

The Sustainability of the Therapeutic Cannabis Sector in Colombia

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Abstracts

The medical cannabis industry in Colombia is recognized as an emerging industry, and the development of the regulatory framework stimulated the interest of entrepreneurs in creating companies for medicinal purposes. The objective of the work was to examine the key components of the sustainability of the therapeutic cannabis sector in Colombia. In this sense, the study with a mixed approach and analytical scope included a review of the theoretical aspects and regulatory framework. A statistical analysis was carried out to determine the perception of potential clients of the medicinal cannabis industry. A downward projection was found in the number of licenses granted. In conclusion, the therapeutic cannabis sector in Colombia shows promising potential, and its long-term sustainability requires addressing the gaps identified in the implementation of policies, improving social inclusion, promoting innovation for the development of high value-added products, and ensuring environmentally sustainable practices. From a social perspective, the industry promises to generate employment and boost rural development. Environmentally, the industry could contribute to reducing deforestation associated with illicit crops. The sustainability of the sector is an achievable goal, but it will require coordinated efforts in the regulatory, economic, social and environmental spheres to materialize its potential.

Keywords: Therapeutic cannabis, medical cannabis, sustainability.

Introduction

The emergence of drug trafficking at a global level has put the economic, social and environmental viability of some countries in check. As a consequence, states have found it necessary to implement regulatory frameworks to regulate the manufacture and use of psychoactive compounds.

Progress in scientific research and the enactment of laws that regulate the industrial manufacture of the cannabis sector for medical and therapeutic use have driven a notable increase globally.

According to the International Narcotics Control Board (INCB, 2022), "this is due to the growth in global cannabis production over the last 20 years, which reached 764.3 t in 2021, which represents a further increase compared to the 650.8 t recorded in 2020" p.36.

In the Colombian context, the medical cannabis sector is gradually gaining recognition as a flourishing industry internationally. Approximately ten years ago, the legal framework for access to cannabis for purposes in medicine and scientific research was established. This materialized with Law 1787 of 2016, which was later regulated by Decree 613 of 2017

This work approached from the perspective of sustainability highlights from the economy, the contribution made to the Gross Domestic Product (GDP) by illegal crops, to the country's total GDP, with an increase from 0.16% in 2013 to 0.42% in 2021. The implementation of legal and regulated medical cannabis initiatives has significant potential to mitigate adverse economic impacts, as suggested by recent studies (Rey, Martínez, Cohecha, 2020).

In the socioeconomic sphere, it is notable that regions with the presence of illicit crops exhibit poverty rates that exceed 54%, a figure that exceeds the average of other Colombian municipalities by 15% (Portafolio, 2018). However, the remuneration of salaried workers in the agricultural phase in recent years grew 6.6% in 2020 and 7.1% in 2021 (DANE, 2021).

The industrial sector of cannabinoids for medical use in the country is emerging as an important catalyst for job creation, covering agricultural, administrative, and scientific areas (Rey, Martínez, Cohecha, 2020). Advances in scientific research have corroborated that the components of cannabis and its by-products have therapeutic properties with the potential to significantly contribute to the well-being of patients (Rojas et al., 2019).

Environmental statistics reveal that a significant segment (13%) of the country's annual deforestation is linked to illicit crops (Min ambiente, 2023). According to official data from the Ministry of Environment, in 2021 there was a reduction in forest cover of 174,103 hectares, which represents an increase of 1.5% in the deforestation rate compared to the previous year (Min Ambiente, 2022). This phenomenon is causing a substantial deterioration in the soil quality and biodiversity of the affected ecosystems.

In this context, the need arises to analyze: What are the characteristics of the crucial elements in the progress of the Colombian medicinal cannabinoid sector? What is the perception of potential customers about the use of medical cannabis?

The objective of this paper is to analyze the key components of the sustainability of the therapeutic cannabis sector in Colombia. The methodology used included an exhaustive bibliographic exploration and an analysis of the current regulatory framework. The economic, socio-cultural and environmental implications associated with the sector were examined in depth. The analytical approach adopted contrasts the theoretical and legal foundations with the current situation of the sector, from the perspective of sustainability.

