low deciduous forest located in the higher parts of the park plays a fundamental role in the infiltration of water into the phreatic mantles that supply the springs from where the settled population transports water to their homes through hoses. The vegetation also has the function of protecting the soil from water and wind erosion, it also represents a green lung for the permanently settled population and for tourism it is an element of scenic beauty and visual amplitude.

The geology that makes up this site is from the Mesozoic era, and although the rocks are ancient, they remain over time as true monoliths distributed throughout the protected natural area. The youngest rocks belong to the Quaternary period, some examples are boulders, gravels, sands and silts, which are found in the almost flat and flat part of Acapulco Bay. This configures soils with different fertility quality, the most fertile are located in the upper part (wild land use) and the less fertile in the lower part, hence it has been destined for residential land use (Cruz Vargas & Niño-Gutiérrez, 2013).

In terms of hydrology, runoff moves from the higher parts of the relief to the lower areas, a situation that during the rainy season drags with it garbage, soil, silt, and trees that sometimes hinder transit from this site to downtown Acapulco. This in turn causes high vulnerability and risk for the settled population, since landslides, landslides, and landslides, among others, are frequent. These events are documented in the local press. The physiographic province to which the region where the study area is located belongs is the Sierra Madre del Sur, in the granitic trunks of Acapulco.

The outcropping rocks in the park correspond to a complex called "Xolapa", made up of metamorphic rocks such as: biotite schists to biotite gneisses, with quartzite and marble; intrusive rocks, granitic rocks from the Cretaceous; and sedimentary and recent deposits. "El Veladero" has several geomorphological units, which are distributed throughout the area of the ANP territory. The highest part that surrounds the city are the mountain ranges; between the contour line that ranges from 200 meters to 500 meters, is the piedmont. Above 50 meters are the valleys and alluvial plains, which are of fluvial origin (Vargas, 1997).

El Veladero's hydrological administration belongs to Hydrological Region 20 (RH-20), known as Costa Chica. The watershed is made up of a series of rivers such as Papagayo (which is closer to El Veladero National Park), Nexpa, Marquelia, Ometepec, among others. During the rainy season in "El Veladero" some water runoffs are formed and even give rise to the formation of springs, which can store water at least 10 months a month; in turn, water infiltrations are important in the runoff of groundwater bodies that are of high importance for the municipality of Acapulco. During the peak of the rainy season, the streams flow down with such force that they can cause small-scale disasters, such as vehicle rollovers and drainage flooding (Ibidem, 1997).

"El Veladero" has an important function within the municipality of Acapulco in terms of water catchment and management. Below the two polygons, there is a whole network of subway water bodies that supply water to the entire municipality, which in turn denotes the water ecosystem services provided by this study area. Most of the water flows in the municipality of Acapulco, both subway and surface, are distributed within the two polygons that make up "El Veladero". This is evidence of the hydrological importance of the ANP.

The general climate of the entire municipality of Acapulco is tropical and sub-humid (Aw), with predominant rainfall in summer and dry winters. This climate has an average annual temperature of 27.8°C, with a maximum temperature of 29°C in August and a minimum of 26.5°C in January. The temperature varies during the year by at least 2.5°C. Annual precipitation is 1,411.1 millimeters. The rainiest month is September, which is usually the month when the rainy season begins, with 386.7 mm, and the least rainy months are February and March, with about 0.9 millimeters (INEGI, 2020c).

The main soil types are represented by the gleyic Solonchak (Kg), the eutric Regosol (Re), the dominant soil within the study area is the Leptosol or Litosol (L) and the gleyic Feozem (Pg) (INEGI, 2021). Solonchak soils are characterized by being found in areas with low slopes and susceptible to flooding, where saltpeter accumulates, so the main quality that characterizes them is their high salt content. It also has an alkaline pH and can have an A horizon, a B horizon or a gleyic horizon or one with excess moisture, such as the one found in the study area, within the first 50 cm of depth (SEMARNAT, 2008).

Regosols are mostly very young soils, which are located on unstable material, are light-colored and have very little organic matter. They are found in most climates and on all types of slopes, commonly in arid, semi-arid, dry tropical and mountainous regions (INEGI, 2001). Lithosols are very thin soils, with a high amount of stony material and may also contain a high amount of calcareous material, in addition to being poorly developed. They are the soils most commonly found worldwide and are associated with sites with quite complex relief, so it is very common to find them in Mexico (Correa & Niño-Gutiérrez, 2016). These soils are found in all types of climates and particularly in mountainous areas. Due to their shallow depth, stoniness and calcium content that can immobilize mineral nutrients, their agricultural use is very difficult, to the extent of being limited, so it is preferred to keep them with their original vegetation (SEMARNAT, 2008).

Feozem soils are formed on unstable material. They are found in temperate and humid climates, with natural vegetation of tall grasses or forests. They are dark soils with a high amount of organic matter, which is why they are highly valued in agriculture; they are mainly used for planting cereals such as soybeans, wheat and barley, as well as for planting vegetables. In Mexico, they are distributed mainly in various portions of the Neovolcanic Axis, the Sierra Madre Occidental, the Yucatan Peninsula, Guanajuato and Queretaro (Idem, 2008). The dominant soil in the municipality of Acapulco is Leptosol, so it can be found in most of the territory of "El Veladero".

The vegetation found within "El Veladero" corresponds to medium sub-deciduous forest, which is distributed throughout the NPA in the form of patches or small spaces, within which there is also the presence of low deciduous forest. The deciduous and sub-deciduous forests are characterized by vegetation dominated by trees of different deciduous species. They develop in warm environments with rainy summers, where annual precipitation varies between 1,000 and 1,229 mm, with well-defined and extensive dry seasons. Similar to the evergreen forests, they are divided into medium and low, depending on the height of the dominant tree vegetation (SEMARNAT, 2020).

Another important characteristic is the height of the canopy of the trees that make up these forests, the canopy rarely exceeds 15 meters in height, although in exceptional cases, they reach up to 30 meters. These forests are known as subcaducifolia or caducifolia depending on the proportion of trees that lose their foliage in the dry season. Some of the trees that make up this type of vegetation have adapted to store water in their stems, as in the case of copales (*Bursera*), pochotes (*Pachira quinata*) ceiba (*Ceiba pentandra*), parota (*Enterolobium cyclocarpum*) and several species of columnar cacti. This vegetation is often subject to slash-and-burn agriculture and extensive cattle ranching. These activities severely degrade it, which is why it is considered one of the most threatened tropical ecosystems in the world (SEMARNAT, 2010).

Within the study area, this vegetation has been affected by the presence of clandestine cattle ranching, which is managed by the population located around "El Veladero". The dominant plant species in the ANP are oaks *Quercus affinis* and *Quercus laurina*, while in areas disturbed by anthropogenic presence, acacia species predominate: carnezuelo or cornizuelo (*Acacia cornígera*) and guizache (*Acacia cymbispina*), in the herbaceous stratum, which is defined as plants of a height less than or equal to 10 cm (Madrigal & Vargas-Chacón, 2016), there are grasses (*Bouteloua sp.*) and zacate colorado or zacate barba negra (*Heteropogon sp.*) (Vargas, 1997). The wild vegetation zones within the municipality of Acapulco correspond to deciduous, sub-deciduous and evergreen forests, which are present within the study area, where the oak forest is the vegetation that stands out within the territory of the NPA.

The fauna in "El Veladero" consists mainly of songbirds, reptiles such as iguanas and snakes, including the boa (*Boa Constrictor imperator*), black iguana (*Ctenosaura pectinata*), green iguana (*Iguana iguana*), fish hawk (*Pandion haliaetus*), scorpion (*Heloderma horridum*) and cojolite (*Penelope purpurascens*) (SEMARNAT, 2016). Within the territory, one species has also been found in the category of endemic species, it is the Pata de Res gecko (*Phyllodactylus lanei*) (CONANP, 2022); however, this has been the only endemic species found within the ANP and given the lack of studies related to flora-fauna research and a management plan for "El Veladero", it is difficult that another species can be found and categorized in this way (Data Mexico, 2019).

As a diagnostic, it was found that "El Veladero" National Park is made up of low deciduous forest vegetation preserved in 50% concentrated in steep slopes and cliffs with scenic beauty and visual amplitude that covers 100% of the lagoon of Coyuca de Benítez to the north, to the northwest the bay of Santa Lucía and to the south Puerto Márquez, The remaining 50% of the vegetation in the national park is underconserved, especially in the areas surrounding the three towns that have been in this federally protected natural area since 1993, where the population practices primary subsistence economic activities, in addition to serving as dormitories for employees of the tourism and commercial sectors of the city and port of Acapulco. If the observed trend of concentration and expansion of the rural-urban zone towards the lands of "El Veladero" National Park continues, the deterioration of the landscape will accelerate dizzyingly, which would lead to think about a recategorization of the area under study more in accordance with a management category that allows the rational use of the still existing natural resources, according to the following analysis of Strengths, Weaknesses, Opportunities, and Threats (SWOT):

Strengths:

1. The destination of Acapulco has a variety of natural, scenic and historical resources, traditions, living culture, among others. Some of them have been declared Federal Protected Natural Areas, as is the case of "El Veladero" National Park since 1980, and in other cases, cultural heritage that represents an important potential for the diversification of national and foreign tourism.
2. Existence of tourism and handicraft products with potential for commercialization in the tourism sector.
3. Existence of the Fideicomiso Acapulco (FIDEACA), the International Tourism Fair (FITUR), for cooperative publicity campaigns, business appointments with wholesalers and tour operators, among others.
4. Existence of tour operators and travel agencies in Acapulco.
5. Growing interest on the part of businessmen in tourism development, which is demonstrated in greater commercial actions for press trips and support for attendance at national and international fairs.
6. Positive degree of satisfaction on the part of national and foreign tourists.
7. Deep sense of rootedness in the inhabitants, which facilitates their incorporation into sustainable tourism development.

Opportunities:

1. World tourism trends oriented towards cultural, nature, and business tourism segments, among others.
2. Existence of the Municipal Secretariat of Citizen Security and Civil Protection, Tourist Police and intersectoral agreements in the area of tourist security.

3. Interest of international organizations in the conservation, recovery and enhancement of the natural and cultural heritage.
4. Importance of tourism as an activity that generates jobs and foreign exchange.
5. Air, sea and land communications to contribute to the fluidity of national and foreign tourism.
6. Important indexes of massification and saturation of the tourism in other sites of Acapulco.
7. The use of new technologies will allow low-cost promotion.

Consolidate mechanisms for the development and innovation of regional products with emphasis on nature tourism products, ecotourism and avi-tourism or even adventure tourism.

Weaknesses:

1. Insufficient development of the process of planning, implementation and monitoring of tourism in natural protected areas.
2. Insufficient human resources, tools and competencies among professionals and professionals to manage and lead sustainable development in NPAs.
3. Lack of an information system for tourists and visitors to "El Veladero".
4. Weak research and management competencies of human resources focused on NPAs.
5. Lack of potable water supply, electricity, sanitation, wastewater treatment and solid waste, which increases local environmental disturbance.
6. Incomplete statistical information and outdated Tourism Satellite Account.
7. Alteration and damage to the landscape due to the presence of buildings outside of "El Veladero" National Park.
8. Low demand for nature tourism.

Threats:

1. Strong competition from the national market due to the existence of tourist sites with better tourism planning in ANPs, quality offers, variety of services, and more aggressive tourism promotion strategies.
2. Insufficient connectivity, telecommunications and basic services that promote accessibility to "El Veladero".
3. Insufficient protection of Palma Sola's natural, forest and even cultural resources, which generates a significant risk of loss of natural and cultural heritage.
4. Social conflicts, citizen insecurity and drug trafficking that deteriorate the image and discourage investment in Acapulco.
5. High levels of informal commerce, which generates conditions that affect the security and quality of tourism.
6. Climate change, vulnerability to natural disasters and poor planning generate problems and delays for national and foreign tourists.
7. Lack of adaptation to technological innovations and new market structures in tourism training.

From 1980 to 2019 a rudimentary tourism was developed in an incipient way from the public educational sector in the municipality, given that teachers and students made field visits to "El Veladero", however, as of January 2020, as a result of the pandemic, such tours were suspended and possibly will be suspended permanently according to the evolution of COVID-19, reason for which there is no tourism as such in said Natural Protected Area. Therefore, the proposal is as follows: i) it is important to protect and conserve the low deciduous forest so that the neighboring community can promote environmental education, which may include soil conservation and construction of terraces to counteract the laminar water erosion that is triggered every rainy season.

Bench terraces are a series of platforms or steps (like "benches") that are built with the purpose of modifying the slope of the land to favor water absorption and increase production, thus allowing the sustainability of land use over time. They have a flat part (embankment) that is used for cultivation, and a cut part (*slope*) to provide stability; ii) the vegetation must be preserved over time through the planting of trees that grow in this place, such as: acacia (*Acacia sp.*), oak (*Quercus sp.*), ceiba (*Ceiba pentandra*), amate (*Ficus insipida*), tepehuaje (*Lysiloma acapulcensis*), bonete (*Jacaratia mexicana*), cazahuate (*Ipomoea murucoides*) and pochote (*Bombacopsis quinata*), among others.

This will happen to the extent that the population becomes involved in the creation of a community nursery composed only of native vegetation and iii) fire prevention in "El Veladero" National Park, to include: (a) legal prevention, apply laws, regulations and norms that require support in the use of regulatory sanctions by the agencies in charge of monitoring and sanctioning infractions to the regulations, (b) cultural prevention, the analysis of situations in each identified area, will be the main idea to modify human behavior regarding the use of fire in the specific areas, which will lead to a change in people's attitude, making them more reserved, protective and respectful of natural resources. Include a persuasive campaign through education and information (community education programs using mass media and originality: radio, television, newspapers, films); popularized by outdoor advertising; publication and distribution of printed materials; conferences and press releases, lectures in urban and rural schools, courses for the rural population, celebration of festivals, exhibitions and fairs, personal contact and problem solving through the conciliation of interests, among others and c) physical prevention, physical prevention actions and forest or silvicultural management for preventive purposes.

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5. Conclusion

Multifunctionality in the new rurality is a modern strategy that allows options for the development of places and population that wish to progress, so that, through the conservation of "El Veladero" by means of local citizen participation, it can propitiate the diversification of Acapulco's tourist offer, which shows as a focal node the conventional tourism of sun and beach. However, by means of an updated analysis of the existing population, economic, social and environmental variables in the NPA, it is feasible that multifunctionality and the new rurality are strategies that allow reorienting the local development of sites such as "El Veladero" National Park, located in emerging countries.

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Chapter 6 Conflicts in livestock-wildlife interaction (health aspects and predatory behavior)

Capítulo 6 Conflictos en la interacción ganadería-fauna silvestre (aspectos sanitarios y conducta predatoria)

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Abstract

The main aim of this chapter is to provide a basic understanding of the conflicts that arise when livestock and wildlife interact. The access granted by the Autonomous University of Campeche to databases such as Science Direct, Springer Link, Ebsco Host and Google Scholar was used. To achieve this objective, the text was divided into two parts. The first part deals with the generalities of livestock predation by wildlife, addressing conflicts mainly with carnivores and existing strategies to reduce encounters between these animal populations. The second part deals with the health interface between livestock and wildlife, where emphasis is placed on the importance of studying diseases in wild animal populations, as they are reservoirs of etiological agents that cause diseases in livestock as well as humans.

Livestock-wildlife interaction, Livestock predation, Livestock-wildlife health interface

1. Introduction

Human-wildlife conflict is defined as any interaction between them that results in negative impacts on human social, economic, or cultural life, wildlife conservation, or the environment. It occurs when humans or wildlife are having an adverse impact on the other. These conflicts have occurred since the dawn of humanity, they occur on all continents, both in developed and developing countries (IUCN, 2005). The biggest challenge in many countries is the growth of the human population and its settlements close to nature reserves, where the conflict becomes more intense where livestock and agriculture are an important part of the livelihoods of the population.

According to the Worldwide Fund for Nature (WWF), the human population is expanding, and nature reserves are dwindling, people and animals are increasingly coming into conflict over living space and food. They are also causes of conflicts, the development of infrastructure, urbanization, and climate change. Some types of conflicts are, for example: i) Destruction of crops by elephants, primates, birds, hippopotamuses, and rodents; ii) Attacks on livestock by part of big cats, hyenas, wolves, and feral dogs; iii) Deaths and injuries to humans by crocodiles, tigers, bears, big cats and hippopotamuses; iv) Driving accidents caused by deer, antelope, elk, coyotes and wild boar; v) Transmission of zoonotic diseases by primates, rodents, wild boars, birds, foxes and deer. These conflicts between humans and wildlife require strategies to favor coexistence and mitigate the consequences for human health, safety, and well-being, as well as to maintain biodiversity and ecosystem health (Nyhus, 2016). A prerequisite for finding effective solutions is understanding the details, mechanisms, and nature of the conflict.

Therefore, the objective of this work is to describe two types of conflicts in the wildlife-livestock interface; the first section describes the origin, scope and strategies that have been developed to mitigate the problem related to livestock predation and the second section will establish a review on the transmission of zoonotic diseases by wildlife, especially large mammals, in addition to both problems some management strategies are identified that promote food security, resource conservation and rural development.

2. Methodology

A search was carried out in the databases provided by the Autonomous University of Campeche through CONRICyT such as Science Direct, Springer Link, Ebsco Host and Google Scholar search engine using as keywords: livestock and wildlife interaction, depredation of livestock, conflicts with carnivorous animals, strategies to decrease predator/livestock conflict, livestock/wildlife health interface: brucellosis, tuberculosis, whit the purpose of describing the origin, scope and strategies that have been developed to mitigate the problem and promote food security.

3. Result

There are many articles on the established topics and those that best explain the conflict and strategies on livestock and wildlife, as well as its effect on the health of livestock was selected. Each section was explained based on previous studies and reviews on the subject.

4. Depredation of livestock

4.1. Livestock production

Livestock is an economic activity of very ancient origins that consists of the management of domesticable animals for their use with productive purposes. Due to population growth and rising incomes in many developing countries, there has been a dramatic expansion of the livestock sector globally in recent decades. In developing countries, annual *per capita* meat consumption has doubled from 14 kg in 1980 to 28 kg in 2012. In the same period, total meat consumption tripled, from 47 to 137 million tons. Milk consumption for the period described doubled from 114 to 222 million tons. The analysis of the data indicates that the trend will continue for about ten or twenty years before its growth slows down (Alexandratos and Bruinsma, 2012).

There are more than 4.2 billion cattle, sheep, goats and pigs grazing on 30% of the planet earth's surface and in some regions, overgrazing has reduced the density and biomass of plant and animal species altering ecological succession, nutrient cycling and landscape alteration (FAO, 2018). Of course, this high livestock production demands a large amount of food resources such as forage and grains, among others, to sustain the supply of meat and milk. The production of these food resources has had an impact on the use of the land, where the areas of crops and pastures have increased with the detriment of forests and jungles. The conversion of natural habitats to pasture or cropland has been a rapidly growing trend since 1850 (Klein-Goldweijk and Battjes, 1997). This conversion in land use and its growing expansion within natural ecosystems implies a loss of biodiversity and exerts great pressure on the populations of wild animals, wild or free-living.

4.2. Livestock and wildlife interaction

Livestock production and wildlife are part of a socio-ecological system (Biggs *et al.*, 2015) in which the activities of humans determine the interactions between them, inducing conflicts. The impacts of these interactions can be direct, because of the physical presence of livestock on shared pastures, or indirectly through the changes they create in the vegetation. These changes can be primary influences such as: herb removal or trampling; and higher order effects such as: changes in structure, productivity, or composition of the vegetation (Kauffman and Pyke, 2001). Changes in vegetation created by farm owners will influence wildlife through factors such as quality and quantity of food, cover from predators, or availability of nesting sites. It can also have cascading effects through a food chain by altering prey abundance for higher trophic levels. However, there are numerous reports that attest that controlled coexistence between domestic livestock and wildlife is possible, especially in interaction with wild herbivores such as large ungulates.

