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ORIGINAL

Evaluation of the cost-benefit ratio of two fish production systems in 4 farms in La Plata, Huila

Evaluación de la relación costo-beneficio de dos sistemas de producción piscícola en 4 fincas de La Plata, Huila

Marly Yulieth Arenas Gómez[1], Héctor Javier Flórez Diaz [1], Verenice Sánchez Castillo [1]

[1]Universidad de la Amazonia. Florencia, Caquetá, Colombia.

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Corresponding Author
Marly Yulieth Arenas Gómez

ABSTRACT

The pisciculture plays an important role in the economic dynamization of the municipality, small farmers and their families. Despite the fact that the families dedicated to this agricultural activity claim to obtain significant income, they do not keep a record that shows the economic profitability of their production system. The objective of this research study was to evaluate the current cost-benefit relationship in fish production on four farms in the municipality of La Plata, Huila. The management systems implemented on the farms were characterized, their profitability was analyzed, and the fish farmers' perception of their systems was identified. Qualitative methods such as field visits, interviews and quantitative methods such as surveys were used to collect the information and later systematize it using ATLAS.ti version 9.0 software. It was found that most of the producers choose to implement a semi-intensive system, which is related to the availability of resources they have on their farms and that part of the benefits are not only economic but also of high-quality self-consumption, thus demonstrating that their system is an important source of family sustenance. Finally, it was found that the fish farmers are satisfied with their production systems.

Keywords: Pisciculture; Production System; Cost-Benefit; Semi-Intensive; Income; Self-Consumption; Livelihood.

RESUMEN

La piscicultura cumple un rol importante en la dinamización económica del municipio, de los pequeños productores campesinos y de sus familias. A pesar de que las familias dedicadas a esta actividad agropecuaria afirman obtener ingresos significativos, no llevan un registro que evidencie una rentabilidad económica en su sistema productivo. Este estudio investigativo tuvo como objetivo evaluar la relación del costo-beneficio actual en la producción piscícola en 4 fincas del municipio de La Plata, Huila, se caracterizaron los sistemas de manejo implementados en las fincas productoras, se analizó su rentabilidad y se identificó la percepción de los piscicultores acerca de sus sistemas. Para ello, se utilizaron métodos cualitativos como visitas de campo, entrevistas y cuantitativos como encuestas para recopilar la información y posteriormente sistematizarla mediante el Software ATLAS.ti versión 9.0. Se encontró que gran parte de los productores optan por implementar un sistema semi-intensivo, el cual está relacionado a la disponibilidad de recursos que tienen en sus predios y que parte de sus beneficios no son solo económicos sino también de autoconsumo de alta calidad, demostrando así que su sistema es una fuente importante para el sustento familiar. Por último, se evidenció que los piscicultores están satisfechos con sus sistemas productivos.

Palabras clave: Piscicultura; Sistema Productivo; Costo-Beneficio; Semi-Intensivo; Ingresos; Autoconsumo; Sustento.

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INTRODUCTION

Fish farming has gained recognition throughout history because it is an important economic line in national and supranational growth.[1] According to [2] a total world production of 178 million tons of aquatic animals was achieved in 2020, corresponding to an increase of 3 % compared to 2018. The largest fishery and aquaculture producers in 2020 were the Asian countries, which had 70 % of production; far behind were the American countries with 12 %, Europe with 10 %, Africa with 7 %, and finally, the countries of Oceania with 1 % of production. In the same year, the countries with the highest percentage of production were China 35 %, India 8 %, Indonesia 7 %, Vietnam 5 % and Peru with 3 %.[2]

Colombia has grown in fish production because it has certain advantages since it lends itself as a method for families to appropriate fishing skills. Likewise, it appears as an alternative for new economic and agricultural development opportunities for the country, thanks to the large land area and water resources it possesses, which facilitates crops such as Tilapia (Oreochromis), trout (Salmoninae), cachama (Serrasalmidae) and other native species to present high productivity up to the point of export.[1]