Theoretical Framework

The global expansion of the cannabinoid sector for therapeutic use has shown great potential after its legalization in the continents of Europe, Australia, and America, among others (Armstrong, 2021). Colombia could become a leading cannabis exporter and achieve comparative advantages, due to low labor costs, availability of fertile land, non-existence of seasons, and agricultural regulatory and institutional expertise (Martínez Rivera, 2019). These characteristics could contribute to the economic development of the country to a great extent, a term that explains a country's ability to generate wealth and improve the quality of life of the population (Roldán, 2018), as well as the possibility of developing innovative, technologically developed organizations with their own patents (North et al. 2009).

Colombia has historically been a country dependent on commodities such as coffee, coal and flowers, among others, limiting economic development and the possibility of generating greater added value from its organizations. Although it has comparative advantages in terms of cannabis production costs, it is crucial to expand the focus beyond merely sourcing raw materials such as seeds or basic extracts. To maximize the economic and competitive potential of the sector, it is imperative to invest in research, development and innovation, with the aim of generating high value-added products that can compete effectively in the global market.

Medical cannabis has proven to be a wealth-generating product in the medical and recreational industry. Its FDA-approved medicinal use helps relieve neuropathic pain in patients with cancer, arthritis, AIDS, stress, anxiety, improves appetite, decreases nausea and depression (Freeman et al., 2019; Torres, & Rosselló, 2022).

According to Rivera (2019), "Grand View Research" estimates that the global cannabinoid industry could be valued at USD 63,000,000,000 by 2025. Colombia could generate an export potential of more than USD 17,700,000,000, perhaps more than the oil industry, with a significant impact of more than one hundred thousand jobs (Rivera, 2019). The increase in the global manufacture of cannabis is remarkable, which registered a growth of 103% between 2016 and 2017, going from 200 to 406 tons, thus evidencing its potential as an export product. It took two years for cannabis exports to reach US\$100 million, in contrast to flower exports, which took 10 years to reach the same figure (INCB, 2018; Ramírez, 2019).

Despite Colombia's comparative advantages for the cultivation of cannabis, due to its excellent legal framework, technical benefits, natural wealth, labor, accessibility to water, and land, there are some limitations for the development of the cannabis industry for medicinal use. The criminal stigma that the product has carried for years, due to its illicit use in drug trafficking, represents one of the greatest barriers to accessing bank financing (Ramírez, 2019), despite the fact that there is clarity about the differences between the psychotropic effects of Tetrahydrocannabinol (THC) and Cannabidiol (CBD) with psychoactive and medicinal effects, but without psychotropic effects (FUNDACIÓN CANNA, 2017).

Countries such as Uruguay and the Netherlands show the possibility of ending the black market to acquire the product, dismantling labor informality, drug trafficking, and generating contributions to GDP.

Recent discoveries in medicine and projections about the cannabis industry in Colombia represent the imminent exploitation that the market will have, at least 50%. Efficiency in the application of regulations, and the granting of licenses, will allow the development of an emerging industry. Medical cannabis can contribute to the agricultural sector, to national and international investment, it is an alternative for the pharmaceutical industry, and a mechanism to weaken illicit businesses (Vélez, & Echeverri, 2021).

Regulatory and Policy Aspects

The Ministries of Justice and Law, Agriculture and Rural Development, and Health and Social Protection, through Resolution number 227, "regulate Decree 811 of 2021, which replaces Title 11 of Part 8 of Book 2 of Decree 780 of 2016, in relation to licenses, quotas, and authorizations for safe and informed access to the use of cannabis and the cannabis plant, their derivatives and products" (p.1).

In the context of the development of the medical cannabis industry in Colombia, the regulatory framework has established a set of administrative and legal requirements that companies must satisfy in order to obtain the necessary licenses and operate in the sector. These requirements vary according to the position that each entity occupies in the value chain, ranging from obtaining seeds to the production of final by-products. The primary objective of current legislation is to ensure the comprehensive traceability of cannabis inputs and by-products, implementing a system of registrations and licenses that covers each phase of the supply chain (SC) (Ramírez, 2019).