4.3. Improved forage quality

The improvement of forage quality occurs indirectly when grazing with domestic cattle at certain times of the year eliminates mature vegetation, resulting in higher biomass and availability of tender forage in the following seasons. Anderson and Scherzinger (1975) found a relationship between increased moose populations and cattle grazing on common grasslands. The authors hypothesized that proper spring grazing of cattle during the active growth stage of pastures delays pasture maturity, allows regrowth, and thus increases pasture availability and quality in fall-winter, a time when the number of moose increased in these grasslands.

Austin and Urness (1986) showed that the crude protein values of deer diets in pastures where there was previous grazing or not by cattle did not differ significantly, as did *in vitro* digestibility, which confirms that previous grazing of livestock in areas where deer still feed does not affect nutrient availability. In the same study they found that the influence of cattle grazing, and the deer was a function of grazing intensity. Higher intensity has more impact on the vegetation consumed by deer by altering the diet in favors of other species and grasses, however, neither the crude protein or the *in vitro* digestibility was affected in the deer diets. Here the strategy is to control the stocking rate of the cattle to find a balance and not affect the availability of food for the deer.

4.4. Conflicts with carnivorous animals

The predation of livestock by large carnivores is common throughout the world; the destruction of wild habitats by population growth has resulted in the decline of populations and even extinction of several species of carnivores (Farris *et al.*, 2015). Due to the above, there is a strong antagonism and a deep-rooted hostility against wild predators. The main causes of the conflict have already been mentioned and are the growth of the human population and its settlement in areas where wildlife lives and the deterioration of the habitat and decrease in the prey available to predators.

The above factors increase the overlap between wild carnivores, livestock, and humans, increasing the chances of encounters and therefore of conflicts. In the world, the main problem is the depredation of livestock by wild carnivores (Rosas-Rosas *et al.*, 2008; Kaartinen *et al.*, 2009), since it causes economic losses to the rural population, calculated between \$95.6 (Kebede *et al.*, 2022) and \$134,253 dollars (Peña-Mondragón and Castillo, 2013), or 12% of the net income of a household (Butler, 2000). According to the International Union for Conservation of Nature and Natural, variations depend on the country, type of livestock depredated (sheep, cattle, horses, poultry) and predator (hyenas, jaguars, lions, leopards, bears, great eagles), the latter being perceived as threats that often result in retaliation against the species considered guilty, which causes conflicts between conservationists and producer about what should be done to resolve said situation (IUCN, 2020), in addition there are other costs such as fear, avoidance behaviors and the threat to human life (Jacobsen *et al.*, 2022).

This psychological dimension of damage by predators is truly important, especially for the design of strategies for managing the conflict of predation on large and small livestock, because together they influence human responses to these losses (Kellert, 1985). However, these attitudes toward predators are not determined by any direct cost imposed, but rather are the product of a dynamic and complex web of individual, social, and cultural factors (Dickman *et al.*, 2013). Thus, the way in which this conflict is managed has consequences for the conservation of large carnivores and biodiversity, since several of the wild predatory species reported are in some category of important risk in terms of conservation of species (Table 1). In some cases, various strategies have been designed to mitigate and/or avoid this conflict and its detriment to the wild species involved.

Table 1 Predatory wild species and their category of extinction risk

Species	Country or continent of origin	Risk Category*
<i>Lycaon pictus</i>	Africa	Endangered
<i>Spizaetus isidori</i>	South America	Endangered
<i>panthera tigris</i>	Asia	Endangered
<i>panthera pardus</i>	Asia/Africa	Vulnerable
<i>Panthera leo</i>	Africa	Vulnerable
<i>Panthera uncia</i>	Asia	Vulnerable
<i>Panthera Onca</i>	America	Near threatened
<i>Leopardus wiedii</i>	America	Near threatened
<i>canis lupus</i>	Cosmopolitan	Minor concern
<i>cougar concolor</i>	America	Minor concern
<i>Crocuta crocuta</i>	Africa	Minor concern
<i>Canis latrans</i>	America	Minor concern
<i>Ursus americanus</i>	America	Minor concern
<i>Lynx spp .</i>	America, Asia, Europe	Least Concern except the Iberian lynx (<i>Lynx pardinus</i>) which is Endangered
<i>Leopardus pardalis</i>	America	Minor concern
<i>Puma yagouaroundi</i>	America	Minor concern

Data Taken from IUCN: <https://www.iucnredlist.org/>

These attacks on livestock of course bring with them an economic problem due to the loss of the animal, so that persons must make decisions and actions that prevent this depredation.

It is suggested, for example, night confinement of cattle, installation of fences, putting watering holes for fauna, adjusting the animal load to prevent cattle from walking towards the edges of the forest or jungle that leads to encounters with predators, avoid disposing of carcasses in the forest or jungle so that predators do not get used to consuming meat from domestic animals. It is suggested not to hunt these predators as they play an important role in controlling other species.

4.5. Strategies to decrease predator/livestock conflict

The IUCN has a specific advisory group called the HWCTF (Human-Wildlife Conflicts Task Force) by providing resources, training, and interdisciplinary guidance. However, the same organization recognizes that the efforts to reduce the conflict are not yet significant (Gross *et al.*, 2021). In this regard, several investigations have been carried out to identify errors in the implementation of predation control strategies, which are detailed below.

Control by killing (lethal control)

Lethal control is one of the main ways to deal with conflicts with large carnivores, both illegally and legally, with some governments carrying out or supporting population culls or targeted killings of problem individuals. Lethal control strategy is readily available and is perceived to be cheaper, more practical, and effective than non-lethal methods. For example, a recent study conducted on a group of ranchers in Wyoming, United States, found that lethal mitigation strategies were perceived as more effective than non-lethal mitigation strategies, this result differed depending on the predator species in question (Scasta *et al.*, 2017).

Such a perception can be explained because killing the predators may be perceived as effective due to the benefits for a small minority of farmers, and even worse if the neighbors experience the secondary effects of the lethal intervention, such as displaced predations, they may perceive that the problem grows and then it requires a more lethal intervention, which causes a vicious circle (Santiago-Ávila *et al.*, 2018).

The great disadvantage of this method is that by killing predators, their social groups are fragmented, which makes them disperse more and attack other localities, or ecological niches are vacated that allow the establishment of smaller and more numerous predatory species that still consume livestock (Treves *et al.*, 2016). In addition, killing predators that occasionally feed on livestock has raised concerns associated with ethical issues and ecological impacts as declining populations of large-bodied predators have led to ecosystem degradation and the disruption of vital ecological processes. important for life on this planet (Ripple *et al.*, 2014). For these reasons, non-lethal control strategies have been developed for these species.

Non-lethal predator control strategies

There are aversive and dissuasive techniques, which consider changes in the behavior of animals through learning. Aversive conditioning relates a negative experience to a particular behavior, and deterrent conditioning interrupts the predator's behavior through mechanisms such as neophobia or pain (Zarco and Monroy, 2014). These strategies seek to reduce predation, with the additional benefits of a favorable public perception by promoting animal welfare of both predators and prey and reducing lethal incidences on non-target animals, being methods more compatible with conservation of species and less probability of triggering ecological disturbance effects (McManus, 2015). These strategies include:

Carnivore deterrents: These are physical objects and sensory stimuli that interrupt specific elements of carnivorous behavior or act on ecological aspects of the predator (Wilkinson *et al.*, 2020). As an example, there is the use of the so-called fladry which is a visual barrier used to scare away wolves and coyotes and even wild boars, whose foundation is the neophobic behavior of wolves. It consists of a strand of polywire with plastic flags attached and arranged at a similar distance between them of 40 or 60 cm, although 30 or 45 cm is more recommended. There is also the turbo fladry (electrified wire) and others with materials such as nylon or vinyl and making special knots and increasing the current standard length.

They are recommended as a temporary dissuasive measure, coinciding with the calving period, to avoid attacks in the most sensitive times. Studies carried out in the United States indicate that the fladry is useful for a period of 23 to 157 days. For greater effectiveness, it is recommended to combine it with other methods of livestock protection and consider habituation by predators, so it should be used only temporarily (Figure 1) (Iliopoulos *et al.*, 2019, Young *et al.*, 2019).

Figure 1 Fladry is a line of flags, or a rope mounted along the top of a fence, from which are hung strips of cloth or colored flags that are intended to deter wolves from crossing the line



Credit Ian McGregor, Oregon State University Service Livestock. <https://ourimpact.oregonstate.edu/story/livestock-producers-embrace-progressive-tactics-dealing-wolves>

Flashing Light Deterrents: This technique involves placing light devices at each end of an imaginary ellipse surrounding the cattle sleeping area, these devices continuously emit flashing lights that vary randomly and turn on at dusk as light levels decrease and turn off at dawn in response to increased light levels. It is effective against predation by cougars and other predators (Wanjira *et al.*, 2021).

Acoustic deterrents: These include all types of sound-producing devices from shouting, clapping, and a variety of home-made and commercially-produced noise-making devices (rattles, can-rattles, vehicle horns or sirens, and/or whistles), as well as sounds of recorded animals and recordings of human voices, of gunshots, use of radios, devices that produce loud explosive sounds such as discharges or of firearms projectiles or other explosives or sound generators, to take advantage of the tendency of wild animals to fear/avoid to humans, ultrasound is also included. Acoustic and visual aversive devices are often used in combination as they are more successful than when used alone (Wilkinson *et al.*, 2020).

Chemical repellents or conditioned prey aversion: These are chemical substances such as capsaicin, cinnamaldehyde, uidecenovannillylamina, derivatives of coal tar and other chemical products that are used on prey animals in the form of pour-ons or in collars, preventing the predator from approach the animals. The chemicals are placed on the prey to produce an unpleasant adverse effect such as vomiting, nausea and/or diarrhea in the predator, so that the predator learns to reject this prey in subsequent encounters by associating it with a taste or smell that makes them uncomfortable. The disadvantage is that predators end up getting used to these repellents so, like the previous aversives, they must be used randomly (Wilbanks, 1995).

Livestock Protection Animals: Since 1970, dogs have been used as livestock guardians in the United States. The disadvantage of using these animals is that they can sometimes be aggressive towards people, they can start to disturb the animals they protect, and they are also subject to injury and death. On the other hand, since 1980 llamas have been used to protect small livestock from attacks by coyotes, foxes, and dogs with successful results. Donkeys through their behavior of braying, biting, running, chasing, and kicking the intruder have also been used to protect livestock.

The advantages of using animals against predation are the reduction or elimination of predation, reducing labor to confine sheep and goats at night, and efficient grazing (Andelt, 2004). The disadvantages of this strategy are the investments for the acquisition of animals, operating costs (food, health) and in the case of guard dogs, the legislation on handling dogs associated with their use (Eklund *et al.*, 2017).

Predator removal: Refers to those techniques that reduce the number or change the demographics of carnivores to a defined area (Wilkinson *et al.*, 2020). It can be of selective type, which consists of trapping the culprit predator or a group of predators of the species in question, and then it can be removed to take it to another area within its natural geographical distribution (translocation) or the animals can be humanely removed and even taken into captivity in zoos or sanctuaries (Smuts, 2008). However, the predator removal strategy has shown that it is only effective in the short term since a sustained suppression of predators is not generated, so it is recommended to identify the role of the predator within the ecosystem and the possible consequences of the elimination on animals, competitors and prey. On the other hand, the recorded translocations of animals show that the animals do not stay at the release site and even that the aggressiveness of the animals towards people increases, causing a great danger (Athreya *et al.*, 2011).

Another predator removal strategy involves sterilization or contraception of predatory species. In this case, the reproduction of the “problem species” is avoided. The strategy has involved the development of various contraceptives and methods of administering these drugs. In this regard, it has been shown that in coyotes (*Canis latrans*) sterilization successfully reduces, but does not eliminate predation (Bromley and Gese, 2001). These types of strategies must also be evaluated, establishing the objective, proportion, and periodicity in which the population must be sterilized to achieve the goal of reducing the size of the predator population or to stop the growth of the population and thus achieve the desired reduction and reduce the harm to domestic animals.

Zootechnical management of livestock: It refers to all those activities that are carried out for the maintenance of healthy livestock and that research has shown to influence the probability of being preyed upon. These management strategies include:

- a) Stocking rate, which is the amount of land allocated to each animal during the entire grazing part of the year, and which differs between zones by climate (annual rainfall) and vegetation, animal species, size and physiological stage, size of the prairie or ranch and the number of hectares for grazing. The stocking rate supported by a system defines the general health of the environment and production (Lyons *et al.*, 2001).
- b) Rotational grazing refers to the movement of cattle through a series of pastures or paddocks, preventing cattle from being more vulnerable to predation because they are dispersed over large areas (Barnes, 2015). Restricted grazing in which animals graze only for periods of time while being watched to ward it off predators is also recommended (Rollin, 2004).
- c) The selection of livestock breeds since it has been observed that the phenotypic (color and size) and biological characteristics of livestock can favor predation (Khorozyan, *et al.*, 2018).
- d) Construction of farrowing pens to minimize the risk of predation in the most vulnerable stage of the production species (Barnes, 2015).
- e) The construction of pens to confine the cattle and thus avoid predation by carnivores. It is recommended to carry out this confinement at night, which is the time when most predatory attacks occur (Eklund *et al.*, 2017).
- f) Use of fences to delimit the entrance of predators to the management site is a strategy that has been used since 1930 and better results are observed with the use of permanent or temporary electric fences, as well as the use of two electric mesh fences (Wyckoff *et al.*, 2016)

Land use and management of wild prey: It is a natural resource management approach that allows the separation of prey and livestock by altering habitats and/or making free-living prey available by:

- a) Land use zoning guidelines. This strategy is successful in terms of separating livestock from carnivores through land use planning (Strand *et al.*, 2019).

- b) Establishment of protected natural areas and buffer zones, which are part of the zoning principles to allow wildlife conservation and anthropogenic activities (Gurung *et al.*, 2009). Buffer zones are areas that are used to minimize the negative impacts of human settlements and their activities in protected areas (Wilkinson *et al.*, 2020).
- c) Habitat enhancement for predators to occupy other areas of the landscape (Wilkinson *et al.*, 2020). This involves manipulating the habitat to favor prey species and thus decrease livestock predation and involves everything from vegetation thinning to subtle changes in grazing (Rollin, 2004).
- d) Conditioned taste aversion consists of the use of food to divert the activity or behavior of a target species, without the intention of increasing the density of this population (predators), generally food is used to drive animals away from activities or places where they are causing problems (Rollin, 2004).
- e) Use of food baits that consists of using another type of food to "distract" the predator, a strategy that can cause an increase in the number and concentration of predators in areas where there are cattle (Fernández-Arhex *et al.*, 2015).

Economic incentives: The financial mechanisms aim to reduce the economic loss that depredation generates for farmers, which is done with a compensation through direct payment to farmers for the livestock attacked by the carnivore. On the other hand, photographic tourism has been created that generates income for locals through tourists who pay to see wild animals. Both strategies have problems, since the first requires an expert opinion carried out by trained personnel to determine whether the death of the cattle was due to predation and even identify the predatory species involved (Oropeza-Hernández *et al.*, 2014). In this regard, research showed that the main problem with compensation incentive schemes is the lack of clarity regarding the equitable distribution of benefits and the lack of implementation with additional interventions such as: educating the public about the value of carnivores or how to use non-lethal methods to prevent predation. On the other hand, photographic tourism also requires the training of personnel who will serve tourists, organize the visit, design the viewing route, and establishments and infrastructure for hosting tourists (Drumm, 2004). It has even been observed that in cases where an ecotourism strategy has been used, the projects have not shown sufficient evidence of its usefulness in reducing threats to livestock or improving the status of the biodiversity it seeks to protect (Eshoo *et al.*, 2018). Currently, the commercial strategy of certification as "Predator-Friendly Beef" producer has been evaluated, this designation implies the production of meat on farms where predators are controlled through non-lethal strategies, which has been working since 2013. Bogezi *et al.*, (2019) found that there are numerous barriers to its implementation, ranging from marketing problems to administrative and logistical barriers to socio-cultural implications, despite this it represents an opportunity to promote coexistence between livestock and predators. and could be adapted to local markets and cultures elsewhere.

Considerations

Recently, the strategies have been scientifically evaluated to demonstrate their feasibility. In this way, the implementation of good husbandry management practices for livestock is one of those considered to be of the first order (Reyna-Saenz *et al.*, 2020). In this regard, due to the habituation behavior of predators to the strategies used, the use of fences (mainly electric) and the establishment of pens (lambing sheds) for birth control are the ones that have been most effective and long-lasting (Khorozyan and Waltert, 2019). It is also recommended to consider in the construction of enclosures and fences, the biology and behavior of the predatory species or species to be successful in preventing damage (Eklund *et al.*, 2017).

Other strategies that have shown the efficient reduction of losses due to predation is the use of animals to protect livestock, followed by the effectiveness observed by the lethal control of animals. However, the latter is not compatible with wildlife conservation efforts, so its recommendation is discarded. Economic incentives have promoted tolerance of large carnivores in some localities and reduced retaliatory deaths (Van Eeden *et al.*, 2018), so it is recommended that payment schemes be carefully executed, adapting to the individual situation to ensure that the desired conservation results are achieved through the satisfaction, economic and cultural needs of the people who bear the costs associated with the conservation and coexistence with wildlife (Dickman *et al.*, 2011). It is also recommended to reconsider the importance of traditions, stories, and beliefs about the history of the community towards wildlife, as it opens opportunities for communities to develop awareness to live with a wild species (Gross *et al.*, 2021).

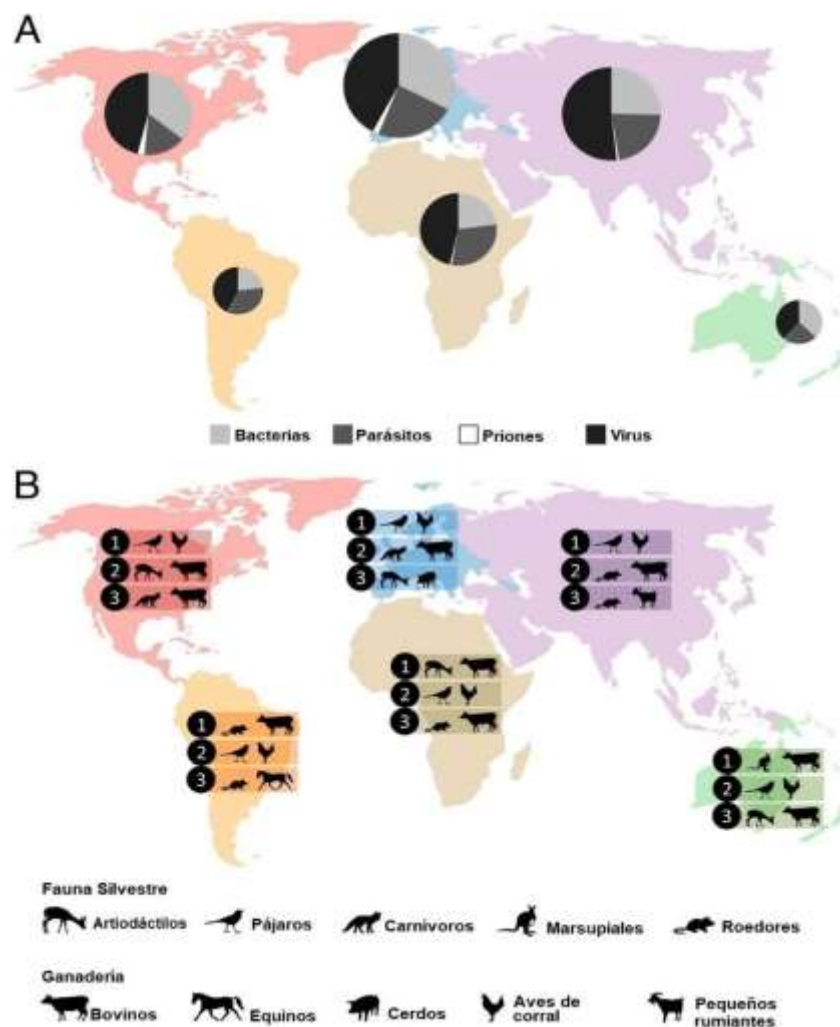
Is crucial in the successful implementation of strategies to control predation by carnivores, to consider the spatial differentiation of the environment (landscape, vegetation, climate) and the anthropic characteristics of the predation sites (social and cultural values), and the particularities of each region so that policies and strategies are oriented to the conditions and particularities of each locality, region or country (Reyna-Saenz *et al.*, 2020); and establish routine monitoring for all intervention strategies used in specific areas and thus be able to make the relevant adjustments in time and that allow the coexistence of anthropogenic activities and conservation of species permanently.