According to [3] Colombia strengthened the fishing system with the creation of laws that directed the operation of the activity; in this case, Law 13 of 1990 - General Fishing Statute -, its regulatory decree 2256 of 1991, and Law 101 of 1993 - General Law of Agricultural and Fishing Development, enacted by the Congress of the Republic. In Colombia, it is known that there are 121 000 fishermen among the estimated 300 000 fishermen and 2 700 fish farmers.[4]

Between 2012 and 2021, the aquaculture production index increased by 116,16 %, from 89 064 to 192 521 tons of products, including tilapia (Oreochromis), trout (Salmoninae), cachaca (Serrasalmidae), and other species. This highlights that the departments with the best characteristics for the development of this agricultural activity are Huila, Meta, and Tolima.[5]

The [6] indicates that Huila participates in fish farming activities at the departmental level. Between 2013 and 2017, it increased its production of carcass meat between 34 436 Tn and 46 310 Tn, whereas red tilapia production predominates. On the other hand, [7] wrote that "Huila made a contribution of 73,048 tons in red and silver mojarra, corresponding to 39 % of the national fish production, tilapia has a share of 58 %, cachama with 19 %, trout with 16 %, and others 7 %". It is also considered that Huila has an 80 % export share, which shows an increase in sales and consumption since 2019.[8]

The municipality of La Plata focuses its productive economy in the primary sector because it has an extensive rural area in which agricultural and livestock activities are exercised. Within the activities of an economic nature that are most marked in the municipality are agriculture, livestock, fish farming, and forestry; these are practiced or are related to 80 % of the population, followed by trade and services with 15 % and 5 %, respectively.[9]

Currently, there is little information regarding the fishing activity in the municipality of La Plata. In 2021, there was a fire due to protests by the people, and the municipality's mayor's office was damaged.[10] According to the [11] fish farming accounts for 5,4 % of production in the rural sector, with species such as Tilapia (Oreochromis), trout (Salmoninae), cachama (Serrasalmidae) and mojarra (Gerreidae). There are also two production models: semi-intensive, which consists of polyculture with several species, and intensive, which involves monoculture with a single species, usually Tilapia (Oreochromis).[12]

On the other hand, regarding the feeding of such fish production, it is distinguished that according to the stage of the fish batch, by calculating the biomass, the amount necessary to feed them will be known; however, the semi-intensive model is more associated with the combination of various feeding alternatives such as the implementation of concentrate with natural supplements; and the intensive model is commonly carried out only with concentrate.[12] Because of this, it is necessary to inquire about the cost-benefit relationship in terms of fish production in order to understand if the producer is generating economic viability and is capable of supplying its needs.

The municipality of La Plata is very relevant to fish production and its dynamization. From this perspective, in fish farming, there are two production systems (intensive and semi-intensive), the first based on a monoculture of specimens and the second on a polyculture of different species. Consequently, within the four farms, there is an area of lakes between 10 x 30 meters approximately with a depth between 1,20 and 1,80 meters deep.80 meters deep. Three farms have an intensive system; two produce tilapia (Oreochromis), and one produces cachama (Serrasalmidae).

In contrast, the other farm has a semi-intensive system in which it produces trout (Salmoninae), cachama (Serrasalmidae), and mojarra (Gerreidae) at the same time. Feeding depends on the category in which the fish are found, i.e., if they are fry, juveniles, or adults, the amount of feed will be evaluated by calculating 3 % to 5 % of the biomass planted; in general, most fish are fed with concentrate. This is the opposite of producers who base the fish diet on forages, different types of plants, and insect larvae as a food source. However, producers do not keep records that show the profitability and management of both production systems; therefore, the cost-benefit ratio of fish production systems is unknown. What are the characteristics of the cost-benefit ratio of fish farmers in the municipality of La Plata Huila?