At the international level, the regulation and supervision of the market for psychoactive substances, including medical cannabis, is under the jurisdiction of the INCB. This agency plays a crucial role in monitoring the production and trade of these substances globally, setting annual production quotas for each nation. In the specific case of Colombia, the responsibility for distributing and managing these quotas falls on the Technical Quota Group (GTC), a national entity that operates in line with international guidelines (Ramírez, 2019).

Colombian legislation has established a specific process for obtaining licenses in the medical cannabis sector. In accordance with current regulations, the evaluation period for the approval of these licenses has been set at 30 calendar days. This period is conditional on the applicant fully complying with all the requirements stipulated in the regulation and making the corresponding payment of the license fee (Ministry of Health and Social Protection, 2017).

Methodology

The focus of this work is mixed, from the qualitative point of view, a review of specialized sources was made between scientific articles and current regulation. From the quantitative point of view, a statistical analysis was made about the perception of potential customers, linear regression and moving average methods were applied to determine the projection of the number of licenses requested and granted to new entrepreneurs. The type of research is analytical, the key components of the sustainability of the Colombian therapeutic cannabis sector. The design is field, not experimental, cross-sectional. In this sense, a five-point Likert-type questionnaire

was applied to 115 people, obtaining a total of 85 responses, the object of study was not intervened and the data were collected during the second half of 2023. The criterion for inclusion in the sample was people over 18 years of age, willing to use medicines produced from medical cannabis.

The research paradigm is structuralism because it allows us to identify the invisible structures that account for the essential nature of all social phenomena (Martínez M., 2007), to investigate is to analyze and explain. The structures of the development of the cannabis industry sector are identified, described and analyzed from their reality, the researcher plans an approach structure from its categories (business development, regulations and sustainability) and concludes with some explanations of what has been studied (Hurtado, 2010), and these categories are conceived with the conception of the existence of possible relationships (Rojas, 2019).

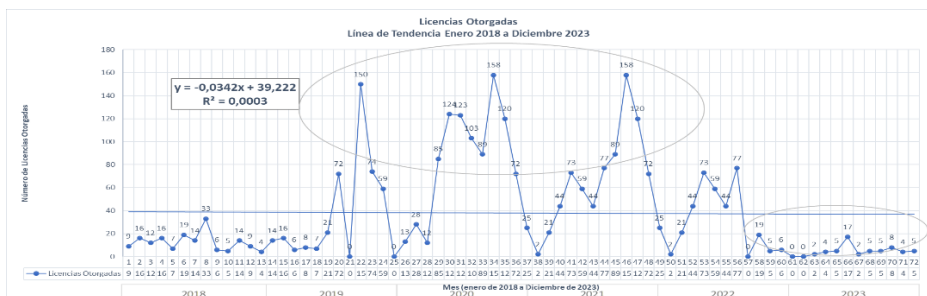
After addressing the methodological aspects, the results are shown below.

Results

The medical cannabis sector in Colombia has experienced significant interest, evidenced by the volume of license requirements registered between the beginning of 2018 and the end of 2024. Out of a total of 3,732 applications submitted, only 1,950 were approved, representing a success rate of 52.3%. This phenomenon suggests two main interpretations: first, there is considerable entrepreneurial enthusiasm for this industry; In second place, almost half of the applicants (47.7%) face obstacles to comply with the established technical or regulatory standards, which limits their entry into the market. These figures underscore the need to strengthen training and technical advice for potential participants in the medical cannabis industry.

The frequent instability of people in their positions (technical and administrative) results in a decrease in the ability to adequately guide business applicants. As a consequence, delays and inefficiencies are observed that exceed the established period of thirty days for the issuance of licenses (Ramírez, 2019). (Graph 1) illustrates the number of licenses granted monthly between 2018 and 2023, in the middle of that period, substantial increases were evidenced between July 2019 and August 2022, however, the number of licenses granted fell in 2023.