5. Livestock/wildlife health interface

The changes in land use, from an ecosystem to an agroecosystem caused for example: by the intensification of livestock, agricultural intensification, deforestation, and invasion of virgin habitats, increases contact with wildlife. Thus, the transfer of diseases from domestic reservoirs to wild populations and vice versa is very important; and it is here that man is involved, since many diseases are zoonotic and anthroozoonotic (Daszak *et al.*, 2000; Fischer and Gerhold, 2002).

The study of diseases of wild animal populations is a discipline that has developed extensively in recent years given their importance, proof of this are the more than 78,000 scientific articles published in the period from 1912 to 2013 (Figure 2) (Wiethoelter *et al.*, 2015). In this study, it was determined that diseases that affect domestic cattle such as rabies, salmonellosis, tuberculosis, brucellosis, leptospirosis, and echinococcosis are among the first ten according to the number of publications (Table 2). However, it is considered tuberculosis and brucellosis as the most dangerous and important for including man in this interface (Cleaveland *et al.*, 2001; Bengis *et al.*, 2002; Miller *et al.*, 2013).

Figure 2 Geographic distribution of pathogens (A), where the size of the circles is proportional to the number of publications obtained for the corresponding continent. Prominent interfaces between wildlife and livestock (B), showing the three main interfaces between wildlife and livestock reported by continent.



Taken from Wiethoelter *et al.*, 2015.

Table 2. The three main interfaces between wildlife and livestock, including the predominant diseases

Wildlife	Type of livestock	Illness
Birds	Poultry	Poxvirus infections.
artiodactyls	Cattle	Bovine tuberculosis, brucellosis, malignant catarrhal fever, foot and mouth disease.
Carnivores	Cattle	Rabies, bovine tuberculosis, echinococcosis, leptospirosis, salmonellosis.

Taken from Wiethoelter et al., 2015.

At the international level there are organizations that are responsible for monitoring the diseases mentioned, this involves a multidisciplinary work involving veterinarians, epidemiologists, chemical laboratory workers, doctors, biologists, and other professionals. The World Organization for Animal Health (WHO) is in charge at a global level and in Mexico the National Service for Agri Food Health, Safety and Quality (SENASICA) is the organism in charge of sanitary control in wildlife. Tasks such as movement control, containment, protection of cattle with barriers, elimination of wild hosts, selective elimination of infected animals, reduction of risk factors such as vector control, treatments and vaccinations allow to have control of the diseases of domestic animals and therefore of public health.

5.1. *Brucellosis*

Brucella spp. are the etiologic agents of brucellosis, they are facultative, nonmotile, gram-negative intracellular coccobacilli that can infect a wide range of mammalian species, including humans, and some amphibians. In developing countries, *B. abortus*, *B. melitensis*, and *B. suis* are the main causes of animal and human brucellosis. *Brucella* animal infection can occur through multiple different routes. The most common is through the gastrointestinal tract, but conjunctiva or inhalation are possible, and spontaneous abortion in infected ruminants is the hallmark of infection. Fetal and placental tissues and associated fluids expelled in abortion events are the main way of transmission in animal populations (Nielsen and Duncan, 1990). The bacterium can reside in the environment for up to a year, depending on favorable conditions (moisture, soil composition, temperature, ultraviolet exposure, etc.) (Cheville *et al.*, 1998). However, the presence of scavengers can reduce the time the bacteria remain in the environment. Of note, scavengers have not been recognized to increase the risk of transmission to livestock and scavengers are generally believed to reduce the risk of transmission (Cross *et al.*, 2013).

The enormous challenges that remain to control and eradicate brucellosis are: (1) to develop and validate new diagnostics to replace culture, ideally an ante-mortem assay; (2) develop effective vaccines that provide better protection to animal populations and that comply with the differentiation between infected and vaccinated animals antibodies; and (3) address disease in natural animal reservoirs and dedicate resources to animal brucellosis management to reduce incidence in human populations, effectively applying a One Health framework (Hull and Schumaker, 2018).

5.2. *Tuberculosis*

Organisms of the *Mycobacterium tuberculosis* complex have been traditionally associated only with humans and domestic livestock. However, due to the improvement in molecular diagnosis and epidemiological techniques the detection of mycobacterial infection in new hosts has improved and is no longer considered solely a disease of humans and livestock and nowadays tuberculosis is considered has become established in the wildlife population (Miller and Olea-Popelka, 2013). There are several cases throughout the world of the livestock-human-wildlife interface, mainly in Africa and Asia, and fewer in Latin America. Political instability, fragmented public health infrastructures, diversion of health resources, inadequate tuberculosis control programs, and relatively high rates in certain Latin American countries all play a role in the continued presence of tuberculosis. Similar issues apply to tuberculosis programs for cattle (Cosivi *et al.*, 1998)

Bovine tuberculosis is well documented in cattle herds in many Latin American countries and has the potential to spread to humans or wildlife through unpasteurized milk, contaminated meat, or environmental contamination. The environmental conditions, the potential interface with livestock and routes indirect transmission, such as carcasses or contaminated grass, are important factors when considering the risk of infection to wildlife. In Brazil, swamp deer (*Blastocerus dichotomus*) are giving negative results.

However, unlike ungulates, predators may be more at risk. Infected cattle could pose a threat to wild carnivores or scavengers through ingestion of infected meat or carrion or indirectly by eating insects which were in contact with infected secretions. There has been a report of a wild panther with tuberculosis from Argentina. In the mid-2000s in Argentina, carcasses of wild mink were found with lesions consistent with tuberculosis, which was later confirmed. The presence of the disease in wild mink poses a potential threat to disease control if wild and domestic animals share resources such as land or water (Miller and Olea-Popelka, 2013).

Miller *et al.*, (2012) reported that a jaguar (*Panthera onca*) imported to a US zoo from Venezuela showed clinical signs consistent with tuberculosis and *Mycobacterium bovis* was cultured from samples taken at necropsy. This jaguar had come from an institution where whole carcass feeding was practiced, and ingestion of infected meat was likely the source of infection. For chronic infections such as tuberculosis, disease interface problems can cross international borders creating additional challenges.

As with brucellosis, tuberculosis at the livestock-human-wildlife interface should be studied in greater depth and solutions sought to control and eradicate the disease. Vaccination of livestock, control of wildlife and elimination of vectors are the great challenges ahead.

6. Conclusion

Livestock activity has a great impact on all components of the environment, it is already known that it affects the soil, water, atmosphere, and biodiversity. The destruction of wildlife habitat by the expansion of grasslands or croplands used to feed domestic livestock has led to proximity between wildlife and livestock. This closeness, known as interaction, has implications mainly for food and water competition, but also for the risk of diseases at the interface between domestic animals, wild animals, and humans, as well as cases of livestock predation by carnivores that have seen their natural preys decrease and to feed by attacking domestic livestock.

This coexistence can be an opportunity to increase the income of the producers by including wildlife in their production system, allowing them to use the grasslands of domestic cattle, promoting their reproduction to offer recreational services such as photographic safaris and controlled hunting. These producers would migrate towards a type of diversified livestock that in some way benefits the habitat of wildlife that for decades or centuries has been pressured and put in danger of its existence.

7. References

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Chapter 7 Parasitized animal selection in small ruminant production systems: Field conditions alternatives

Capítulo 7 Selección de animales parasitados en producción de pequeños rumiantes: Alternativas en condiciones de campo

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Abstract

The aim is to provide knowledge about animal selection systems in the field that allows to reduce deworming and increase shelter, as part of targeted selective treatment (TST). The access granted by the Autonomous University of Campeche to databases such as Elsevier, Springer and Ebsco Host was used. The level of parasitosis is measured indirectly and animals that require it are dewormed. The count of eggs in feces is the most effective way to know the degree of parasitosis and can be compared with other systems. The degree of anemia is measured with the FAMACHA® card to select animals, applied with hematophagous parasites. Body condition is an indirect measure of body weight and is used as a selection criterion. Diarrhea is used to select animals to deworm. Productive indicators such as low daily weight gain and decrease in milk production are used as selection criteria. The selection using the happy factor system is calculated by dividing the energy deposited by the energy consumed, considering a good nutritional plane, if properly calculated it has proven to be a good indicator of deworming and finally it is concluded that, due to the type of parasites, the production system and breeds involved it is better to combine these systems to find the management that best suits the productive system.

Targeted selective treatment, Selection systems, Anthelmintic treatment

1. Introduction

Nowadays gastrointestinal nematodiasis persists as a problem in small ruminant production systems (Torres-Acosta *et al.*, 2012). The latter, although the use of modern anthelmintics (AH) with a broad spectrum of effectivity. However, producers often misused these AHs and propitiated the anthelmintic resistance phenomenon. Most parasitologist now agree that factors affecting the rapid anthelmintic development are the treatment of animals at the same time and in times of years where there are few infected larvae in the pasture, both practices finally leave less infected larvae in refugia (Kaplan, 2009).

Due to latter, alternatives strategies must be used to prolong the useful life of the AH. In this regard, only animals which suffer a parasitosis must be identified and treated. However, most of the times these illnesses are subclinical and is difficult to identified animals without evident signs of parasitosis. In this context, some other factors have been studied and proved to use at field conditions as an indirect way to diagnose parasitosis. I.e., the identification of animal to have a decline in productivity or clinical manifestation of verminosis must be treated (Bath and Van Wyk, 2009).

Nowadays, the fecal egg count (FEC) remains as the gold standard for diagnosed animals parasite populations, and clinical diagnosis for the detection of anthelmintic resistance; the three most important purposes of FEC are: i) screening anthelmintic efficacy, ii) identification of animals with low, medium and high parasite loads, and iii) clinical diagnosis of parasitism in single animals; this system is used to validate the use of others system based in productivity or clinical manifestation of parasitism (Nielsen, 2015).

Many systems have been developed to diagnose verminosis, some of them are focuses in one parasite characteristic, i.e. FAMACHA® system was developed to diagnose anemia in sheep and goats and is used in regions where the main parasites are hematophagous (*Haemonchus contortus*), FAMACHA® chart contains standardized set of five colors which are related with the range of hematocrit values F1, >28%; F2, 27%–23%; F3, 22%–18%; F4, 17%–13%; and F5, <12% (Van Wyk and Bath, 2002).

Body condition score (BCS) is a practical, low-tech measure that is accepted as an indicator of general condition and body reserves and therefore can act as an indicator of resistance to nematode infections mainly in adult sheep and goats (Cornelius *et al.*, 2014).

Liveweight gain is non-invasive, and relevant to the economics of the farm, weight changes over short periods can also provide an index of the effects of non-hematophagous parasites such as *Trichostrongylus* and *Ostertagia/Teladorsagia* spp. Changes in body weight are largely an indicator of resilience (i.e. the ability to resist the effect of parasite challenge by these genera) (Van Wyk, *et al.*, 2006).

The happy factor system uses energy efficiencies and is calculated by dividing the energy deposited by the consumed energy. If the parasites are not affecting the nutrient utilization means that can be accounted for, as a lack or poor herbage availability, thus, calculating energy efficiency may provide a useful indicator of the drenching time in the sheep farm (Greer *et al.*, 2009). The aim of the review was known the main parasitized animal selection systems in the field that allows to reduce the amount of deworming and increase refugia.

2. Methodology

A detailed search was carried out in the databases provided by the Autonomous University of Campeche through CONRICyT such as Ebsco, Elsevier, Springer and the Google Scholar search engine using as keywords selection systems, parasitized animals, methods of selection of parasitized animals, combinations of methods of selection of animals to be dewormed, always using the criterion of used in the field. Those articles that contained the use of parasitized animal selection systems at the field level and those that have been tested and are effective in the production units were selected.

3. Results

A wide range of articles published in the different integrators was found and those that best explain the methodology to be used in the parasitized animal selection system and the results reported were selected. A detailed explanation of each system of selection is presented through out the revision.

3.1. Using the Fecal Eggs Count System

Adult parasites inside the animal will lay eggs in different quantities according to the parasite specie. Some species lay many eggs like *Haemonchus contortus* and other species lay few eggs i.e., *Trichostrongylus colubriformis*. However, the Fecal egg count system named like eggs per gram of feces (EPG) is an indirect way to know the adult population of adult parasites inside the animals. Due to the variation in nematode lay habits, there is much animal-to-animal variation in the EPG counts, thus many authors recommended sampling a random proportion of the flock the latter to get a clear picture of the parasite load in the animals (USDA 2014).

The MacMaster technique, despite being a laboratory test it is related to field techniques due to the quality and quantity of materials and equipment necessary to develop it, in addition, the training is not complex, and it is not necessary for huge facilities. Furthermore, it is a required technique if you want to be specific in the selection of parasitized animals (USDA 2014).

3.1.1. In which animals should this system be used?

Sheep grazing pasture, especially, ewes and rams which stay on the farm for a long time during their reproductive life and suffer the parasitosis although their age and have a developed immune system. It is important to sample a representative number of animals (10% of the total) and separate adults from lambs, as counts normally are very different, even though the animals share the same pasture (USDA 2014).

Figure 1 Sheep in grazing pastures in tropical conditions, animals do not have a specific breed and two or more breeds are present in the small ruminant production system



Source: Own

3.1.2. How to get the samples

To get samples are necessary two persons: the sampler and one helper. Workers can group the sheep into a corner of a pen and hold them sampler must pick up 4 or 5 grams of feces (8 to 10 pellets each) that are fresh. Use a clean plastic bag or disposable glove to collect, invert and tie off. fecal samples must be taken directly from the rectum to have free environment contamination samples and after that can be placed in a cooler with ice packs. It is important to correctly identify the samples with the identification number of each animal and all the animals should be randomly selected to assure the correct representation of the flock (USDA, 2014).

Figure 2. A) Taking a sample of feces in sheep directly from the rectum, B) feces in a plastic bag. It is necessary to obtain 5 grams of feces



Source: Own

3.1.3. Transportation of the samples

Feces samples must be transported within 24 hours of collection. The best temperature to transport the samples is $<5^{\circ}\text{C}$, it is important not to freeze the sample until they reach the laboratory facilities. The latter to avoid the hatching which will lead to an underestimation of the real egg count level and a load of parasites. If there is no possibility to run the samples on the same day, it is important to refrigerate the samples and run the analysis within the 5 days of collection (USDA 2014).

3.1.4. Analysis of the samples

Usually, the solution of feces samples and saturated solution deposited in the McMaster chamber showed air bubbles, pollen, and other artifacts for this reason it is important that a trained person examine the sample. Another important thing is the use of a quantitative technique, for this case the McMaster technique which allows knowing the number of eggs per gram of feces in the sample. Qualitative techniques can note allow us to differentiate between a moderate (150 to 700 eggs per gram) or severe infection ($> 1,000$ eggs per gram of feces). The modified McMaster technique is described as follows:

Preparation of the saturated solution. Heat water to a 60°C . On a scale weight 1,280 grams of sugar. Add the sugar to the heated water slowly while mixing the solution, after adding the total sugar let it cool. Label a mortar with a consecutive number and tare labeled mortar with a strainer on the scale. Weight two grams of fecal pellets into the strainer on the scale. Dispense 28 ml of saturated flotation solution into the strainer on the mortar using the pestle crush the pellets against the strainer and mix.

Fill both chambers of the McMaster slide using a pipette, eye dropper, or an insulin syringe. It is important that the chambers do not have large bubbles, if this occurs empty the slide and refill the chamber must be entirely filled and not just the area under the grid. After that, let aside for approximately five minutes before the microscope observations to allow parasite eggs to float to the surface of the chamber.

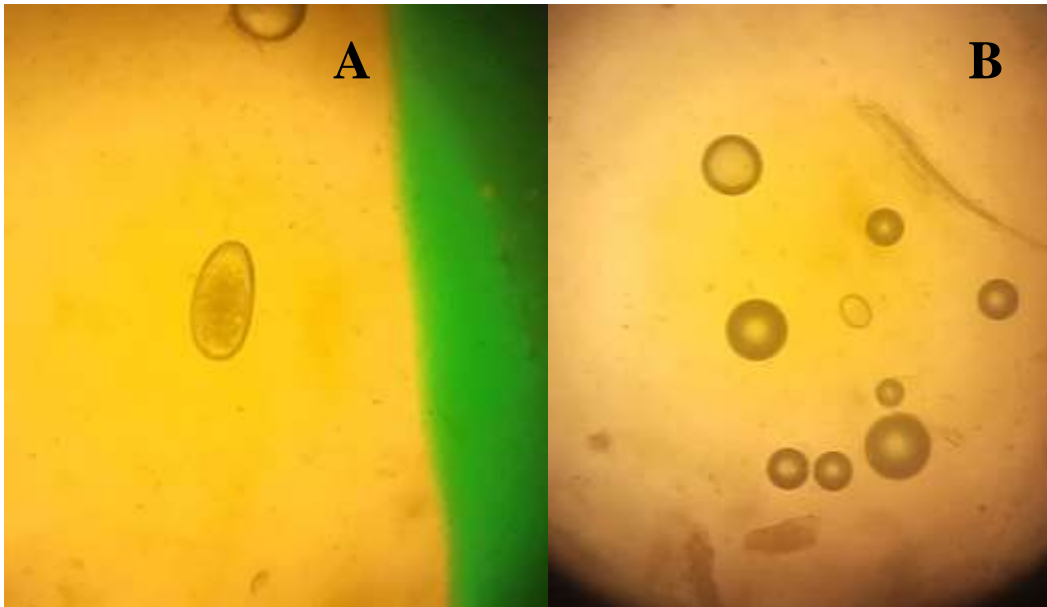
Place the slide onto the microscope stage. Focus the grid lines of the McMaster slide using the low power objective (4X). Turn to the 10X objective and refocus the grid lines. Start at the top or bottom corner of the grid and observe the full McMaster chamber with a zig-zag movement, this way does not lose track of whether you have counted only one or both chambers.

Count all eggs inside the grid areas including eggs on the grid line if greater than $\frac{1}{2}$ egg inside the grid. Count only strongylid eggs (oval-shaped eggs $\sim 80\text{-}90$ microns long). Even if you only count strongylid eggs this technique allows you to have an idea of other parasites present in the sample and can count them, however, the numbers are often difficult to interpret.

The total eggs recorded in both chambers must be multiplied by 50 as follows: (chamber 1 + chamber 2) * 50 = eggs per gram of feces (EPG)

The multiplication factor of 50 come from the ratio of feces (2 grams) to flotation saturated solution (28 ml). Thus, each egg observed in the sample represents 50 eggs/gram. If you do not observe any eggs in the sample means that the sample has less than 50 eggs in total (USDA 2014).

Figure 3 A) Classical shape of strongylida parasite eggs at 10X magnification; B) Eimeria oocyst and air bubbles in feces sample



Source: Own

3.1.5. Pooled versus individual samples

As was stated there is a large animal-to-animal variation in the result of the egg output, with 30% of the animals being responsible for 70% of the total egg output. Pooled samples can help but it is important to know the grade of parasitism of each animal to take a decision about the deworming action. To run samples of all animals can be expensive, for this reason, it is recommended to check all the animals and to use an alternative that allows to identify animals with signs of parasitosis and to take samples only from these animals.

3.1.6. How many eggs can sheep tolerate?

There is no agreement about the cut-point of the quantity of EPG which indicates a deworming treatment. However, some veterinarians recommended a threshold of 500 to 800 EPG to develop a control program based on monitoring the parasite loads. Normally, EPG <250 is considered low; from 250 to 800 is moderate, and >800 is severe. However, there are several factors that can be considered at the deciding moment of deworming between them the species of gastrointestinal nematodes (GIN) present in the production system; infection from the previous season, grazing heavily infested pasture as well as individual variability in EPG counts (USDA 2014).

3.2. Using the FAMACHA® System

This system has been developed as an indirect way to diagnose anemia in sheep and goats and is used for TST in regions where the main parasites are hematophagous (*Haemonchus* spp). The system uses a score of the color of the mucosa ocular surface in a FAMACHA® chart, this element contains a set of five standardized colors which are related to hematocrit (Ht) values as follows: F1, >28%; F2, 27%–23%; F3, 22%–18%; F4, 17%–13%; and F5, <12% (Van Wyk and Bath, 2002).