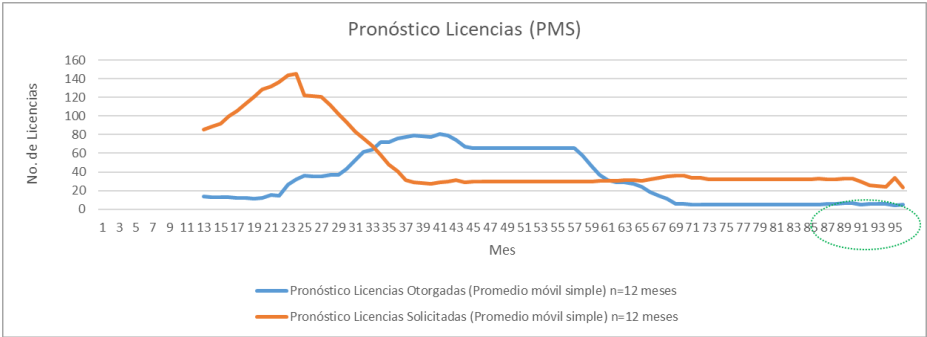
Figure 1. Licenses Granted (January 2018 - December 2023)



Source: Analysis by the authors based on information provided by the Ministry of Justice

The number of licenses granted by 2025 is projected to be approximately 66, an approximate monthly average of 5.5 licenses Graph 2, Table 2.

Figure 2. Forecast of Licenses Granted (year 2025)



Source: Analysis by the authors based on information provided by the Ministry of Justice

Table 1 Forecast of Licenses Granted (year 2025)

Año	2025											
Mes	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dic
x	85	86	87	88	89	90	91	92	93	94	95	96
y	5	5	6	6	6	7	5	5	6	6	5	5
Prom.	5,5											
Suma	66											

Source: Analysis by the authors based on information provided by the Ministry of Justice

In addition, Colombia is projected to have a potential increase in the industry by 2030 of 1,733 million dollars (Suarez, 2022).

Colombian legislation on medical cannabis includes support measures for SME entrepreneurs. These provisions include the extension of the validity period of licences from 5 to 7 years, as well as the provision of technical assistance to those who choose to form partnerships. However, a significant disparity persists between technical training needs and the entrepreneurial skills required for success in this sector.

The government's policy to replace illegal plantations incorporated an innovative initiative in the context of the medical cannabis industry. This strategy offers support to projects that seek to integrate into the legal cannabis sector, under the condition that participants commit to the voluntary eradication of their pre-existing illicit crops. (Ministry of Health and Social Protection, 2017).

In relation to the perception of potential customers of the cannabis industry, around the regulatory framework and policies, a high level of knowledge and acceptance of regulatory policies among the participants was determined. A significant proportion, reaching two-thirds of respondents (68.8%), demonstrate familiarity with the regulatory framework governing the production, application, and distribution of cannabis. Moreover, a substantial majority,

represented by (78.1%) of the respondents, expresses a favorable opinion towards the government strategy that promotes the transition from illegal plantations to obtaining licenses for the legal cultivation of cannabis.

The regulatory framework for medical cannabis in Colombia has incorporated an innovative technological tool to facilitate the supervision of the sector. This is the platform called the Cannabis Control Information Mechanism (MICC), designed to serve as an interface between regulatory entities and licensees. This digital system allows for the systematic recording of operations and transactions related to medical cannabis, thus providing an efficient mechanism for supply chain monitoring and control.

Despite the advantages promised by the MICC in terms of safety, accessibility, and efficiency, its implementation faces significant challenges in relation to small and medium-scale producers. The effectiveness of this technological platform is compromised by the structural limitations that characterize the rural and remote areas where these growers operate. The absence of basic services such as internet connectivity, constant electricity supply, drinking water, and the precariousness of communication routes and general infrastructure, constitute substantial barriers to the full integration of these actors in the digital control system, which alone shows deficient levels of quality of life.

Sustainability of the therapeutic cannabis sector

Economic outlook

The legislative evolution around the use of cannabinoids has catalyzed a progressive increase in the sector, generating a panorama of opportunities in the economy on a global scale. The data for 2017 reveal a scenario where the United Kingdom positioned itself as the main manufacturer of cannabis-derived medicines, accounting for 63% of global manufacturing with a volume of 258.4 T. Canada ranked 2nd, with a share of 32.4% and a production of 131.4 T. In terms of international trade, the United Kingdom, the Netherlands, and Canada stood out as the main exporters, while the United States emerged as the largest importer of these products (International Narcotics Control Board [INCB], 2019).

In the North American context, scientific research and regulatory advances have fostered a favorable environment for therapeutic medical use cannabinoids, with thirty-three states adopting permissive legal frameworks. In the Latin American region, Uruguay has assumed leadership as a forerunner in the legalization and regulation of cannabis. Recently, other countries in the region have followed this trend, implementing legislation that allows the development of this emerging industry. Nations such as Mexico, Ecuador, and Peru, which share climatic characteristics similar to those of Colombia, are in the process of establishing their own medical cannabis markets (Manrique and Carmona, 2019). This regional panorama suggests a growing acceptance and competitive potential in the medical cannabis market in Latin America.

Colombia has been listed as an attractive destination for investment (national and international) in the medical cannabis industry, this is based on a combination of favorable factors, including a robust regulatory framework, optimal climatic conditions, a potentially important market, and competitive labor costs (Ramírez, 2019). The positive perception of the country as an investment

destination in this sector is supported by the results of our research, where a substantial majority of participants, specifically 84.4%, state that Colombia offers a conducive environment for foreign investors in the medical cannabis industry (Graph 3). This convergence between the country's structural advantages and the perception of the sector's players suggests a promising outlook for the development and expansion of this industry in the Colombian context.

Figure 3. Attractiveness of foreign investment



Source: prepared by the authors

The possibility of obtaining multiple annual harvests, combined with the availability of arable land, results in exceptionally low production costs. While in Colombia the cost of producing a gram of cannabis flower is estimated at 0.05 USD, in markets such as the United States and Canada this can reach 2 USD (Manrique and Carmona, 2019).

The price competitiveness established for Colombian raw materials and pharmacological cannabinoids has generated constant demand from international customers, exceeding the stability demanded in other manufacturing nations. Notably, international customers show their willingness to assume prices significantly higher than those currently in the Colombian market, without this negatively affecting demand. This phenomenon suggests considerable potential for increased profit margins in the Colombian cannabinoid industry.

An analysis of the data reveals that 70% of the licenses have been granted in peri-urban areas, while only 30% are located in rural or difficult-to-access areas. This asymmetrical distribution responds mainly to two factors: the vertical integration strategy adopted by most companies, which seek to control each of the phases of production, and the greater availability of qualified human resources in the vicinity of urban centers, especially for the processing and manufacturing stages (Ramírez, 2019).

The development of the sector demands sophisticated technology and adherence to high quality standards, which implies substantial investments. The projected economic figures are promising: with a cultivated area of 45 ha in 2019, it is estimated that exports of extracts and resins would reach USD 109,000,000 by 2020. This accelerated growth significantly exceeds the historical performance of traditional industries such as floriculture, which required a quarter of a century to achieve comparable figures. In a conservative scenario, exports are expected to reach USD 800,000,000 in five years (Ramírez, 2019).

In the context of the medical cannabis industry, Colombia is facing a promising economic scenario that deserves to be considered as a strategic opportunity, given the competitive advantages and growth potential described above. From a public and economic analysis

perspective, it is crucial to emphasize the concept of international dependence as a determining factor in the development of this sector. This paradigm facilitates the attraction of foreign capital and know-how, in exchange for the provision of high-quality inputs, thus laying the foundations for robust international marketing.

Colombia, traditionally recognized for the export of flowers, coffee, avocado, charcoal and bananas, faces the challenge of producing technified products. In the context of medical cannabis, although biomass production is economically advantageous, the approach must go beyond the mere export of inputs or raw materials. The optimal strategy involves the development of highly complex derivative products to maximize economic benefits. In this sense, Colombia must advance in its assimilation of technology.