During the inspection of the animals the ocular mucosa is compared with the FAMACHA® chart and animals with a score of F4 and F5 are separated and selected to an anthelmintic treatment, while animals in F3 are considered as suspected and are investigated using another selection system like body condition or a sample of feces is taken to run the McMaster technique and calculate the fecal egg count (Van Wyk and Bath, 2002). As other system developed to select animals which can be benefited with the anthelmintic treatment the aim of FAMACHA® system is preserve the refugia through the decrease in the frequency of anthelmintic treatment and at the same time delay the resistance of parasite to the active ingredients of the commercial anthelmintics (Bath, 2011; Hoste *et al.*, 2011).

However, as all animal selection system the use of the FAMACHA® chart methodology present variations between breeds, production system, animal categories and nematodes species (Rizzon-Cintra *et al.*, 2018). About the application of FAMACHA® it is necessary to have in mind the next precautions:

- The system is only applicable where the main parasite is *H. contortus*, which cause as a clinical sign anemia.
- The redness coloration of ocular mucosa can be caused by another affections like eye disease, environmental irritants or systemic disease and the latter can cause confusion and mask anemia.
- Other causes of anemia can be discharged and the presence of *Haemonchus* worm must corroborated during the grazing season.

It is necessary not only just the elevate score of FAMACHA® it can be using another sign of parasitosis like diarrhea, bottle jaw, poor condition, dull hair coat, intolerance to heat or exercise (USDA 2014).

Figure 4. The FAMACHA® anemia guide cart



Source: (USDA, 2014)

3.2.1. How to examine animals with the FAMACHA® system

It is necessary to expose the lower eye mucous membranes and compare with the equivalent in the FAMACHA® card, the technique include:

- Cover the eye by rolling the upper eyelid down over the eyeball.
- Push down the eyeball. Apply a gentle pressure on the eyelashes of the upper eyelid are curling up over the thumb.
- Pull down the lower eyelid.
- Pop! mucous membrane will pop into view. Be assuring to score the bed of mucous membrane.

Compare the color of the mucous membrane to the FAMACHA® card and avoid shade the eye with your body or something more, try to do the comparison as quick as possible to avoid eye irritation (USDA 2014).

Figure 5. The lower eye mucous membranes are exposed and compared to the colors on the FAMACHA® card to estimate the level of anemia



Source: (USDA, 2014)

3.2.2. How often do the inspection

The inspection of the animals can vary according to the season.

During the wet season the inspection must be every 2 weeks because when the infection dose is high animals can go downhill fast.

During the dry season the nematodes are less active, and the inspection and the interval of inspection could be extended to four weeks (USDA 2014).

3.2.3. Where to use this system

The main criteria are the presence of hematophagous parasites (*Haemonchus* spp), animals must be in grazing system and finally is recommended in adult sheep, under these condition FAMACHA® system is considered one of the best criteria in ewes (Molento *et al.*, 2009; Leask *et al.*, 2013; Sotomaior and Cintra, 2018)

3.3. Using Body Condition System


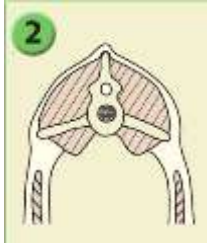
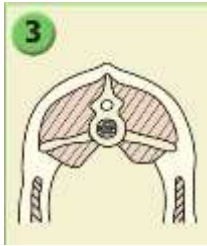

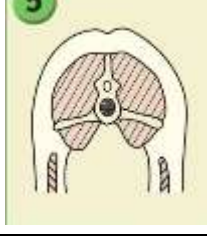
As anthelmintic resistance (AR) is a factor to be reduced in small ruminant populations, herd- and individual-targeted treatment approaches have been introduced to promote sustainable use of anthelmintics.

Targeted selective treatment (TST) is based on realistic thresholds for pathophysiological and/or production-based treatment indicators, such as clinical signs, body condition score (BCC), fecal egg count (FEC), weight gain or milk production (Bath and van Wyk, 2009; Charlier *et al.*, 2014).

Body condition is a method of scoring the condition of the animal based on the following points (Table 1):

- The prominence of the spinous processes of the anterior lumbar vertebrae is assessed by palpation.
- The sharpness and degree of the cover of the ends of the transverse processes and the extent of the muscular and fatty tissues beneath them are assessed by spanning the lumbar vertebrae with the fingers and thumb.
- The depth of the musculus longissimus dorsi and the degree of subcutaneous fat cover is assessed by palpating the region between the spinous processes and the transverse processes.

Table 1 The scale used for the measurement of body condition in sheep

Grade 0: extremely emaciated and on the point of death.	
Grade 1: spinous processes prominent and sharp; transverse processes also sharp, fingers pass easily under the ends, and it is possible to palpate between each process; Mm. longissimus dorsi shallow and practically without subcutaneous fat cover.	
Grade 2: spinous processes are prominent but smooth, and individual processes can only be palpated as fine corrugation; transverse processes are smooth and rounded, and fingers can pass under the ends with little pressure; longissimus dorsi muscle of moderate depth with little subcutaneous fat cover.	
Grade 3: spinous processes have only a small elevation, are smooth and rounded, and individual apophyses can only be palpated with pressure; transverse processes are smooth and well covered and firm pressure is required to palpate the ends; Mm. longissimus dorsi full with moderate subcutaneous fat cover.	
Grade 4: spinous processes can be detected with pressure as a hard line between the ends; Mm. longissimus dorsi and associated subcutaneous fat; transverse processes cannot be palpated; Mm. longissimus dorsi full with thick subcutaneous fat cover.	
Grade 5: The spinous processes cannot be felt even with firm pressure and there is a depression in the subcutaneous fat where the spinous process is normally felt; the transverse processes cannot be felt; Mm. longissimus dorsi is very full with very thick subcutaneous fat; there may be large fat deposits over the rump and tail.	

Source: Romero, 2015

Body condition score (BCS) is a practical, low-tech measure that is accepted as an indicator of general condition and body reserves and therefore can act as an indicator of resistance to nematode infections mainly in adult sheep and goats (Cornelius *et al.*, 2014).

As the FAMACHA© system is not applicable to non-hematophagous worm species, body condition scoring (Cottle, 1991) was tested on one farm, where despite a predominance of *H. contortus*, periodic problems with *Trichostrongylus* spp. infections occur. Initial results with condition scoring on this farm are encouraging regarding the levels of both phenotypic and genetic correlation with hematocrit values and fecal egg counts (Van Wyk and Bath, 2002). The role of body condition scoring must be evaluated, particularly on farms with predominantly *Ostertagia/Teladorsagia* spp. and/or *Trichostrongylus* spp. infection (Van Wyk, *et al.*, 2006).

In a study by Cornelius *et al.*, 2014, with Merino ewes in two production units using 271 3-year-old and 258 4-year-old animals, a relatively higher body condition response to treatment was observed in low body condition ewes prior to lambing compared to better condition ewes on a farm where nutrition was suboptimal and parasite load was high. Ewes with low pre-lambing body condition were 3 times more likely to fall into critically low body condition (<2.0) if left untreated.

It can be recommended to treat ewes with lower body conditions and leave a proportion of ewes with higher body conditions untreated in a targeted selective treatment program. A study by Soto-Barrientos with ewes in tropical conditions in 2018 showed that BSC was a good method to detect parasitized animals with a load > 750 HPG in ewes with a BSC < 2 with a 1.1% false-negative rate. This study involved a total of 724 animals between 6 and 11 months of age, hair breeds, mainly Pelibuey and Katahdin with some Blackbelly and Dorper crosses.

In a study by Calvete *et al.* (2019), sheep of the Aragonese breed and its variants with Romanov were studied, a total of 590 females with aged between 0.8 and 10.9 years old were studied. The study demonstrated the importance of BSC as a selection system for parasitic animals, where BSC < 2.75 required selective deworming, this selective deworming prior to mating increased the fertility of the ewes and the proportion of lactating ewes that became pregnant in the first ovulation cycle. It should also be noted that the HPG count must be greater than 600 to consider targeted selective deworming.

3.4. Using Bodyweight Gain System

Of the targeted selective treatments (TST), the use of liveweight gain is non-invasive, in the pen, and relevant to the economics of the farm. Weight changes over short periods can also provide an index of the effects of non-hematophagous parasites such as *Trichostrongylus* and *Ostertagia/Teladorsagia* spp. Unlike a static weight figure, which is related to body size, changes in body weight are largely an indicator of resilience (i.e., the ability to resist the effect of parasite challenge by these genera) (Van Wyk, *et al.*, 2006).

Average daily liveweight gains for each animal are calculated as the difference between its first and last recorded weight divided by days in the trial. The predicted target weight is calculated for all animals in the trial. To determine the effect on the production of leaving animals untreated, short-term (4 weeks) weight gains are compared between their predicted target weight in the weeks of treatment and lambs with TST that in the same weeks had reached their predicted target weight and, therefore, would not be treated. The system allows the prediction of the live weight of an individual lamb or group of lambs over a short period by considering the nutrition available to the animal, the lamb's stage of development, and environmental factors such as temperature. Only those lambs that failed to reach the target weight gain will receive anthelmintics. This approach was found to be able to sensitively identify those animals that were underperforming (Kenyon *et al.*, 2013).

A study on the use of liveweight gain as a marker for TST using Scottish Blackface to Texel sheep breeds (Kenyon *et al.*, 2013) showed very encouraging results in slowing the development of anthelmintic resistance, while effective control of gastrointestinal parasitism was achieved.

In a study by Busin *et al.*, 2014, the practical application and effect of a TST approach were investigated through liveweight gain as an alternative for the treatment of parasitic gastroenteritis in lambs (n = 385) over a period of 2 years. Liveweight, buttock fouling, and anthelmintic treatments were recorded individually at 14-day intervals during the grazing season. Adopting a TST approach did not have a negative effect on lamb liveweight gains, finishing time, or buttock fouling measures compared to routinely treated (RT) lambs; however, a 50% decrease in anthelmintic treatment was observed in the TST group. The implementation time of this system averaged 2min per lamb. It is concluded that TST through liveweight gain could be suitable for commercial sheep farms, in association with automated weighing systems, potentially reducing selection for anthelmintic resistance, without having a negative effect on production. An important benefit of using weight change as an index of relative parasitism is the potential for automation in situations where the cost of time and labor required for inspection of individual animals is prohibitive (Van Wyk, *et al.*, 2006).

Using automated weighing systems, radio frequency identification (RFID) ear tags are electronically interrogated to identify sheep as they walk towards a weighing platform, and the body weight at a particular time is recorded in a computer database. Differences in individual weights can be automatically calculated in successive evaluations, and animals that do not meet pre-set weight change criteria can be identified. Electronic gates linked to the database then direct animals to different pens according to treatment decisions based on weight changes. These systems, introduced for sheep in Australia, can process a few hundred animals per hour and have been used as a basis for individual nutritional decisions (Rowe, 2004).

While automated systems are technically feasible, the guidelines for treatment decisions based on production performance indices are less clear than those aimed at preventing serious parasitic diseases such as haemonchosis. Differentiation between the relative effects of parasites and nutrition may be difficult unless simultaneous assessments of parasite load are made. Another important issue concerns the relationship between parasite egg counts and clinical helminthiasis: high parasite egg counts do not necessarily reflect an inability to cope with the current parasite challenge, with the result that treating poorer performing animals may not prevent considerable contamination of pastures with parasite eggs from resilient animals (Van Wyk, *et al.*, 2006).

3.5. Using Evidence of Diarrhea

Diarrhea is one of the most serious health problems faced by small ruminants in grazing system around the world, as it leads to loss of weight and body condition. In many cases, diarrhea is related to a poor or nonexistent gastrointestinal nematode (GIN) control program that leads to high herd loads, mainly of *Teladorsagia circumcincta*, *Trichostrongylus* spp. and *Nematodirus* spp. In other cases, diarrhea is due to interactions between the animal and its diet, weather conditions, and the presence of bacterial and protozoal infections. The relationship between diarrhea and GIN infection is complex, it is an interaction between the direct effects of the infection and the host's immune response. The ingestion of GIN larvae during grazing is an important cause of diarrhea in adult animals (mainly females) of all ages. However, it is unclear whether the infective larval load and/or adults are responsible for diarrhea or the host animal's immune response that leads to diarrhea, like enteric food allergies in humans (Williams and Palmer, 2012).

As animals grow, they gradually develop immunity to GINs and may mount an immune response against larval stages, adults, or both (Hein *et al.*, 2010). During primary infection with abomasal GIN such as those mentioned, there is colonization of the mucosa that leads to goblet cell hyperplasia, decreased villus-crypt ratio, shedding of enterocytes into the intestinal lumen, and other pathophysiological events that may result in diarrhea. caused by a large amount of GIN that inhabit the mucosa of the digestive system of animals (Pullman *et al.*, 1989). The latter, suggests that diarrhea in young animals is highly likely to be caused by GIN. Broughan and Wall (2007) found a positive correlation between diarrhea and fecal egg count (FEC) in young lambs (3–6 months of age) and postulated that fecal soiling in young animals may be an indirect indicator of GIN load. However, as the age of the animals increases, there is an inverse correlation between diarrhea and FEC (Jacobson *et al.*, 2009). In other words, there is a tendency for adult animals with lower FEC to suffer more intense diarrhoea, complicating the scenario at certain times such as inadequate nutrition (times of drought) or in mothers close to childbirth or lactating (Kahn, 2003). Several studies have verified this inverse correlation between the FEC and the presentation of diarrhea. Douch *et al.*, (1995) reported that sheep that have been selected as resistant to GIN based on low FEC tend to have a higher incidence of diarrhea than sheep from unselected animals.

It is clear then that elevated GIN FECs do not necessarily lead to significant diarrhea, and it is also evident that sheep that are more resistant to GIN infection may be more prone to diarrhea. This suggests that the nematode-associated diarrhea seen in grazing small ruminants may be due to the inflammatory response to ingested infective larvae, in other words, to immunopathological mechanisms that result in shedding of parasites as part of the response acquired immune. So, in young pre-weaning animals it is possible to associate diarrhea with high parasite loads and decide to deworm the animals, but in post-weaning and adult animals it is not the most indicated, since these animals have low FEC and receiving an anthelmintic treatment does not it would alleviate the situation and it is probable that the resistance of the parasites to the anthelmintics will be increased.

3.5.1 Genetic selection

In Australia, they have selected sheep with low FEC and low propensity for diarrhea and found that these sheep regulate parasitic loads through an IgA-mediated immune response that inhibits the ingestive behavior and fecundity of the parasites in the mucosa, which would be a mechanism more neutralizing for the control of GIN. Contrary to the rapid and efficient IgE-mediated immune response that leads to the immediate expulsion of GIN (Williams *et al.*, 2010).

3.5.2. DISCO (Diarrhea Score)

This indicator of diarrhea is based on the dry matter content of sheep feces (mainly lambs) at the time of taking sample, and it refers to the consistency of feces, which is valued in a scale from 1 to 3. Feces with a value of 1 are considered normal if they are firm and consistency, those with a value of 2 are classified as soft, and those with a value of 3 are diarrheal. Values 1, 2 and 3 correspond to 40%, 26% and 16% dry matter, respectively. A score of 3 correlates with diarrhea and consequently with a high number of gastrointestinal nematodes.

This technique is proven for *T. circumcincta*, *Trichostrongylus axei*, and *Cooperia cuticei* infections. This indicator correlates very well with FEC ($r=0.42$) and when it has been used, the number of treatments with commercial anthelmintics has been reduced by up to 20% (Kenyon and Jackson, 2012). Bentounsi *et al.*, (2012) tested the efficacy of three indicators for the implementation of targeted deworming treatment in lambs in Algeria: anemia indicator (FAMACHA©), diarrhea indicator (DISCO) and weight gain. These indicators were compared with the FEC. The results indicate that the DISCO indicator proved to be the most effective, correctly identifying 80% of the sheep that need treatment. It was followed by FAMACHA© with a 50% accuracy level and finally weight gains, which were not a useful indicator.

Likewise, according to these results, it is suggested that the DISCO technique can be used by producers on their farms according to their specific situations, however, precautions must be taken during its application because it may be likely that they may be occurring losses in the production system before the clinic sign of diarrhea. Likewise, erroneous interpretations of the indicator may occur, in cases in which other pathogens of the digestive tract such as coccidia, which can cause diarrhea. For these reasons it is necessary to point out that the application of the indicator requires, of an adequate interpretation, to have an available knowledge of the situation of the endoparasites present in the farm (Cabaret *et al.*, 2006).

3.5.3. DAG score

Dags are the dried feces that hang from the wool or hair on the back of sheep. Fecal consistency (formed granules, soft granules, watery diarrhea) may reflect the parasitic load of GIN in small ruminants (although not due to *Haemonchus contortus* whose main affectation is anemia). The score ranges from 0 (no dirt) to 5 (a lot of dirtiness) (Table 2).

Table 2 Dag Score apply to sheep and goats as selection criteria to use an anthelmintic treatment

Score	Description	Action
0	No fecal dirt at all	None
1	Very light dirt on the edge of the tail	None
2	Light dirt on the edge of the tail	None
3	Moderate dirt, dag formation	Consider treatment
4	Lots of dirt, serious dag formation	Recommended treatment
5	Very severe watery diarrhea spreading to the hocks	It is essential to deworm

Source: (Edith *et al.*, 2018)

3.6. Using Milk Production and Lamb Nursing

There is few information about the use of milk production and lamb nursing as indicators of parasitosis, however, during its use in the field showed to be a good alternative to use in TST programs. At this respect Hoste *et al.* (2002a) found that goats in their first lactation and high milk production have a high FEC. The establishment of TST strategy to treat goats with higher milk production with anthelmintic, results were that, in two years of study reduced anthelmintic treatments by 48% and 66% respectively without negative effects on milk production compared to conventionally treated animals (Hoste *et al.*, 2002b). In another study, the TST strategy was tested on 11 dairy farms in France for two years, resulting in a 40% reduction in anthelmintic use with no significant changes in milk production or FEC, compared to conventionally treated animals (Hoste *et al.* al., 2002c), these results show that milk production could be an appropriate marker to identify those goats that require treatment, thus contributing to the delay of anthelmintic resistance.

This selection system has been used in Italy and appears to be very user-friendly approach for sheep farmer who are used the system with good results in southern Italy (Cringoli *et al.*, 2009), While is considered a poor treatment indicator in cows (Ravinet *et al.*, 2014). For the case of sheep Schwarz *et al* (2020) using Lacaune dairy sheep found and increasing EPG in ewes with high milk production indicating high yielding ewes to be less resistant to GIN infection and this effect was most pronounced in earlier lactation but remains along the lactation period in a moderate range; and their results indicate the potential use of milk yield data as TST indicator. There is evidence that ewes nursing multiple lambs have higher FECs than ewes nursing a single lamb. This is likely due to increased nutritional stress and energy deficit in ewes nursing multiple offspring, leading to a relaxation of immunity that normally occurs in the peripartum period and consists of a transient increase in shedding. NGI eggs during the last third of gestation and the first weeks of lactation (Beasley *et al.*, 2012).

3.7. Using the Happy Factor System

Anthelmintic resistance phenomena must lead to managing the parasite population unexposed to treatment (known as refugia), the latter to slow the development of resistance (Jackson and Waller, 2008). In this sense, it may be achieved treatment all the flock at specific times (when it is considered the season with the highest parasite prevalence), i.e. wet season in tropical conditions or summer drenching in Western Australia (Besier and Love, 2003) or apply the treatment only a selected proportion of the animals of the flock at any one time using some productions traits or heaviest animal (Leathwick *et al.*, 2006).

In addition, to this factor, we must consider the parasite species of the region, the breed of the animals in the production system, as well as the challenge likely to be encountered (Kenyon *et al.*, 2008). In this sense, one such selection indicator uses to identify which are candidates to be dewormed in many different environments and that not relying on clinical signs or production traits is necessary. A solution can be nutrient utilization, which has been shown to be affected by gastrointestinal parasites in both pens (Sykes and Coop, 1976) and field (Thamsborg and Agergaard, 2002) infections. This system uses energy efficiencies and is calculated by dividing the energy deposited by the consumed energy. If the parasites are not affecting the nutrient utilization means that can be accounted for, as a lack or poor herbage availability, thus, calculating energy efficiency may provide a useful indicator of the drenching time in the sheep farm.