The incorporation of technology, frequently introduced by companies in the global sector, is crucial to raise the standards of quality and production efficiency. This process of technological improvement not only increases the competitiveness of the sector, but also contributes to overall economic growth, effectively reflected in the national gross domestic product.

On the global stage, various producers are vying for a position in the medical and pharmacological cannabis market, particularly in the lucrative markets of Europe and America. This competitive environment demands the adoption of an innovative approach and cutting-edge technology. In addition, there is a growing trend in economic, social and environmental sustainability, which adds an additional dimension to the requirements of international competitiveness.

The research reveals a significant gap in the creation of added value in the cannabis industry. An overwhelming majority of the participants in the study, specifically 68.7%, stated that they had no knowledge of cannabinoid pharmacological drugs manufactured with sophisticated or cutting-edge technology that are of national origin. This finding suggests that the potential for innovation in this sector has not yet been fully exploited. (Graph 4).

Figure 4. Innovative potential of cannabinoids with state-of-the-art technology



Source: prepared by the authors

On the other hand, the development of exports in the sector could represent a crucial opportunity for trade diversification and the generation of foreign exchange earnings. This would not only help strengthen the national economy, but would also promote improved supply chain indicators and wider use of resources globally.

Unfortunately, there are great limitations, mainly for SMEs and small entrepreneurs due to the high cost of licenses, high investment costs in the transformation and adaptation of infrastructure, restrictions on financing by the banking sector, inefficiency in administrative procedures of the public sector in the issuance of licenses, ignorance of the therapeutic benefits of cannabis, in addition to the stigmatization of the medical cannabis business due to the history of illicit use in drug trafficking (Blanco & Vásquez, 2018; Cruz & Pereira, 2021; Espitia, 2020; Hurtado & Villa, 2020; Jaramillo & Vélez, 2021; Jelsma, 2019; Lozano, 2017; Martínez, 2019; Ramírez et al, 2019).

Social Aspects

It is essential to make a distinction between development and economic growth. The first is characterized by its focus on the comprehensive improvement of the living conditions of the population, tending to reduce poverty, raise welfare standards, reduce wage gaps and expand job opportunities. In this context, we proceed to examine the specific social implications of the cannabis industry. It is crucial to emphasize that the mere increase in economic indicators does not guarantee per se, an advance in the socioeconomic development of a nation, but it does allude to economic growth.

The cannabis industry presents significant potential for decreasing unemployment, particularly in the agricultural sector. Current data indicate that 1 ha cultivation requires, on average, 17 workers. Projections for the year 2030 suggest a considerable labor impact, with an estimate of 41,748 jobs, of which 26,968 would correspond specifically to the agricultural field (Ramírez, 2019).

The presence of global international corporations could generate a significant economic and social impact through job creation, promoting the development of people's talent and skills in technology. It is notable that economic experts point to the economic workforce as a comparative advantage for investment in Colombia. However, this characteristic may not necessarily translate into the well-being of workers. Therefore, it is necessary to prevent labor overexploitation in the sector.

Despite government policies promoting the transition from illegal to legal crops, the farmers involved face difficulties in abruptly abandoning their livelihoods. This situation is complicated by the lack of resources to acquire licences and the absence of state financial support, which necessitates a gradual transition process. In addition, these farmers are in a vulnerable position, pressured by narco-guerrilla groups that demand the sale of their crops, which puts their safety and that of their communities at risk.

After the ratification of the peace agreement in Colombia, there has been evidence of a slowdown in its implementation. It is imperative to resume reintegration efforts to effectively integrate ex-combatants into communities, particularly in initiatives such as the medical cannabis industry.

A viable strategy for mitigating opposition to government is to address inequalities effectively. This involves facilitating the development of self-sustainable businesses that comprehensively improve well-being, including employment, adequate nutrition, housing, educational training, basic services, road accessibility, health care and safety. This last aspect has been severely

compromised by the homicides of numerous ex-combatants. Only by satisfying these conditions can lasting peace and harmonious social relations be found.

In this context, 68.8% of the participants in the study conceive of a lack of tangible benefits in terms of social investment, which suggests that the guidelines for the development of the economy have not yet achieved the expected results. This implies that the creation of businesses and job opportunities for returnees is hampered by persistent adverse circumstances. The lack of an effective state presence is notorious, while the influence of irregular groups seems to remain constant in certain regions.

Figure 5. Social Investment



Source: prepared by the authors

In the department of Cauca, a region that has historically been a leader in the unregulated cultivation of cannabis, innovative initiatives are being developed within the framework of legality. An emblematic case is that of the Misak indigenous people, who have positioned themselves as a pioneer in the production of cannabis for the international market. This project benefits from the academic collaboration and technical support of a university entity, in conjunction with the company Pharmacielo, which represents a model of strategic alliance between local communities, academia and the private sector in the medical cannabis industry (El Tiempo, 2020).

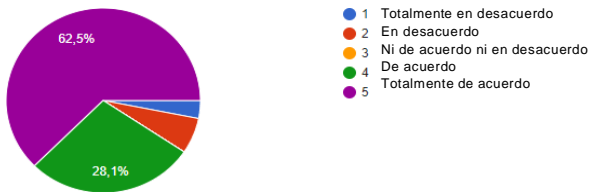
However, this initiative soon met resistance within the community itself. The traditional authorities of the Misak people expressed their disagreement with the project, arguing that it contradicted their ancestral values. Specifically, they expressed concern about what they considered to be a commercial usufruct of the land, which, according to their worldview, should be respected as a sacred entity and not as a resource for economic benefit (Ancestral Authority of the Misak Nu Nakchak People, 2020).

It is imperative that government authorities strengthen their efforts to promote synergistic collaboration between academic institutions, state agencies, and private entities in the development of initiatives related to the cannabis industry. This need is evident in the results of the survey, where only 15.67% of the participants recognize an efficient integration and relationship between these sectors. The low perception of cross-sectoral cooperation suggests a significant area of opportunity to improve the implementation and success of projects in this emerging field.

According to estimates by the international corporation Khiron, the potential number of people nationwide who could benefit from treatments based on medical cannabis amounts to

approximately 6,000,000 (Martínez, 2019). This projection is supported by the results of the survey, where 90.6% of the participants expressed their willingness to use pharmacological cannabinoids on the orders of the doctors (Graph 6).

Figure 6. Propensity to use pharmaceutical cannabinoids



Source: prepared by the authors

Additionally, 81.3% of respondents expressed credibility in the standards and specifications of the goods made by the national cannabinoid industry. These data suggest the existence of a significant and receptive domestic market for these therapeutic products (Figure 7).

Figure 7. Credibility for manufacturing in the country



Source: prepared by the authors

It is crucial to underline that the development of the medical cannabis sector has to go beyond mere economic objectives, focusing primarily on its potential to improve the quality of life of millions of patients globally. To achieve this end, it is imperative to prioritize and promote scientific development in this field. However, in Colombia, state investment in science and technology remains at suboptimal levels, representing less than 0.5% of the Gross Domestic Product (La República, 2019).

Environmental Profile

The survey results reveal a mostly positive perception of the potential environmental impact of the medical cannabis industry. A significant 87.6% of participants believe that the development of technified plantations and greenhouses for the production of medical cannabinoids could contribute to mitigating critical environmental problems, such as deforestation, soil degradation and damage to vulnerable biodiversity (Figure 8).

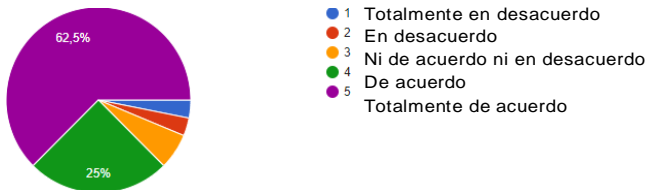
Figure 8. Attenuation of soil deforestation



Source: prepared by the authors

The survey reveals significant environmental awareness among participants in relation to the agricultural practices of the medical cannabis industry. A large majority, represented by 87.5% of the participants, recognize that the absence of fumigation with chemical substances on these crops contributes positively to the preservation of soil quality.