The suggested formula uses the liveweight gain calculation, Eq. 6 (AFRC, 1993) multiplied by the liveweight gain of the farm.

$$\text{ME}_m = 0.4 \text{ liveweight}^{0.75} \quad (4)$$

where ME_m = ME required for maintenance (MJ)

$$\text{ME}_g \frac{1}{4} \text{ MEI} \text{ ME}_m \quad (5)$$

where ME_g = ME available for growth (MJ)

$$\text{NE per kg} \frac{1}{4} 4:4 \text{ } \frac{1}{2} 0:35 \text{ liveweight} \quad (6)$$

where NE = net energy (MJ)

According to the formulae energy available for growth (ME_g) but not ed up as NE deposited in carcasses would have dissipated as heat, this proportion can be used as a measure of inefficiency. Thus, efficiency can be calculated as 1 less the energy dissipated as heat Eq.7 (Greer *et al.*, 2009). Differences in the way of calculating the efficiency of energy utilization came from both sub-optimal pasture levels of mass and temperature (Ames and Brink, 1977) were accounted for by dividing the product of Eq. 7 by the product of each Eq. 9. Finally, the efficiency is estimated using the formula of Eq. 9.

$$\text{Energy utilization efficiency} = 1 - \frac{(\text{ME}_g) - \text{NE}}{\text{MEI}} \quad (7)$$

$$\text{TE} = -0.0018 \times \text{T}^2 + 0.0492 \times \text{T} + 0.6606 \quad (8)$$

where TE = correction for efficiency due to temperature.
T = mean temperature ($^{\circ}\text{C}$)

$$\text{Energy utilization} = ((1 - ((\text{MEg} - \text{NE}) / \text{MEI})) / \text{PI}) / \text{TE} \quad (9)$$

Greer *et al.* (2009) validating the model during at the star grazing season of 2006 and 2007 in Scotland and they compare with animals in a neo suppressive treatment; for the grazing season of 2007 the calculated treatment threshold was 0.65 and was calculated from the data of partial observations of the previous grazing season in 2006, any animal which not reach the target was dewormed; these authors find an optimum threshold efficiency value of 0.66 with a sensitivity of 74% and specificity of 87%. The pasture mass was not affected by the treatment and finally, animals using the model of selection showed less FEC during the study. In this context, the model appears to be successful to identify animals that need an anthelmintic treatment and could be used as part of a selective anthelmintic treatment program at a farm level. The model allows for reducing the proportion of nematode eggs with resistant alleles deposited onto the pastures through the selection of animals and this effect may be expected to be increased with time due to the identification of animals with less anthelmintic treatment (resilient) and their selection (Greer, *et al.*, 2009).

Another study by Kenyon *et al.* (2013) evaluated the impact of different treatment approaches including the TST (using the happy factor) in a five-year replicated trial and compared it with the neo suppressive treatment (ivermectin); these authors did not find differences in the liveweight gain between the suppression treatment (NST) and the targeted selective treatment (TST), since they report a reduction of 2%; the latter may be explained by the fact that animals are treated based on its performance would provide protection against the production loss and confirm the efficiency value of 0.66 sets since the beginning of the trial. In addition, the TST regimes allow for an increase in the parasites in refugia, which in long term slows the decline of drug efficacy and provide a balance between the animal performance and provision of refugia in temperate grazing environments.

Recently, McBean *et al.* (2021) studied if the standard threshold calculated in a previous study done by Greer *et al.* (2009) can be used on farms in another location, with different conditions and different animal breeds; these authors found that all farms had a reduction in anthelmintic use ranged from 30% to 89%, despite this reduction were obtained the variations on breeds, temperature, pasture quality suggests that the standard threshold for this study was to low. However, its use although not optimal for all farms could be used initially in TST schemes, since reducing the drug application, maintaining the parasite's refugia, and allowing the opportunity to refine the treatment threshold.

3.8. Combination of the different systems

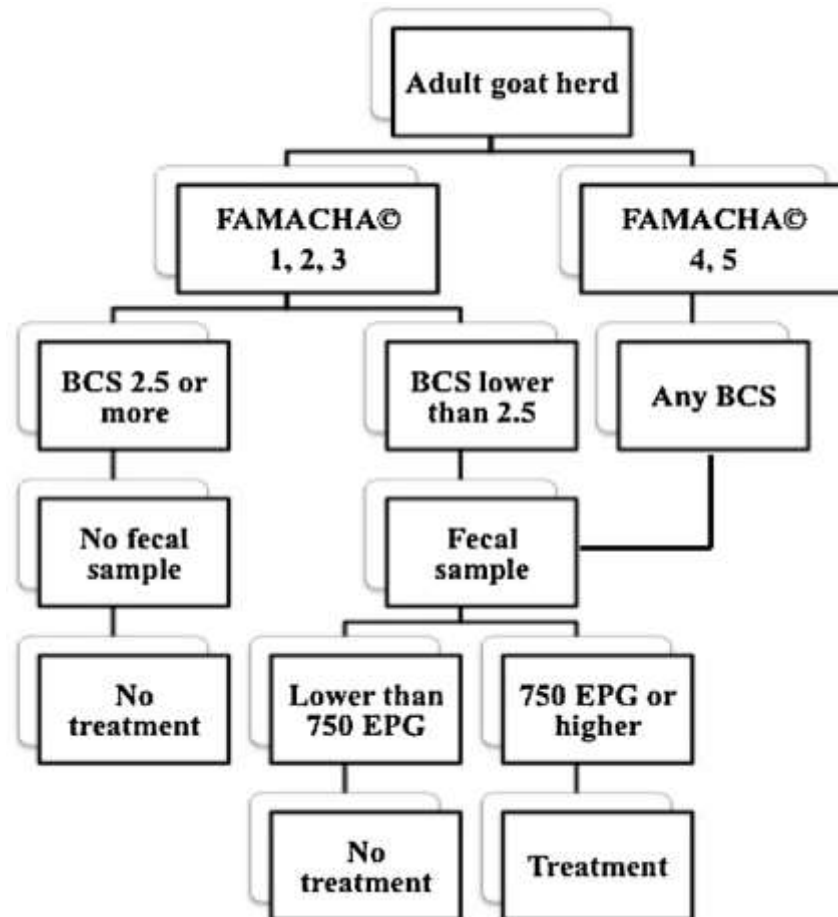
The main limitation of any TST scheme remains to be the difficulty of identifying those animals that are not coping with worm challenge. Only the FAMACHA© score and body condition score (BCS) have been regarded as being of practical value or having the potential for repeatedly examining herds and identifying individuals for AH treatment (VanWyk and Bath, 2002).

However, both methodologies have limitations when applied to adult goats even under conditions where *Haemonchus contortus* is abundant: (i) the sensitivity of FAMACHA© scores 4, 5 to detect anemia in goats is low (23–31%; Vatta *et al.*, 2002a), (ii) anemia can be caused by many factors (Van Wyk and Bath, 2002), (iii) BCS is also influenced by management and health aspects other than GIN infections (Vatta *et al.*, 2002b). It has been suggested that the combination of FAMACHA© and BCS, which can be applied simultaneously to a given flock, may achieve the full potential of clinical evaluation for hematophagous and non-hematophagous GIN infections (Van Wyk and Bath, 2002).

3.8.1. FAMACHA©, Body Condition Score, and Faecal Egg Count.

The FAMACHA© method is a selective deworming strategy based on the degree of anemia of an animal through the paleness of its ocular mucosa using a card. This card consists of 5 colors ranging from deep red to pale or white, where it is used to measure on a scale of 1 to 5 the coloring of the palpebral mucosa of sheep (Kaplan *et al.*, 2004). This method together with the measurement of body condition and a copro-parasitological examination as well as fecal egg count (FEC) allows the formulation of a deworming criterion (Moors and Gauly, 2009). This method is a very useful tool to identify the parasitic risk caused by *H. contortus* in small ruminants (Harlow, 2016, Golcalves-da Silva *et al.*, 2017); however, it must be performed by a trained professional for its correct use.

Figure 6. Decision tree in the combined targeted selective treatment (C-TST) scheme for goats with the criteria used for every step to determine when an animal was treated with an anthelmintic drug. (BCS = Body condition score; EPG = Eggs per gram of feces)



Source: Torres-Acosta *et al.* (2014)

The use of a combined decision key based on FAMACHA©, body condition score, and FEC has shown promise in Switzerland, and when used in the same goats, trained farmers achieved comparable scores to veterinarians resulting in a 49.7 percent reduction of anthelmintic treatments compared with strategic drenching three times per season (Charlier *et al.*, 2014)

Torres-Acosta *et al.* (2014) proposed a combined TST scheme in which a fecal sample is obtained from animals with FAMACHA© scores ≥ 4 or BCS ≤ 2 , and the AH is dosed only to those animals crossing an FEC threshold in naturally infected animals at farm level. Such TST scheme was built and validated for sheep and goats under hot humid tropical conditions of México using a threshold ≥ 750 eggs per gram of feces (EPG), and such TST scheme avoided unnecessary AH treatments for $> 70\%$ of sampled adult hair-sheep (Medina-Pérez *et al.*, 2015).

Table 3. Evidence-based indicators to support targeted selective (TST) anthelmintic treatments against gastrointestinal nematodes in ruminants

	Growing lambs	Dairy sheep/goats
Targeted selective treatment	Liveweight gain Production efficiency FAMACHA* FEC Diarrhea score	Grazing management Milk production level† Body condition score FAMACHA, body condition score, and FEC, in combination

Source: Charlier *et al.* (2015)

3.8.2. Faecal Egg Count, Body Condition Score, Antibodies

Genetic selection of resistant animals. Genetic resistance (GR) is the variation in immune response represented by a population of animals with the ability to control an infection or disease. To make a selection of animals (SA) with a resistance phenotype in a population, it is necessary the evaluation and measurement of various standards related to parasitological, immunological, and pathogenicity parameters, among which are the determination of EPG, body condition, percentage of hematocrit, the concentration of antibodies (IgA, IgE), the degree of eosinophilia in blood, among others (Maza, *et al.*, 2020, Estrada-Reyes, *et al.*, 2017, 2019, Reyes-Guerrero *et al.*, 2016).

A research topic that is receiving more attention is that of automation of parasite diagnostic processes. FEC-, antibody- and DNA-based technologies are all suitable for further automation (Mes, *et al.*, 2001, Roeber, *et al.*, 2012). Provided large numbers of samples can be analyzed, diagnostic costs can be reduced by automation, while there is also potential for greater deployment of diagnostic tests at the pen-side (for example, McCoy *et al.*, 2005).

4. Conclusion

Due to the different epidemiological conditions i.e., production system, animal breeds, and species of parasite, found in the animal production systems is better to combine some animal selection systems to find the management that best suits to the animal production systems to improve productivity

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Chapter 8 Study Habits and Their Relationship with Academic Performance. A Recap on the Different Methodologies

Capítulo 8 Los hábitos de estudio y su relación con el rendimiento académico. Una recapitulación sobre las diferentes metodologías

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Abstract

Habits are behaviors and customs that are learned by repetition. In education, habits are the action mode that students practice in their academic training. The studies carried out on study habits have been oriented toward various academic levels: primary education; secondary education; university careers in various areas of study such as zootechnics, medicine, dentistry, and administration; and others. Many studies have emphasized the importance of study habits and their impact on academic performance, which is the result of learning. There are different scales in study habits, among which the most outstanding are these: Álvarez and Fernández's study habits and techniques questionnaire, Fernández Poza's inventory, Palsane and Sharma's inventory of habits, and others that are modifications of the previous ones and that address physical and environmental conditions, planning, and structuring of time and knowledge of basic study techniques as the main theme. The results show deficiencies in study habits in students, although some other studies have indicated a high relationship with academic performance.

Planning, Qualifications, Study techniques

1. Introduction

Ordinarily, in education, habits are the constant modes of action that students practice in their academic training, that is, the way in which they face academic work on a daily basis, which implies organization in their time, space, techniques, and methods to be used (Sánchez *et al.*, 2016). Habits represent the activities or experiences that are carried out continuously in order to obtain a greater benefit in the learning process (Pineda & Alcántara, 2017). Study habits allow the student to react to new content and to know, understand, and apply it (Mondragón *et al.*, 2017). To acquire good study habits, general recommendations are made, such as: establish study schedules, properly distribute and organize time, review subjects daily, make summaries and outlines, write down main ideas, use the dictionary, and study in a clutter-free place free of noise but with good lighting and ventilation (Ogbodo, 2010; Sánchez *et al.*, 2016). Additionally, there are other aspects that must be taken into consideration, such as taking advantage of study time, achieving ideal conditions, discarding disturbing elements, effectively planning the work, correctly selecting the sources of information and documentation, adequately presenting the results, and mastering the techniques of observation, attention, concentration, and relaxation (Kumar, 2015; Mondragón *et al.*, 2017).

Studies carried out regarding study habits have been directed toward various academic levels, among which we can mention those referring to the basic level in primary school (Ozsoy *et al.*, 2009); secondary education (Sánchez *et al.*, 2016); university courses (Hernández *et al.*, 2012) in various areas of study such as zootechnics (Escalante *et al.*, 2008), medicine (Torshizi *et al.*, 2013), odontology (Castro *et al.*, 2015), and business administration (Mondragón *et al.*, 2017). In all these studies, the importance of study habits and their impact on academic performance are emphasized. The variables that affect academic performance are so many that their study is generally simplified using only one or two of them. The most frequent are gender, age, sociocultural environment, educational center type, study habits, reading habits, and leisure habits. Knowing the factors that affect better student performance is a primary task if you want to design improvement programs to prevent school failure (Capdevila & Bellmunt, 2016).

Academic performance is the result of learning, caused by the pedagogical intervention of the teacher and produced in the student (Sánchez *et al.*, 2016), generated as the result of numerous social variables that act in and from the person who learns, such as institutional, pedagogical, psychosocial, and sociodemographic factors (Montero *et al.*, 2007). The grades of schoolchildren are used to assess the results of teaching, and they constitute a criterion that can define academic performance (Capdevila & Bellmunt, 2016).

Habits are behaviors and customs that are learned by repetition. In general, habits can be classified as good and bad and can qualify different aspects of life, such as health, nutrition, and academic studies. Good habits allow individuals to achieve their goals (Mondragón *et al.*, 2017), while a person with poor study habits will not be able to learn properly. It is generally believed that a student learns effective study habits at school. Therefore, college students are assumed to already have effective study habits. But the environment of school and college is very different, and the need for effective study habits at the college level is higher compared to those required at school (Kumar, 2015).

Study habits enhance and facilitate learning skills; they are key steps to get the most out of learning and to achieve the best performance during academic training (Ríos-Falcón & Ramos-Enciso, 2013). A student with good study habits is able to study on their own, becoming autonomous. As indicated by Ozsoy *et al.* (2009), study habits are the amount and types of study routines that the student uses during a regular period that occurs in their environment. Routines include frequency of study sessions, review of material, self-assessment, rehearsal of learned material, and study in a supportive environment.

It is ordinary to use terms such as “study habits,” “study techniques,” “study methods,” or “learning strategies,” or simply the term “study.” Given all this diversity of concepts and to avoid confusion in terminology, we will speak of study habits as something general, which encompasses both techniques and strategies or study methods (Capdevila & Bellmunt, 2016).

Study skills, study habits, study attitudes, and study motivation play a fundamental role in determining the academic performance of students (Credé & Kuncel, 2008). Some authors have included metacognitive strategies to explain academic performance. Metacognitive strategies or metacognitive control skills consist of mental operations to achieve cognitive goals. The literature focuses on four metacognitive skills: prediction, planning, monitoring, and evaluation (Ozsoy *et al.*, 2009). Study skills are defined as the abilities of students to manage time and other resources to complete an academic task successfully. Finally, study habits and attitudes have been one of the main elements that explain school performance.

a) Some Scales that Measure Study Habits

Study Habits and Techniques Questionnaire (Álvarez & Fernández, 2015)

One of the preferred classifications of study habits is that of Álvarez & Fernández (2015), in which study habits are classified in three ways: with study habits, with poor habits, and without habits. The study habits and techniques questionnaire (SHTQ) has been chosen in several studies for being quick to administer and for permitting adjustment to the needs of the investigations. It has been applied in primary education (Aluja & Blanch, 2004), compulsory secondary (Capdevila & Bellmunt, 2016), and at university level (Enríquez, 2013).

In the methodology, the aspects that directly or indirectly affect the study task are evaluated. The appreciated aspects refer to three general areas: physical and environmental conditions, planning and structuring of time, and knowledge of the basic techniques. These aspects have been broken down into seven scales that make up the instrument: (a) general attitude toward study, which includes everything that refers to the predisposition, interest, and motivation toward the study; (b) place of study, which refers to the physical location that can contribute to greater concentration and performance; (c) physical condition of the students, which refers to situations in their organism that allow for good study performance; (d) the work plan, which includes everything that refers to a good planning and structuring of the time that will be devoted to study, taking into account the number of subjects and their difficulty; (e) study techniques, which offer guidelines on how to study and collect different steps that must be followed for the study of a topic or lesson; (f) exams and exercises, which include the guidelines that should be followed when these are carried out; and (g) works that include the aspects that must be taken into account to do a job (Álvarez & Fernández, 2015).

Pozar Study Habits Inventory

Fernández Pozar’s inventory of study habits (Fernández Pozar, 2014) has been widely used in many areas. Among the studies employing this inventory are a study of compulsory secondary education in students with attention deficit disorder with or without hyperactivity (Iglesias García *et al.*, 2016); a study in university careers with higher education students in physiotherapy (Torres Narváez *et al.*, 2009a, 2009b), mechanical engineering (Bayona & Ricon, 2017), and public accounting in Colombia (Quintana Arevalo *et al.*, 2017); and studies in Peru within faculties of engineering, ecotourism, and education (Ríos-Falcón & Ramos-Enciso, 2013) and within social sciences, engineering, and biomedical sciences (Cárdenas *et al.*, 2018). At the university level, a comparison has been made in three different institutions (Martínez Aguilar *et al.*, 2014) and among students studying for an administration degree in Mexico (Mondragón *et al.*, 2017).

The study habits inventory (SHI) is a test developed with the purpose of detecting to what extent the student knows how to study and in what aspects they are failing, so that the educator has elements that help him or her guide the students in the acquisition of habits. The results of these habits are classified as poor, bad, fair, good, and very good. The purposes of the SHI are to diagnose the nature of the habits, attitudes, or conditions with which the student faces his or her specific study task. The result is to make a prediction about the consequences of the influence of these habits, regardless of the incidence of other variables, and to act based on the diagnosis to modify defective habits or favor the acquisition and increase of those habits considered beneficial (Fernández Pozar, 2014).

The study habits inventory consists of 90 elements distributed as follows: (a) environmental conditions of the student, where personal conditions, physical conditions, and academic behavior are integrated; (b) study planning, which includes the schedules of all the activities and the organization of the materials and elements necessary for the study; (c) use of materials, which includes the management of books, reading, and preparation of summaries; (d) assimilation of contents to determine the degree of memorization and personalization that refers to personal and team work; and (e) sincerity, which considers issues of responsibility, solidarity, and punctuality (Fernández Pozar, 2014).

Palsane and Sharma Habits Inventory

The Palsane and Sharma habits inventory has been applied frequently to college students from India (Illahi Bhat & Khandai, 2016), in dentistry (Gilavand, 2019), and especially in medical sciences, in places like London (Trockels *et al.*, 2019) and in the Middle East, such as in Iran. The Palsane and Sharma study habits inventory consists of eight areas: (a) time division, (b) physical fitness, (c) reading ability, (d) observing, (e) learning motivation, (f) memory, (g) exams, and (h) well-being. It consists of 45 elements (Rezaie Looyeh *et al.*, 2017).

Other Classifications

In other cases, inventories of study habits and motivation have been modified, making use of the instruments used by other authors, including the Francisco Pozar inventory (Hernández *et al.*, 2012). These inventories have broken down habits regarding (a) interest in studying, (b) organization and planning for study, (c) attention and effort in class, (d) memorization, (e) comprehension of reading, (f) studying at home, (g) having controls for exams, and (h) intrinsic motivation for learning.

In other classifications, habits are indicated as bad, good, or excellent (Torshizi *et al.*, 2013). However, other scales have been associated with the success or failure of studies, as indicated by Escalante *et al.* (2008), who listed these factors associated with study habits: hygiene strategies, which allow for maintaining and promoting health, both physical and mental; material conditions, where all the resources and materials necessary to address the subject content are considered, in addition to considering the physical space and its characteristics; study strategies, which is the form of study that the person adopts to acquire knowledge (creating the study habit integrates the will, motivation, and psychological isolation); and study capacity, which includes all the mental actions to improve learning, including observation, association, and synthesis.

Although many of the topics that study habits address are similar, many variants have been generated in which the scales and aspects are grouped differently. In one study by Nonis & Hudson (2010), a seven-point scale was assigned for initially two study habits: schedule activities on a regular basis and concentration capacity (ability to pay attention in class). Later, a third habit -access to notes- was integrated. Access to a good set of notes was critical and also the starting point when learning or studying outside of class.

Study habits have been associated with study attitudes, which were evaluated in Turkey through the administration of a survey of study habits and attitudes, organized with four subscales: work methods, avoid delay, teacher acceptance, and educational acceptance (Ozsoy *et al.*, 2009).

In another study by Castro *et al.* (2015), seven items were used to evaluate study habits: (a) environmental factors, (b) physical and emotional health, (c) study method, (d) organization of plans and schedules, (e) taking exams, (f) search for information, and (g) motivation for to learn.

Another type is Rao's study habits inventory, which consists of 40 items that cover the six dimensions of study habits: (a) planning, (b) effective reading habits, (c) noting the preparation and review, (d) motivation and interest, (e) concentration and clarity, and (f) academic neuroticism (Khan, 2016).

Another study (Montes, 2012) applied the Gasperin study habits test, which measures behaviors and displays linked to student work in light of its six subscales: independent study (11 items), reading skills (10 items), time management (10 items), concentration (5 items), place of study (4 items), and information processing skills (10 items).

The objective of this study was to investigate the different methodologies on study habits and their relationship with academic performance in a study case with agronomic students.

2. Methodology

The study habits and techniques questionnaire of Álvarez & Fernández (2015) was used to identify the study habits of 343 students (203 men and 140 women; average age 19.2 ± 2.8 years). The students were selected using non-probabilistic convenience sampling. Four groups of Texcoco campus, coursing the third year of agricultural high school, were evaluated ($n = 36$, $n = 37$, $n = 40$, and $n = 44$, by each group respectively). Two propaedeutic groups from the Unidad Regional Universitaria Sursureste (URUSSE) in Tabasco ($n = 19$ and $n = 40$); one propaedeutic group from the Centro Regional Universitario Peninsula de Yucatán (CRUPY) in Mérida ($n = 40$); and two groups from the Centro Regional Universitario de Oriente (CRUO) in Huatusco, Veracruz ($n = 42$ and $n = 45$) were selected. An Excel database was created, and the information was analyzed using the SAS program. The Descriptive statistics was applied to preparation of interpretation scales (SAS, 2017).

3. Results of Study Habits in Agronomy Students

In a previously published case study by Peña Escalona *et al.* (2021) in high school students of the Universidad Autónoma Chapingo (UACH), differences between scales were observed, and the correlation with respect to qualification was obtained. Among the scales, the lowest score was planning, which implies that students must organize their academic activities and plan the time they will dedicate to each subject and their rest periods to improve their academic performance.

Table 1. Average of the Scales of Study Habits in Upper Secondary Education Students of the Universidad Autónoma Chapingo

Variable	LUG	PLA	ATE	TEC	ACT	TRA
Average	60.6	34.0	73.0	68.3	77.3	57.7
Standard deviation	18.2	22.4	16.1	17.2	16.9	20.6
Coefficient of variation	30.0	66.0	22.1	25.2	21.9	35.7

LUG: Place of study. PLA: Planning. AT: Attention. TEC: Study techniques. ACT: General attitude. TRA: Work

Source: Peña Escalona *et al.* (2021).

The results showed great uniformity in two different periods and Table 2 shows the averages in a subsample of 68 students to whom the same instrument was used before and after the COVID-19 pandemic.

Table 2. Average of the Scales of Study Habits in Upper Secondary Education Students of the Universidad Autónoma Chapingo Before and After the COVID-19 Pandemic

	LUG		PLA		ATE		TEC		ACT		TRA	
	A	B	A	B	A	B	A	B	A	B	A	B
Median	62.5	62.5	25.0	37.5	72.7	72.7	69.2	69.2	80.0	80.0	60.0	60.0
Average	60.1	60.1	31.2	39.5	73.1	71.6	67.2	72.2	77.2	75.7	57.9	61.0
Standard deviation	19.5	21.5	25.3	24.6	12.3	15.7	16.9	17.3	16.7	17.3	20.3	22.9

LUG: Place of study. PLA: Planning. AT: Attention. TEC: Study techniques. ACT: General attitude. TRA: Work. A: After pandemic, B: Before pandemic.

Source: Own

Compared with the results obtained in the present study, other results of study habits in students from primary school resulted in scores less than 51% in the scales of environment, exams and exercises, study techniques, and practical activities. While the scales general attitude toward study and time planning obtain less than 61%, and in the scales referring to the physical condition of the student was obtained less than 33% (Aluja & Blanch, 2004). For high school students, the study habits observed were higher, since except for time planning (46.4%) the other scales were between 58% and 71%, and the highest value corresponded to the study environment with 85% (Capdevila & Bellmunt, 2016).

In the correlations between study habits and academic performance, a very low coefficient was observed in all cases without exceeding 28% (Table 3). In the study habits scales a highest correlation occurred between TEC and TRA.

In other studies, an important correlation has been observed between academic performance and the scales for general attitude, time planning, place of study, study techniques, and homework. This implies that, for example, the conditions regarding the place of study are positively related to academic performance, regardless of the study techniques that are applied or the attitude that one has toward study (Capdevila & Bellmunt, 2016). Some of the modifications in the study habits scale were those indicated by Sánchez *et al.* (2016), who from 86 items developed a nominal scale from 1 to 10, with which it is possible to numerically relate study habits and academic performance. Using this scale, the researchers found a 40% relationship between these two variables.

Table 3. Spearman Correlations Obtained Between the Scales of Study Habits in High School Students (Higher) and Propaedeutic (Lower)

		High school students (N = 157)							
		Age	score	LUG	PLA	ATE	TEC	ACT	TRA
propaedeutic (N = 186)	Age	1	-0.09 ^{ns}	-0.02 ^{ns}	-0.06 ^{ns}	-0.06 ^{ns}	-0.13 ^{ns}	-0.21*	-0.20*
	score	-0.21*	1	0.20*	0.14 ^{ns}	0.28**	0.18*	0.20*	0.26**
	LUG	-0.10 ^{ns}	0.22**	1	0.17*	0.19*	0.25**	0.38**	0.32**
	PLA	0.07 ^{ns}	0.12 ^{ns}	0.12 ^{ns}	1	0.21*	0.34**	0.36**	0.42**
	ATE	-0.02 ^{ns}	0.15*	0.23**	0.22**	1	0.35**	0.42**	0.29**
	TEC	0.05 ^{ns}	0.14 ^{ns}	0.13 ^{ns}	0.35**	0.38**	1	0.32**	0.45**
	ACT	0.03 ^{ns}	0.17*	0.22**	0.30**	0.33**	0.25**	1	0.42**
	TRA	-0.13 ^{ns}	0.12 ^{ns}	0.29**	0.31**	0.31**	0.49**	0.28**	1

LUG: Place of study. PLA: Planning. AT: Attention. TEC: Study techniques. ACT: General attitude. TRA: Work. **: Highly significant ($p < .01$), *: Significant ($p < .05$), ns: Not significant ($p > .05$). Above the diagonal high school correlations, below the diagonal correlations of the propaedeutic

Source: Own.

In other scales, positive correlations have been found among assertiveness, communication, general study methods and techniques, task performance, exam preparation, class notes, and study accompaniment, finding high correlations between communication and each of the dimensions of study habits (Cunza & Quinteros, 2015).

Contrary to the results of study habits observed before and after the COVID-19 pandemic, in which the values of study habits did not change, another trial shows advantages in the academic performance of students who used different virtual platforms (Sozzi, 2022). Some studies have found a positive relationship between study habits and academic performance.

A low level of habits generates the absence of skills and strategies for study and learning, with deficits in planning and organization and assimilation of content. The results of the research show the existence of a statistically significant relationship between the levels of study habits and the levels of academic performance of students who take algebra (Pineda & Alcántara, 2017). The academic performance presented by the students in many cases is poor, there is little interest, motivation and dedication to study, what is more, the academic performance decreases as they have greater difficulties in making truly important learning (Ríos-Falcón & Ramos-Enciso, 2013). Conversely, it has been indicated that academic performance has been improved through tutoring (Gonzales, 2022).

Some authors have showed concern about the results obtained from study habits (and the variables that comprise it), since higher education shows a clear deterioration which is related to the high rates of disapproval and desertion of the school. Given this, it is common to find propaedeutic or study methodology courses that in some way seek to establish in incoming students a series of habits considered important to face the demands of the university. However, it is assumed without further evidence that study habits largely explain student performance (Montes, 2012).

Low study habits (meeting the minimum level for approval) were found among students of the zootechnical agricultural engineer career of the Center for Professional Studies of the Superior Agricultural College of the State of Guerrero (Escalante *et al.*, 2008). A similar situation has been found in other countries such as Iran, where the average score of students' study habits was 45.07 (± 7.81) out of 90 (maximum score). In this study, 32.8% of students had poor study habits, 31.1% had study habits around average, 14.3% were good, and 21.8% had excellent study habits (Torshizi *et al.*, 2013). Another study showing low results in study habits in administration students (Mondragón *et al.*, 2017).

In this case study habits were not related to academic performance, because students attended school only to get good grades; they had no interest in learning to learn. Instead, they only memorized the information as requested by the teachers, as a result of participating in a traditional education. It is worrying when 60% of the students only sometimes clearly understand the content of what they study, and 43% only sometimes distinguish what is really asked of them, which shows that they do not have adequate study habits to be self-sufficient in learning. Most of the respondents had not carried out correct bibliographic searches, did not know how to discuss homework, and did not know the structure of scientific work (Castro *et al.*, 2015). However, a study carried out in Turkey (Ozsoy *et al.*, 2009) shows a high score in habits with a value of 60 to 70% of the score in all the scales evaluated.

Nonis & Hudson (2010) showed that scheduling had a negative relationship with academic achievement, implying that students who waited until the last minute to study performed better. Even if this is contrary to popular belief, waiting until the last minute can be an effective study strategy for some students and in certain courses. In summary, the results suggest that the amount of time spent studying influences academic performance modulated by a third variable, the study habits used by students (Nonis & Hudson, 2010). Another study, however, showed that, in general, students memorize a large amount of information to pass a subject, studying a day before the evaluations, and retaining the information for only a short time; thus they must return to study for subsequent exams. There is little experience in learning methodologies, especially in secondary education, which causes students to memorize knowledge through repetitive reading, preventing the achievement of meaningful learning (Sánchez *et al.*, 2016).

Results by Hernández *et al.* (2012) showed that students have problems with the organization and planning of study, memorization techniques, reading comprehension, studying at home, and the lack of strategies to increase motivation and self-esteem. In that study, 75% of management engineering students were found to have good study habits that allowed them to maintain control over the exams they had to face. This was true for a lower proportion of students from logistics and ICT careers. Overall, just over half of the boys surveyed said they only sometimes review material, study notes trying to figure out possible test questions, plan their time to prepare for their tests, and apply strategies for taking them. Motivation for reading is one of the main factors that improve academic performance (Chura, 2022).

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5. Conclusion

Study habits have been observed to depend on various factors that need to be taken into account in the analysis because the scales by themselves do not reflect a relationship with academic performance. A few studies have reported high correlations between study habits and academic performance, so they indicate that if students improve their habits, they will perform adequately, and their academic performance will be optimal. However, many other studies, including among agronomy students, have showed low correlations between these variables.

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Chapter 9 Retirement and life project in a group of people from the state of Campeche, México

Capítulo 9 Jubilación y Proyecto de vida en un grupo de personas del estado de Campeche, México

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Abstract

Joy and life project in a group of people from the state of Campeche, Mexico. The objective of this work was to establish within the period of old age and the theory of activity, if retirees or pensioners in the state of Campeche Mexico had an active life project or not, for this purpose 52 people from different localities of the state in order to interview them and obtain their answers, and to know if the pensions they earn allow them to continue with their quality of life prior to their retirement from work, establish new projects or only stay at subsistence level. It was obtained that all of them have a life project, although four of them do not constitute it in a clean way, their pensions cover their needs as long as they manage it correctly, in addition to having social security that provides them with medical attention and medicines in case It is therefore necessary to present common diseases of old age such as short vision or diabetes. All of them are sheltered by their family environment.

Campeche, Retirees, Mexico, Life project, Old age

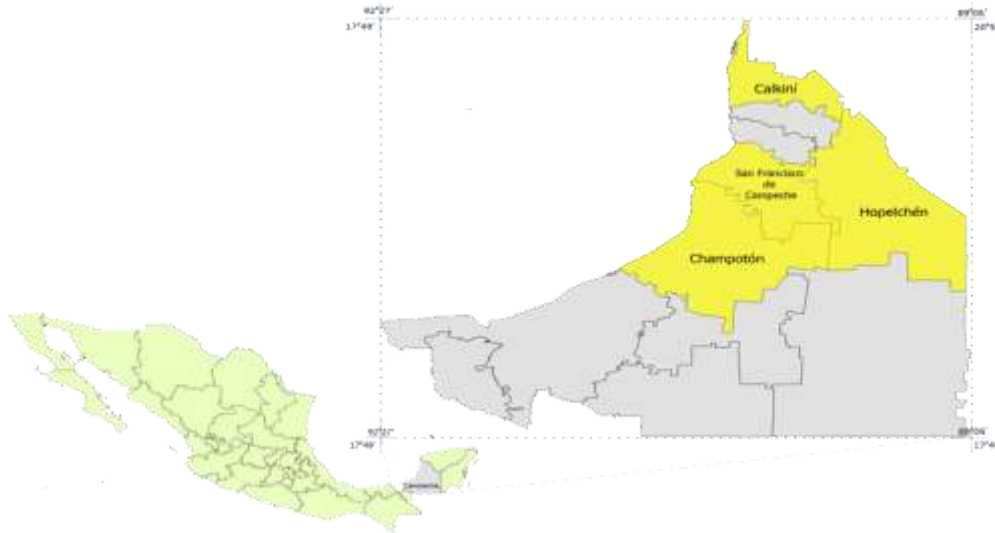
1. Introduction

In the year 2021, during one of the virtual classes of the psychology methods subject, a challenge appeared from the teacher towards the students who are organized into teams of 5 or 6 people: find two variables that were little studied and they will be found within the human development of the individual, to carry out a measurement instrument which could be a questionnaire or an interview guide, as part of the study program of the subject (Valencia *et al.*, 2019a).

Among the variables selected by the work teams, the following were mentioned: pregnancy, confinement, SARSCOV2, virtuality, however a team of students proposed the life project and the retirement of people who have completed a life cycle labor, the importance of this issue is that in psychology at this time it is an emerging issue, necessary to investigate and address because the Mexican population, although it is still young, in approximately two decades there will be a high number of elderly people According to them and reviewing the INEGI Population and Housing Census (2020), it was found that in the state of Campeche, of the thirteen municipalities, Campeche ranks fourth at the state level in terms of population concentration of 65 years and more, having 8.6% of 100%; of the thirteen municipalities, this being the oldest within the state, concentrating a population of 294 077 people with an average age of 31 years and of which 1.9% of women and 2.2% of men are between 60 and 64 years old having

The total population of older people in the entity has grown by 11.1%, with a difference of 2.8% compared to the 2010 Census data and knowing in advance that the largest age group with disabilities in the entity is 60-84 years old, representing 40.9% of the total, makes them more vulnerable and dependent on third parties when carrying out their daily activities, since most disabilities are defined as difficulties walking, going up or down, with 48.4% and seeing, even wearing glasses, with 45.9% all dealing with activities related to the field of health (Valencia *et al.*, 2019b).

The state of Campeche, is located in the Yucatan peninsula, in the southeast of the Mexican Republic (Valencia *et al.*, 2020), whose population still does not reach one million inhabitants and the bulk of this is found in two of the thirteen municipalities; Campeche and El Carmen, where economic activities are concentrated, because although the other municipalities are considered cities, due to their urban characteristics, they could be considered closer to the rural environment than to the city (Figura 1).

Figure 1. Geographic location of Campeche

Source: Niño, Bolívar & Valencia (2016)

Given these data, the responsible team took on the task of collecting information about its variables to define them conceptually and operationalize them to measure them. One of the problems they encountered is that the life project in most of the literature is conceived only for adolescents or young adults, but not for older people, another redeeming point is that to find material on old age or retirement it is necessary carry out the bibliographic search not only in developmental or work psychology but also in areas related to it. In this way, the database on gerontology or the health sector was accessed. In addition, it was found that to investigate retirement we must first frame it within the period of old age development, family relationships, with important items such as health, protection laws, paid or unpaid work in the workplace, and life not only with the life project, but also with the aspirations and social imaginary of what a retiree is.

It was decided to develop the theme of old age first, considering that it is the stage of life that involves the end of working life. Which was not easy because 20-year-old girls were trying to do it, whose vision is definitely far from the stage they wanted to investigate, in addition to the fact that the bibliography found is mostly from Spain, at the Latin American level, there are very few studies found. In the background, the life project and finally the retirement of the adults in the study sample. The objective that gave rise to this writing was to analyze if the life projects of men and women and the amount of the pension they receive as retirees from 60 to 70 years of age, affects their chosen life project, and to know if do retired adults from the state government have a life project? As a research question.

When the work of compiling the information began, to develop the writing, one of the characteristics that the bibliographic material presented was that it is a little studied subject, even when there is an entire branch of geriatrics that studies older adults, and some they are dedicated to diseases, it seems that when they reach 60 years of age and stop being an active worker, the elderly person disappears from the public scene, by ceasing to contribute economically or being productive and is only found in the private sphere, which is not always the case.

On the other hand, today it is common to see older adults with characteristics that do not always correspond to their chronological age, for example, their physical appearance, without the use of supports such as a walking cane, or older adults who are retired and active in different activities already be it exercising, taking care of grandchildren, walking with their peers, or undertaking new activities or learning to use technology with the support of children, grandchildren or more experienced contemporaries in these matters. Given these comments by the students, most of whom have elderly grandparents or acquaintances, we took on the task of trying to explain how the perception of the older adult who is conceived as an active person has changed, and with goals to achieve in your personal life either alone or in the company of your partner or family. It began by characterizing what old age is:

1.1 Characteristics of old age

Old age is the stage of life whose beginning is determined by each society, through the United Nations Organization (UN) established as a cut-off point for the age of onset of old age, 65 years for developed or European countries and 60 years for developing countries. The difference in ages for the establishment of the onset of old age was based on the different conditions and life expectancy of both groups of countries.

Currently, in developing countries such as Mexico, 60 years of age is accepted as the beginning of old age, and this is defined as a social construction, both individual and collective, that determines the ways of perceiving, appreciating and acting in certain socio-historical spaces. Old age as one of the stages of human development is a consequence of the stages that preceded it and reflects biology, the social context, the vision and attitude towards life of each person (Gutiérrez Robledo & Gutiérrez Ávila 2010); (Mendoza-Núñez *et. al.*, 2013).

In this way, it was found that various authors classify aging in various ways, for example, primary aging is a gradual and inevitable process of body deterioration that begins at an early age and continues throughout the years, no matter what people do to postpone it. Secondary aging results from illness, abuse, and inactivity, factors that can often be controlled by the individual (Busse, 1987; J.C. Horn and Meer, 1987) cited in Papalia Diane *et. al.*, (2010).