Figure 9. Soil contamination mitigation



Source: prepared by the authors

Analysis and Discussion of Results

The development of the medical cannabis industry in Colombia shows significant potential, but faces significant challenges in regulatory, economic, social and environmental aspects.

In terms of regulations, there is a gap between the policy and its implementation. Although there is a solid regulatory framework, only 52.3% of license applications were approved between 2018 and 2024, suggesting difficulties in the granting process or lack of technical knowledge on the part of applicants. The projection of licenses granted for 2025 (approximately 66) indicates moderate growth in the sector.

From an economic point of view, Colombia has significant comparative advantages, such as low production costs and favorable climatic conditions. However, obstacles remain, such as limited access to finance and the need to develop higher value-added products to maximize economic benefits.

In the social sphere, the industry promises to generate employment and promote rural development. However, the results of the survey indicate that 68.8% of the participants do not perceive significant benefits in terms of social investment. In addition, only 12.5% recognize the

effective inclusion of conflict-affected communities in medical cannabis projects, suggesting the need to improve the implementation of inclusive development policies.

Environmentally, the majority of respondents 87.6% believe that the medical cannabis industry could contribute to reducing deforestation and soil pollution associated with illicit crops. However, it is crucial to implement sustainable agricultural practices to ensure these benefits.

In summary, while the medical cannabis industry in Colombia shows promising potential, the need to address the gaps between policy and its implementation, improve social inclusion, foster innovation for the development of high value-added products, and ensure environmentally sustainable practices to maximize the benefits of this emerging sector is evident.

Conclusions

The analysis of the key components of the sustainability of the therapeutic cannabis sector in Colombia reveals a complex and multifaceted panorama, with significant potential, but also considerable challenges.

In the regulatory sphere, there is a gap between the formulation of policies and their effective implementation. Although there is a robust regulatory framework, the low license approval rate of 52.3% suggests obstacles in the administrative process or lack of technical capacity among applicants. The moderate projection of licenses for 2025 indicates growth in the sector, but also the persistence of barriers to entry.

Economically, Colombia has notable comparative advantages, such as low production costs and favorable climatic conditions. However, the sector faces significant challenges, including limited access to finance and the need to develop higher value-added products. The perception of Colombia as an attractive destination for investments in this sector (84.4% of respondents) contrasts with the lack of knowledge about national high-tech products (68.7%), which suggests a gap in innovation and the development of sophisticated products.

From a social perspective, the industry promises to generate employment and promote rural development. However, the perception of tangible social benefits is low (only 31.2% recognize positive impacts on social investment), indicating a discrepancy between expectations and the results observed. The limited inclusion of conflict-affected communities in medical cannabis projects (12.5%) suggests the need for more effective policies for inclusive development.

Environmentally, there is a positive perception about the industry's potential to mitigate problems such as deforestation and soil pollution (87.6% of respondents). However, it is crucial to implement and maintain sustainable agricultural practices to realize these potential benefits.

The sustainability of the sector also depends on the effective integration between academia, the state and the private sector, an aspect that shows weaknesses according to the perception of the respondents (only 15.67% recognize an effective integration).

In conclusion, while the therapeutic cannabis sector in Colombia shows promising potential, its long-term sustainability requires addressing the gaps identified in policy implementation,

improving social inclusion, fostering innovation for the development of high value-added products, and ensuring environmentally sustainable practices. The high level of acceptance of medical cannabis among respondents (90.6% willing to use it under medical order) suggests a receptive domestic market, but the success of the sector will depend on its ability to overcome the identified challenges and capitalize on the country's comparative advantages.

The sustainability of the therapeutic cannabis sector in Colombia is presented as an achievable goal, but one that will require coordinated and sustained efforts in the regulatory, economic, social and environmental spheres to fully realize its potential.

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