Social scientists interested in aging use the classification of old age into three groups: the “young old, whose chronological age is between 65 and 74 years; it will be the group of adults with whom this research will work; the “old old man” varies between 75 and 84 years old and the old man of advanced age is from 85 years old, although it is an important classification due to the chronology used, it is also important to mention that if we talk about a functional old age this could be better than the chronological one, since a 65-year-old adult who is sick or has senile dementia is not the same as a 90-year-old person who does not have this disease. The importance of this classification lies in the fact that the life expectancy of the Mexican population in the case of women is 78 years and that of men is 72, likewise it has been shown that women live longer than men due to the protection that it gives them estrogen, and also because they go to the doctor when necessary or use prevention programs promoted by health institutions, which does not always happen with men.

Reaching old age fully empowered implies prior work on the part of people, in the sense that if they took the necessary care to maintain their health, such as having exercised, having an adequate diet, or attending to diseases that he would have presented at the time, not having abused alcohol, drugs or tobacco, having formed a support network with friends or acquaintances, it is very likely that although evident physical changes are observed during aging such as that of the skin that tends to pale and lose elasticity, appearing wrinkles, fat and muscle mass are reduced, body hair begins to decrease and hair becomes fine and whiten or discolored, bone problems or osteoporosis may appear, changes to internal level in sensory, motor or sexual functioning as well as in the brain, which is natural as part of human development, however although the elderly become a little If he is slower in his physical or intellectual tasks, as long as he does not present brain alterations such as senile dementia or Alzheimer's, he is a fully grown adult who, according to life expectancy in the Mexican case, can live up to 72 or 78 years or more.

As part of the discussions that were held with the work team when compiling information to carry out their interview guide, on the stage of old age it was necessary to establish which are the most common diseases suffered by older adults, finding that in the first place Neurological or degenerative diseases appear as serious conditions that influence the daily actions of the elderly, since cognitive, functional, emotional or movement functions are altered and according to F.A.S.S. (Fundación Atilano Sánchez Sánchez) Alzheimer's, dementia, Parkinson's, stroke (cerebral infarction) and ALS occur in a significant part of the population over 60 years of age. They are briefly described below.

Alzheimer, is classified within cognitive diseases because as nerve cells weaken, the brain ages and suffers cognitive deterioration whose maximum expression is progressive memory loss, it can begin with the forgetting of trivial things such as the place where they kept the keys, and progressively they forget who the people around them are, they do not recognize their husband or children and in the most serious case they forget the need to eat or drink water.

Stroke (cerebrovascular disease) (a stroke or seizure; a rhythmical or metrical stress) is one of the most common diseases in the elderly. Its origin lies in the obstruction or rupture of a blood vessel responsible for carrying blood to the brain. This reduces the blood flow to the brain and the nerve cells stop working, it is also known as a cerebral infarction, the most common symptoms when a person suffers a stroke are tingling on one side of the body or face, loss of speech, impaired vision and loss of coordination, as well as headache.

Amyotrophic lateral sclerosis or ALS, is a disease of the neurons in the brain, brainstem, and spinal cord that control the movement of voluntary muscles. Motor neurons wear out or die and can no longer send messages to muscles. Over time, this leads to muscle weakness, spasms and inability to move the arms, legs and body, although this disease shows the first symptoms from the age of 40, it is in old age when it is fully recognized, however, few elderly people present it.

Another disease that older people suffer from is Parkinson's. This directly affects the neurological system as there is a progressive loss of neurons, tremors are generated in the person, reduced mobility, and alteration of balance, in addition, muscular rigidity is observed that makes it impossible to lead a much more bearable and independent life.

In addition to neurological diseases in old age, there are also other types of diseases resulting from the passage of time, among which are heart conditions such as heart attacks, which are considered one of the leading causes of death among the elderly. The risk factors that can lead to a heart attack are smoking, obesity, hypertension, cholesterol and diabetes and the most common symptoms before a heart attack are: Dyspnea, shortness of breath, dizziness, chest pain and arm pain left, fatigue or extreme tiredness, although there are different types of heart attacks, the most common is myocardial infarction.

Osteoarthritis and Arthritis. It is possible that almost the entire elderly population suffers from arthritis that is characterized by inflammation and swelling in the joints that cause pain when making certain movements or gestures. Osteoarthritis usually comes from severe arthritis when cartilage degenerates and can be treated based on anti-inflammatories, infiltrations and rehabilitation, which allows the person to lead a life without pain, although it limits their mobility.

Broken bones (osteoporosis). Osteoporosis itself is a degenerative disease that is understood as a decrease in bone density, the decrease in minerals in the bones can affect the adult when falling and hitting, which can lead to fractures or cracks in the bones. One of the most common is hip fracture in older people. The most affected are women who lose the protection of estrogens after menopause and because they continue to carry out household activities that involve the risk of falls.

Hypertension. It is common for older people to have high blood pressure. This is a chronic disease in which the pressure with which the heart pumps blood to the arteries increases, so that it circulates throughout the body, overweight and obesity can increase blood pressure, raise blood glucose levels, cholesterol, triglycerides, and uric acid, which make it difficult for blood to flow through the body. Most people with high blood pressure don't. you know, because they don't have any symptoms, but some may present: intense headache, dizziness, ringing in the ears, sensation of seeing little lights, blurred vision, chest and/or lower back pain, or swollen ankles To take care of these indexes it is necessary eat a healthy diet and do physical activity <http://www.imss.gob.mx/salud-en-linea/hipertension-arterial>

Diabetes. It is a disease in which the levels of glucose (sugar) in the blood are very high. Glucose comes from the food you eat. Insulin is a hormone that helps glucose enter cells to supply them with energy. In type 1 diabetes, the body does not produce insulin. In type 2 diabetes, the most common type, the body does not make or use insulin properly. Without enough insulin, glucose stays in the blood, and over time, too much glucose in the blood can damage the eyes, kidneys, and nerves. Diabetes can also cause heart disease, stroke, and the need for limb amputations or dialysis <https://medlineplus.gov/spanish/diabetes.html>. The main causes of this disease are stress, poor eating habits and inactivity, being a common disease in old age. Which can lead to obesity and eating disorders in older adults.

Any sense loses efficiency over time and sensory capacities such as hearing can develop some degree of deafness and sight are one of the ones that suffer the most as it is a degenerative process that has no solution.

Hearing loss is one of the problems that most affects old age; Presbycusis or progressive hearing loss is related to age, which accelerates after the age of 55, especially sounds of higher frequencies and affects activities that require auditory enjoyment (learning to play an instrument, going somewhere concert), this hearing loss can degenerate into total deafness, which can also cause comprehension problems at an individual level or communication with people, leading the elderly to social isolation or emotional deterioration in their family environment, however most of the time the adult can be supported with the use of hearing aids that allows them to maintain or improve their quality of life.

Regarding sight, age also influences this and visual problems can develop from tired eyesight, loss of sharpness in sight or difficulty focusing on near objects (presbyopia), glaucoma due to ocular pressure, to the appearance of cataracts, these conditions can occur individually or in combination, which interferes with visual functions and the enjoyment of activities that require visual perception. In some cases, the use of prescription lenses helps, or surgery in the case of cataracts.

The diseases mentioned above are the most common, at this stage of the development of the elderly, however, fibromyalgia is also usually present, which can appear at any time of life and its condition is very difficult to diagnose as it is confused with chronic pain, apathy or reluctance of the person and a last and little studied is depression due to loneliness in which the elderly can fall when they do not have a family support network or live alone by choice.

Within the psychological characteristics that appear during old age are at the family and psychological level, for example stressful situations such as children leaving home for work or personal reasons or their emancipation from the parental home can lead to nest syndrome empty, but also a mourning for the loss of a loved one in this case when separating from the family, or for the death of the spouse, a close relative or acquaintances of their social circle generates stress when facing the duel, and perceive that although it is a natural process of life, you are not always prepared, even a change of house can affect them because it means taking them out of a space full of memories, history, feelings and identity. Difficulty adapting can in many cases cause memory changes or problems, cognitive, emotional or health disorders.

1.2 The role of the family during old age

What is the role of the family in the retirement process? We asked ourselves this question when we began to obtain the results of the interviews and we found that within the Mexican family it is still common at the beginning of the century to have a fairly solid extended family made up of grandparents, parents and children and sometimes even a fourth generation. living in the same space, this is possible in rural communities where the lots (land or property) are half a hectare, this allows to have a house where the children live owners of the place and around them in smaller houses the other families formed by the children and their partners, where social customs and traditions are reproduced, thus having a fairly solid family support network. Even within the city, even if they live in separate houses or in other neighborhoods, since the distances are small, it is common for them to maintain communication with their parents and visit them continuously.

Within traditional families, the values of care and respect for the elderly, such as parents and grandparents, are maintained, family ties are strong and are interwoven by the support in all aspects that the members of the family maintain among themselves. Martínez-Martín (2008), states that when a person maintains strong family ties, built on communication and respect among members, these constitute a fundamental pillar for the participants, not only economically but also emotionally, also influencing on their subjective well-being.

In the Mexican family, in general, the man has been the economic provider and the woman has been the one who has taken care not only of the children but also of her partner, or her grandchildren, and in some cases of sick relatives. And although it may seem paradoxical, this multiplicity of activities keeps housewives active who are not necessarily going to have changes when their partner retires from work. In the case of the supplier worker, there will be, because they will face a series of factors that they had not considered, such as being at home without a rigid schedule to comply with or a specific activity to carry out.

Nowadays, the family is also changing and faces new challenges such as the fact that the children leave the family to establish their own family outside the known circle, it may be that they change their place of residence for work or because their partner is from another place or because they migrated to obtain better living conditions, there is also the phenomenon of prolonged parenting where adult, single children can come and go from the parental home or because they failed in their marriage and return with a child (a) and request the support of parents to work and fulfill their own role as fathers or mothers or because they still live with them and do not want to become independent.

Although there are different styles in the formation of family ties, these are generally the greatest attachment of mothers to daughters and that of fathers to sons, regardless of whether they live together or distantly, they can resume affective ties at any time moment, for example, in making decisions before an important event such as approaching the moment of retiring from a job, they turn to the family, which can take a positive or negative role, making it easier for both the retiree and their family since it becomes an essential support for the integration of the different emotions that take place during the process, cited in Luján Henríquez Isabel, González Cintado Estefanía (2013). When there is no strong family bond, an internal conflict can be created in making the decision to retire from work or postpone it as long as possible.

1.3 Some aspects of retirement and old age

In many societies, the beginning of old age is marked with a socioeconomic criterion, ceasing to carry out productive work is usually the moment of retirement, which is recognized as the stage of economic inactivity. For those people who have had an active professional life, the arrival of maturity is associated with retirement from work, an issue that is not only little studied in our environment but is of enormous importance for the understanding of old age and the end of a working life in a society that ponders productive activity so much, stopping work is something that is sought to be avoided at all costs, when one does not have a life project, or is in the process of reworking it.

The option to retire does not always come from one's own choice, it is often a norm imposed by organizations, when retirement is, or should be, another decision-making process, we retire, we partially retire or we do not retire (Ekerdt *et al*, 1996). On the contrary, an involuntary retirement is usually associated with an unwanted drop in income, which, in turn, is associated with lower satisfaction with retirement (Bonsang and Klein, 2012), cited in Selva Olid *et al*. (2021).

Retirement has two faces, for some people it is the opportunity to enjoy their family and be useful in other areas of their lives, but for other people it is to feel useless in all areas outside of work, for some it is the opportunity to coexist with important people in their lives, but for others it is loneliness and marginalization by society, so for some it is the opportunity to get to know oneself and thereby explore new alternatives that at the time could not be done due to the fact to work, but for others it is disappointment for not continuing to work in the activities that were the most important for them.

According to Merino Tejedor and Elvira Zorzo (2011), from the psychosocial perspective it can be said that retirement is a new reality that entails a transformation of the vital experience and a qualitative change that affects the person in all its aspects. Because it supposes a great change in their life cycle since, as Galvanovskis and Villar (2000) indicate, it changes the structure of functions, habits and the very organization of daily life, which has repercussions on the sense of efficacy and personal competence.

In addition, it implies that the individual at a given moment has to review his life in aspects such as the use of time, physical experiences, intellectual occupation and the social meaning of the person (Moragas, 1998). Therefore, a series of changes must be faced not only in the organization of space and time, but also in the status, the roles performed, the number of social contacts, and the personal and social identity that will affect in the personal satisfaction of the subject and in his adaptation to the new situation.

One of the important factors to be recognized as hard-working beings is that since we were little or children we have been inculcated to carry out activities, regardless of the difficulty that may present, in order to prepare for work in situations similar to those that we are already associated with in some time and this gives us an advantage over others.

We are trained to work, compete, perform, undertake and excel. For the same reason, when thinking about retirement, it is not an easy issue for people to accept, as they are lifelong workers, so they can see retirement as something boring and meaningless.

The fact of retiring has effects both for the person retiring and for the family, since it implies changes in the way their life is structured, the time and the development of activities and roles that are carried out on a daily basis, social relationships, as well as in the identity of the retiree, that is, it implies making changes and having a period of time in which these factors adjust to their new reality.

According to Vega and Bueno (2000), retirement is a continuous process that goes through a series of stages: Early retirement, which is characterized by the fact that the person is oriented towards the idea of retiring, since retirement has not yet happened, speculation is made about how it could be.

Retirement, which presents three types of alternative experiences:

- a. The experience of a situation of “euphoria”, in which retirement is presented as an opportunity to do everything that was desired and could not be done in the years of work;
- b. The phase during which the person enters into the routine of retirement, which is characterized by activities and stable groups and;
- c. The “rest” phase from the moment of retirement, into which some people enter. This phase is characterized by a temporary reduction in activity, as opposed to the increase that occurs in the “euphoria” phase.

After the retirement phase, some people go through *a third stage of "disenchantment" and depression*. This phase can occur when the person perceives that their expectations about retirement are not met as a result of disenchantment or the experiences of the previous phase, some people can go through a reorientation process, in which expectations about retirement are evaluated retirement and are situated in more realistic terms. It is also characterized because a routine lifestyle is developed in it, if the lifestyle is developed by adopting a positive attitude, retirement is faced considering the capacities and limitations, and the role of retiree is better assumed.

In 1986 Bruce Abel and Bert Hayslip pointed out the relationship between the internal locus of control and the levels of commitment at work; noting that people who were more committed to their work saw themselves as more capable of coping with the changes associated with retirement and, consequently, able to cope with this transition. Likewise, Gabriela Topa and Inmaculada Pra (2017) have pointed out that people with high levels of self-efficacy adapt better to this stage, because they better organize this transition, have a greater ability to leave work and have lower levels of self-efficacy of anxiety in the face of the change that retirement entails, cited in Selva Olid; *et al.* (2021), having a positive attitude will depend on whether basic needs are covered and, in most cases, this will be related to a good economic level.

That is, if you have a good job at the time of retirement, it is very likely that you will have a greater possibility of having economic savings predestined, or you will be able to access the benefit of insurance, loans, pensions by the company and the government. Otherwise, it will be difficult to obtain economic benefits, probably full-time workers and/or qualified professionals are the ones who have a pension plan.

Compared to part-time workers and/or those who lack professional qualifications such as agricultural workers or peasants who have to continue working to earn their daily livelihood, whether in the milpa, taking care of grandchildren or sick or older relatives, since they do not they have the benefit of a pension or other income other than their work, although it is true that lately, the Mexican government has implemented a support called 65 y más where they are granted a certain amount of money, it is also true that not all older adults have access to this benefit. In addition, having all the information related to preparing for retirement, beyond pension plans, is vital for making decisions and guaranteeing adaptation to this new stage.

According to the International Labor Organization (ILO), social security refers to having a basic income that allows solving situations that arise from unemployment, illness and work accidents; old age and retirement, and disability and family responsibilities. The ILO argues that these benefits are not only important for workers and their families, but also for their communities at large. By providing health care, livelihood security and social services, social security helps improve productivity and contributes to the dignity and fulfillment of individuals (ILO, 2002).

In the case of Mexico, there are generally laws that protect workers, both those who are active and those who are about to retire, since social security is associated with a government instrument, given that medical assistance, the provision of Food and care for older adults have been financed by it with the resources of society. These services are granted mainly to State servants or workers (Limón, 2000), cited in Villarreal Héctor and Macías Alejandra (2020).

In this work, some articles of the Law of Security and Social Services of the Workers of the State of Campeche are highlighted. Specifically in Chapter II, which refers to the retirement benefits and pensions that a worker can obtain from a state or semi-state institution.

Chapter II Retirements and Pensions

Article 58. Retirement is the relief of the obligation of the public servant to continue performing his job due to his age, his time of service or due to physical or mental impossibility, with the right to receive as a pension the total or part of his last salary. The Institute is obliged to pay the pensions for retirement and of another nature that was consigned in this Law.

Article 59. The pension application will be processed by the interested party through the corresponding Public Entity and the Institute will resolve within 30 business days after receiving the complete file, which must include the IMSS pension opinion and/or the resolution of the corresponding Afore, in the appropriate cases.

Article 60. Public servants acquire the right to a pension: I. By necessary retirement upon reaching 55 years of age and 15 or more years of contributions, II. By voluntary retirement when they have reached thirty years of contributions, without limit of age, with equal contribution time. III. Due to disability, having contributed at least five years to the Institute and there is an IMSS pension resolution; and IV. Due to permanent disability derived from work risks, as long as there is an IMSS pension resolution.

Article 61. The pension fee paid to the public servant, by way of retirement, shall be set as follows: I.- For necessary or voluntary retirement, the percentage of the last salary, in relation to the years of service, according to the following table: 15 years of service 50%, 20 years 60%, 25 years 75% and 30 or more years of service 100%, although for practical reasons the amounts are set in five years, for each year of service the percentage is increased until it reaches 100%. For the final computation of the years of contribution, any fraction greater than six months may be accredited as a full year, provided that the public servant voluntarily pays their fees plus the contributions of the corresponding Public Entity. The annual adjustment of pensions will be carried out in accordance with the percentage increases issued by the State of Campeche through the competent agency.

Article 65. The Institute will recognize the right to pensions at its expense as of: I. The date of termination as a public servant; II. The day after the death of the public servant or pensioner or pensioner, for pensions for widowhood, orphanhood and ancestry; and III. The date of presentation of the respective request in the cases referred to in article 87 of this Law, provided that the requirements to be entitled to the pension have been met.

Article 67. The average monthly salary will be calculated as follows: I. The base contribution salary with which the Institute has received the fees and contributions, during the last sixty months of contributions; II. Each of the amounts will be updated according to the National Consumer Price Index. The salary to be considered will be the one resulting from averaging the updated values; and III. The resulting average salary will have as a maximum the current contribution salary on the calculation date, with the exception of the case in which the public servant has had a decrease in its last tabulator level with respect to the previous ones in the period of sixty months. In this case, the resulting average will be considered.

Article 68. The amount of the pensions that are granted, in no case, will be less than one minimum wage or greater than twenty-five current minimum wages.

Article 74. A pension will be considered accepted when the interested party has not expressed their disagreement within the period of 15 business days counted from the date on which the corresponding resolution was notified. Accepted the pension, the public servant is obliged to definitively separate from the position or position that gave rise to it and will not have the right to request another pension for the same cause. When one or a public servant is entitled to a pension and has held two or more positions, for the purposes of calculating their pension, their longest seniority and the average of the contribution salaries corresponding to each of the positions will be taken into account, in accordance with to the provisions of articles 67 and 68 of this Law.

Article 76. The receipt of a pension granted by the Institute is incompatible with the performance of any paid position in Public Entities.

Article 78. The pensions and/or benefits established by this Law are not likely to be disposed of, assigned, encumbered or seized. Only in cases of maintenance obligations by the pensioner or pensioner can the judicial authority seize pensions up to the percentage established by the legislation on the matter.

Article 79. The verification of the payment of the pensions will be through proof of deposit, transfer and/or any other electronic means agreed with the financial institutions that allow such payments to be identified.

However, not all workers are able to retire after the age of 60, since Articles 1, 2, 5 and 6 of the Law on Security and Social Services for workers in the State of Campeche. Official Newspaper of the State of Campeche. June 3, 1993-current; last modification, on 07-31-2021; They establish very clearly that only the workers whose services were for the Government of the State and the Municipalities, will be protected by law, article 5 dealing exclusively with those people who are not considered public servants and that, consequently, they will not be able to enjoy the benefits of the same, including the retirement guidelines, something similar occurs in the elderly population in Guerrero (Niño-Gutiérrez *et al.*, 2022).

One of the points highlighted by retirees from Campeche is that their pension is paid based on UMA and not on minimum wages, which has undergone important changes within the current government. Given this, we took on the task of investigating why and what. What was found is that José David Méndez Santacruz, head of the Economic Benefits and Health at Work Unit of the Mexican Institute of Social Security (IMSS), in an interview with the Economist, commented that, under the scheme of the 1973 law, only the 5% of the retired population earns more than 10 minimum wages and that the majority of the retired population earns about 8 000 pesos per month, for unemployment they obtain 7 681 pesos and for unemployment in old age 7 793 pesos on average.

Likewise, he recognized that in 2016, a reform to the Constitution deindexed the minimum wage from different payments. “at that time, what the institute interpreted was to apply the UMA law to the general pension cap” because the IMSS calculates the monthly payments of pensions in UMA, which implies a lower amount, since the value of the UMA for in 2020 it is 86.88 pesos per day and the minimum wage is 122.23 pesos per day, due to the heavy monetary burden that it represents for the GDP since at the time the necessary modifications to the law or the requirements to retire were not made to solve the financial problems that arise at this time due to the collection of pensions. Even though the 1997 law has modified some points, the economic burden is still considerable due to the growth of this generational sector. Available February 7, 2020 on <https://www.economista.com.mx/sectorfinanciero>

In another order of ideas, when the retired worker is protected by law, his main goal is to understand and accept his own life and make use of his experience to face personal changes or losses, they have to adapt to the decrease of physical strength and health, to retirement or retirement from work, and to their own death.

If the basic needs are covered and these are related to an acceptable or higher economic level, the adult faces the time factor, what to do with all that free space that begins to have after retirement, how to use it to stay active, and this is where the life project comes in to make decisions and guarantee adaptation to this new stage because the person needs to readapt to the environment that surrounds him in all its aspects, once he is out of the work routine, this can be family, work, social or of any other nature that allows you to continue contributing to your personal or social well-being towards the community in which you are.

Among the actions that can be taken into account when establishing a life project in anticipation of a retirement that ends working life, it is important to take into account that since you no longer have a rigid schedule to comply with, you can opt for different alternatives that allow us to be busy, active and healthy.

Geriatricians and psychologists suggest considering two aspects: the social and the individual, and within the latter there is orientation to the spiritual part, regardless of whether it is within a religious aspect or not, to meditation, which can be through yoga, carry out physical activity according to age, which can be walking, swimming, gentle exercises such as tai-chi, as long as there are no physical impediments, that is, carrying out activities that generate pleasure not only at a cognitive level but also physical, you can also learn new things or carry out projects that had been stuck, for example in the case of women, who traditionally have the role of caregivers at home, they can continue with this role or dedicate themselves to manual tasks such as sewing or weaving, or they may decide to look for other options outside the home that allow them to be busy providing something for the family or obtain some income from the sale of itself.

In the case of men, they often rediscover their carpentry, electrical or mechanical skills that they learned in their youth and that they can contribute to some basic home repairs. That is, if the older adult has worked during his life or if he is a grandmother who has always been at home, one of the jobs of older adults is to continue in their same job or business if possible and the other possibility is that the retired older adult or housewife with less work now want to work and earn money.

The structuring of a life project is aimed at two processes. The life project represents the possibility of updating ourselves, of expanding our borders and potentialities to the maximum, it also symbolizes what we want to achieve (García-Yepes, 2017). But, regardless of the nature of the particular projects, they all refer to a unique and fundamental project, which is defined through the possibility of choosing how to be in the world. The way of being in the world is also the unique and particular way with which each person faces reality and their decisions.

A good life project answers the question: what to do with existence?, but to find the answer to this task, the human being also needs to consider how. The how is strongly linked to the action plan to be followed, to the specific strategies and operational goals that will be required to achieve that project that is being forged. Without it how, that is, without a traced, delimited and specific path, it is impossible to achieve what Navarrete M. Life (2021).

In the case of retirees, they have the cognitive and experiential tools to achieve the project they want, even when they know that it is something they are going to do within their physical possibilities and time, which in this case is a short- or medium-term goal because of their age. In this way, it coincides with Zauza (2007), who notes that "the project represents a reality that seems to pre-exist and attracts us, it also represents a capacity to create, a change to be made." A reality that, even without having been built, is still plausible and has the quality of being extremely captivating, as it implies the option of being creative.

These types of activities can allow us to feel useful and important, and establish new and strong social relationships. This option is reinforced by the activity theory. According to which, if older people remain active within their possibilities, their old age will be more satisfactory in terms of work, being a spouse, father, mother, grandparents, etc. People who age like this maintain adult activity levels for longer and replace lost activities with new ones, maintaining their social ties and roles, as these are the main source of personal satisfaction. The more social contacts they lose as a result of life events, such as widowhood or illness, and they are not replaced by others, the lower personal satisfaction will be.

According to the activity theory, it is important that the person stays active, although more important seems to be the type of activity they do. According to Lemon, Bengtson and Peterson cited by Monroy López (2005). There are 3 types of activity: a) social interaction with family, friends and neighbors; b) formal: participation in voluntary organizations and, c) Lonely: reading, watching television and maintaining some hobbies. Currently it is considered that it is healthier to stay active and substitute some activities for others than to gradually disengage, although not all activities produce the same satisfaction: Not all older adults have the conditions to work, but all those who do not have disabilities can do so.

In the event that the older adult finds himself with an unfulfilled job desire, it is time to do it or when he has always exercised what he likes to do, it is time to continue if he wishes at his own pace, from home either in a individually or with the help of their relatives, whether children or grandchildren. Working does not necessarily mean earning money but being active in some occupation, if possible, must be very satisfying for the grandfather.

One of the examples is that of the baggers in supermarkets, who attend this work not only as a way to obtain a resource, but to feel part of a workforce that supports buyers, feels useful and stays active, In addition to meeting a schedule and socializing with those around them, they establish new friendships among their peers and also give them the opportunity to renew some old ones, either with people their age or with the new generations that attend these companies.

On the other hand, being retired, an important part is to continue living together with people from the close family circle but also to seek and find new friends by approaching free institutions open to the public where recreational activities are carried out, different workshops are offered and psychological support for the elderly such as INSEN, or INAPAM, Retired Teacher's House, because all people have gifts and skills that are exercised throughout life, for example, they can be excellent teachers, cooks, have communication skills , or love for animals, which others can contribute or learn from and, most importantly, coexistence with other people with common interests, which allow them to establish new social support networks, carry out volunteer activities, where they could occupy positions of responsibility, it would be a way of planning retirement by finding in other tasks, a role similar to the one that had in working life.

2. Methodology

It is an exploratory-descriptive, cross-sectional work, the data was collected in a single moment, in the second semester of the year 2021, still in the pandemic phase, which made it difficult for more people to participate 53 people from different locations were contacted, of which 13 answered all the questions, some of the retirees were reluctant to participate or did not answer all the questions and, finally, some of the people contacted do not have the benefit of retirement by being from rural communities or lack of studies.

Inclusion criteria: Retired men and women from state or parastatal institutions in Campeche, who had been receiving a pension for 5 years or less, whose ages ranged between 60 and 70 years.

Instrument: A questionnaire (interview guide) was designed expressly for this work, consisting of 8 socioeconomic questions and 17 questions referring to retirement and life project. It is judged by experts on the subject. Look at annex 1.

Procedure: With a group of students from the third semester, from the psychology degree, the elaboration and application of the questionnaire was worked on, being confined by the pandemic, each girl from the team interviewed people from her locality who met the inclusion criteria, the questionnaires were digitized to perform the data analysis and through video calls of the meet, the results were obtained since the SPSS v.25 program was used to analyze the statistical data obtained as well as the discussions of the work.

We cannot fail to mention some points that the team of interviewers faced, since an example of their inexperience and inexperience was believing that once the instrument was completed, any person who met their inclusion criteria would respond to them, which was not the case. happened; the main obstacle that the research team faced was the confinement when carrying out the data collection because the age group that was required for the sample is considered by the health authorities as "high risk" so finding them on the street to interview them was very complicated because the common reason for response among retirees who were contacted or looked for on the street was "I'm not interested, thank you": the plain and indifferent refusal to participate and, when they knocked on the door of the house in home, the task turned out to be even more complex, since several even refused to let the researchers through for fear of possible contagion -according to the testimony of one of the older adults, because "...who knows how many places you haven't been to asking already" and, furthermore "...I don't know you".

They also met approximately 20 older adults who told them "I have not had that privilege", referring to the fact of being retired with "privilege"; since those who were asked in passing were people dedicated to agriculture, who did not have complete formal studies and whose life has always been in the countryside, so that they do not enjoy any type of benefit or pension in their old age and they have to continue working no matter how old they are in order to earn a living.

3. Results

Of the 13 participants, 8 were female and 5 male. The socioeconomic information of the participants that was obtained was that the ages are in the range of 60 to 78 years, 10 are in the interval of 60 years and 3 of the seventies, in terms of their perceptions, these range between three and thirty. thousand pesos with one person in each case, generally from 3 to 5 thousand pesos there are four people, from 10 to 15 thousand pesos there are eight and only one receives 30 thousand pesos, likewise only one person receives two pensions, this amount is monthly and according to the perception of retirees, it covers basic needs as long as they manage it correctly, some of the retirees mentioned that since their children are still studying, once they finish their degree their pension would be only for their expenses and it would give them more. What stands out is that according to the law they should be paid based on minimum wages, but they are paid based on UMA, which implies that they have a slightly lower perception than what the law stipulated. According to retirees, their pension money may be a bit fair, but it is enough for their personal expenses or to treat themselves from time to time.

The interviewees retired between 48 and 65 years of age, fulfilling a work cycle of between 28 and 48 years of work and although the latter may seem disparate, we must not forget that in the case of teachers they began their working life at 17 or 18 years of age, because from high school they went directly to normal school and graduated very young from the degree, also with a job. Likewise, all the interviewees have their own house, either through an institution or built with their own resources, which they intend to leave as an inheritance to their children, which is why they continue to care for and maintain it. This point is interesting because they only pay their property tax once a year and as they are elderly they get a 50% discount which helps them by not having to pay a monthly rent, allowing them to make better use of their pension in other expenses that they require.

Although it was found that 4 people say they have not planned their life project, when analyzing the interview it is observed that their project is to care for and enjoy the family, which implies that, if they have a life project, but this does not refer to causes social or starting a business but personally and by continuing to be part of their daily work and activities they do not perceive it as such, the 13 people agree that those over 60 years of age can continue with their life projects after their retirement, or start a new one, as long as they are healthy or their illness is bearable with auxiliaries such as glasses or hearing aids, with 12 of the 13 participants saying they felt that they had achieved their goals, most experiencing feelings of joy or happiness, satisfaction and liking when fulfill them.

For the people interviewed, retirement is a positive and opportune experience that allows them to enjoy free time, family, carry out personal projects that they had neglected, modify their home, take care of their grandchildren, travel or simply live life without responsibilities for with an institution, that is, they freed themselves from work commitments.

Likewise, the feelings that retirees express is that of joy and satisfaction because they comment that they fulfilled their scheduled family goals and the things that they can now do without pressure of any kind and above all because they continue to be financially independent.

The most common health problems that were detected as negative interferences in the realization of the life project were: shortsightedness with 9, diabetes with 6, hypertension with 3, these two diseases are quite common in the age period in which the participants found, as well as in the state of Campeche, only one person added depression and stress and none of the participants has motor disability. Even when they have visual problems or diabetes and hypertension, they know that they have the IMSS or ISSSTE that provides them with medical attention and medications this is even more complicated in this pandemic period in poor states in the south and southeast of Mexico (Niño-Gutiérrez, 2021).

It should be noted that all the participants consider that during old age the goals or aspirations do not disappear, but that according to their possibilities they can be fulfilled or at least approach their achievement, since according to one of the participants *"as long as we have life, there will always be the word opportunity"*.

All but one participant are satisfied with what they have achieved to date; 7 said that, without money, meeting goals is not possible, 2 of them mentioned having insufficient capital for their project and, among the most repeated aspirations for the future, are: travel, family unity, health, obtaining material objects such as car or house, rest and three people who said they do not aspire to anything else because they are doing what they want, which is to serve and enjoy the family.

Only 4 of the participants affirm that the pension amount covers food and one of the other three needs of clothing, payment of taxes and health. 5 agree that their pensions affect their future plans mainly because it is thanks to them that they can pay for life necessities, mentioning that, luckily, they do not do badly in it; adding in turn that, in effect, the amount of the same varies according to the last salary and years worked by the person, adding to these variables, the type of position held for the last time in the last five years of work, 8 They said that his pension can cover the plans in his life project.

Likewise, 8 identified the IMSS, 1 ISSSTECAM, 1 AFORES, and 4 "others" as the state institutions from Campeche to which they should go in case of doubts or inconsistencies regarding their retirement process; without knowing that, in fact, the ISSSTECAM is enough, since it is the one that recognizes the law of the state of Campeche.

All indicate that the benefits of retirement during old age tend to be medical care and the monetary pension itself that ensures, in turn, a peaceful life of rest and without work responsibilities; Lastly, 7 of the total number of interviewees would change their current retirement age -which is 60 years- because that way they could enjoy their family and life more, and because one mentioned that, being a woman, they have greater responsibilities than others wear out faster, even proposing that the minimum retirement age be changed to 55, at least for women. According to the federal labor law, the retirement age was 60 years old and 30 years worked in the case of men and 28 years in the case of women, although there are still many workers who are within the period of the 60 years.

4. Annexes

Appendix 1

Questionnaire: Retirement and life project in men and women from 60 to 70 years old.

Purpose: To determine if retirees between 60 and 70 years old have a life project.

Do you voluntarily agree to answer this questionnaire? Yes . Not .

Instructions: Answer according to what is asked. All answers will be confidential, anonymous and will be used for academic purposes. The response time is twenty minutes.

Socioeconomic questions.

Age: _____ Sex: _____ Colony: _____

The house you live in is: own____ rented____ takes care of it____ of your children____

Institution(s) from which you have been retired: _____

Years worked: _____

Age you retired: _____ Institution 1____ Institution 2____

Years receiving pension: _____ Institution 1 _____ Institution 2 _____

Total, current pension amount: _____ Institution 1 _____ Institution 2_____.

1. Do you already have your life project planned? Otherwise ____.
2. Can people over 60 years of age continue with their life projects after retirement?
Otherwise ____ . Why? _____
3. Do you feel that your retirement goals have been met? Otherwise ____ . Why? _____
4. When you achieve goals, what kind of feelings do you experiment?
_____.
5. From the following list, mark the most common health problems that can negatively interfere with the realization of a life project:
 - o ____ Short sightedness
 - o ____ Motor disability
 - o ____ Diabetes
 - o ____ Hypertension
 - o ____ another.
6. Are you satisfied with what you have achieved until to date? Yes ____ No ____ Why?
_____.
7. Without money, can the goals of a life Project be met? Yes____ No ____ Why?
_____.
8. What aspirations do you have for the future?
_____.
9. In the stage of old age is there the disappearance of goals or aspirations? Yes ____ No ____
Why? _____.

Answer the following questions according to what is asked.

10. From the following list, mark the needs that the amount of your pension does cover:
 - ____ Clothes
 - ____ Payment of taxes (water, electricity, land)
 - ____ Health
 - ____ Food
 - ____ Other
11. Does the amount received in your pension affect your future plans? Yes ____ No ____ Why?
_____.

12. Does the amount of the pensions vary according to the last salary and the years worked?

Yes ___ No ___ Why ? _____.

13. With your pension can you cover the plans in your life project? Yes ___ No ___ Why?

_____.

14. Cross out from the following list the state institutions in Campeche to which you can go in case of doubts or inconsistencies regarding your retirement process:

___ ISSSTECAM

___ AFORES

___ IMSS

___ another

15. Do you know which state institutions in Campeche you can go to in case of doubts or inconsistencies regarding your retirement process? Yes ___ No ___

16. What benefits does retirement have during old age?

_____.

17. The minimum retirement age is 60 years. Would you change it? Yes ___ No ___ Why?

_____.

Your responses are protected by the personal data protection law of the state of Campeche and its Municipalities, given at the State Government Palace, in San Francisco de Campeche, Campeche, on the twenty-fourth day of the month of December of the year two thousand and twelve.

5. Conclusions

In spite of the fact when the retirement stage occurs, this is one more step in the working life of working people, retiring from work was a decision made based on their personal goals and in other cases because they ignored the law which mark that from the age of 60 they can retire, this is important because in the case of the analyzed sample, retirement is a positive and opportune experience that allows them to enjoy free time, family, carry out personal projects that they had stopped. On the other hand, the feelings expressed by retirees are of joy and satisfaction for the things they can now do without pressure of any kind and above all because they continue to be financially independent. Despite the fact that they present some problems typical of old age, such as diabetes and hypertension, they know that they have the IMSS or ISSSTE that provides them with medical attention and medicines.

If there are no mobility or disability problems and older adults remain active by carrying out activities appropriate to their age, whether inside or outside the home, they maintain the quality of life they had before retiring.

The participants are people who maintain solid family ties based on understanding, respect and mutual help between family members despite being independent people on a physical and personal level, they require the support of their families and, In fact, the majority obtain it, showing themselves satisfied for continuing to play an important role in it. This shows that being in the stage of old age in no way limits you from having a life project, be it a lifelong one or a new one, likewise older adults are aware that as long as they are healthy, they can do anything that they propose, even with limitations if they have any physical problem, that is, they see it as a natural part of life itself.

Having access to a pension and social security gives them a feeling of security in their old age. Retirement is seen as the stage to enjoy the family, the spouse and establish new relationships or resume some of these, they are also aware of the fragility of life, especially in the pandemic stage, but they know that if they care and follow the indications of the health sector do not have to be at risk.

It is important to study this sector of the population from different angles, especially because of the expertise that they present in different work areas and that are wasted by the new generations and, last but not least, was the learning achieved by the work team of the 3rd semester of methods in psychology at UACAM who understood that having an instrument, disposition, support from the teacher, bibliographic material, does not always make it easier to carry out an investigation when they work with people and not with documents, having to rethink their observations as they progressed step by step with their project, the discussions between them on how to address the problems that were presented to them helped them understand that the research process can be arduous but very satisfying when they achieve their goals.

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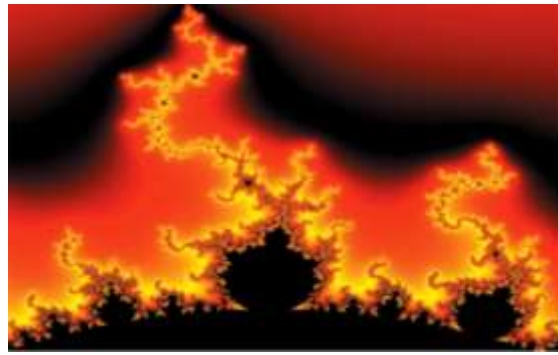
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p^{Uh}	Precio último Hecho	491.61
V_o	Volumen Operado	1241979
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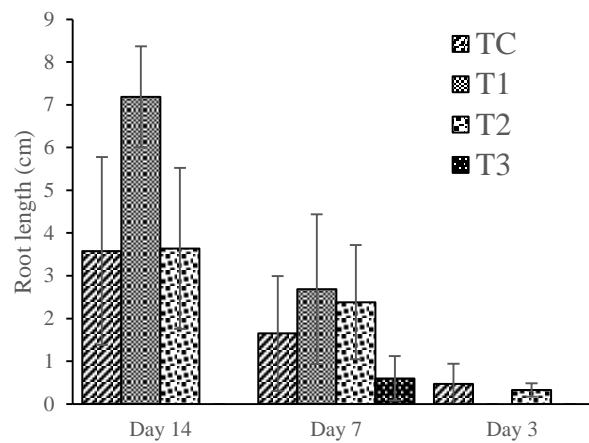
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