METHOD

The farms are located in the village of La Palma, which has coordinates 2° 23'24''N 75°53'31''W, an altitude of 1050 meters above sea level, and jurisdiction of the municipality of La Plata-Huila. The research was developed from a historical-hermeneutic approach, which is based on having a practical interest aimed at understanding the methodological world, i.e., it is interpretive; therefore, this research paradigm is directed toward the understanding of language resulting in the interpretation of social and human reality.[13]

For data collection, a participatory observation was used in which the producers were accompanied in the daily tasks carried out in fish production (feed process and alternatives, water cleaning, recognition of farmed fish, pond capacity, density of fish managed per m2, and control of possible diseases). Subsequently, information was collected through an interview supported by a recording

where aspects such as production history, experiences in the development of the system, lessons learned, and difficulties of the production system were addressed, this information was transcribed and processed using the qualitative data processing software Atlas ti version 9.0.

The production of the findings was based first on an exploratory approach, then on inductive and finally deductive categorizations, which made it possible to establish co-occurrences between codes and to carry out the respective triangulations.

RESULTS

Exploratory analysis

The relationship of the semi-intensive fish farming system of the interviewee was associated with the terms fish, feed, alternatives and production, being evident that, for the fish farmer the quality in production revolves around the adequate implementation of an alternative feed for fish, coinciding with [14,15] where they argue that the quality of fish meat can be determined by the use of alternative diets to the traditional ones.

Likewise, the terms costs, community, quality, commercialize, system, fish farming, and consumption, associated with the subsequent benefit of fish production, indicate that the interviewee's main livelihood and means of living is fish farming since the activity generates economic income and is a source of healthy consumption for the family. According to [16] the reason for this is that small-scale production systems mostly take advantage of waste as fish feed, and with this, they save costs while allowing good quality food.

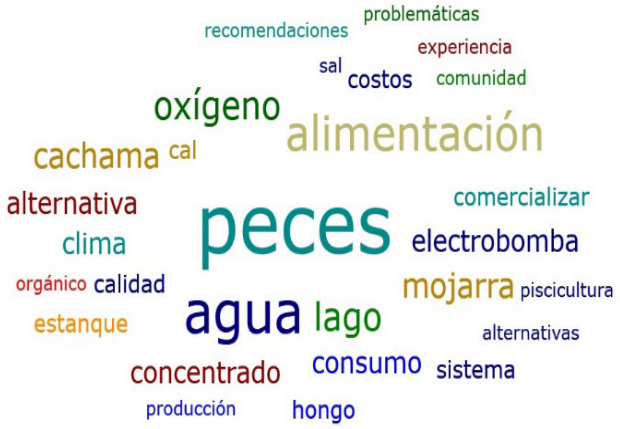

Figura 1. Word cloud on the benefits of fish production and recommendations for its implementation.

In order for the functional and productive characteristics of the system to develop to a reasonable extent, the knowledge and experience of the fish farmer suggest a series of recommendations, where words proposed by the producer such as climate, pond, electric pump, lime, salt, water, oxygen, fungus, are directed to the objective of having tools, inputs and knowledge about fundamental edaphoclimatic factors that are necessary for the management of the pond soil, the care of the fish in such a way that the negative impacts on the productive system are minimized. According to [17] the level of soil capacity to store and retain water is directly related to the effect of climate on it, which can generate problems in the relevant development of the activity (figure 1).

Deductive analysis

The deductive analysis of the narratives yielded a total of 53 analysis codes which were grouped into 4 families of knowledge and perception of the fish farmers about their livestock activity.

Economic Family

In the village of La Palma, fish production satisfies part of the demand in the municipality of La Plata since all of the harvest is *sold* here, which helps boost the rural economy by providing the fish farmers with *income*. In line with the interviewee's statement, [18,19] state that fish production has been consolidated as a strategy to improve the quality of life of rural families by generating significant income.

The profit from fish farming allows the farmers to cover their household expenses and buy the necessary inputs for production, such as feed, fish seed, cleaning and maintenance elements, and the resulting *savings for* the family. In their opinion, the production system represents important economic profitability for them, which is why they have maintained it.

[20] emphasizes that although profitability is associated with profit and utility, it also directly benefits those who receive it since income exceeds the amount invested and spent on the activity (figure 2):

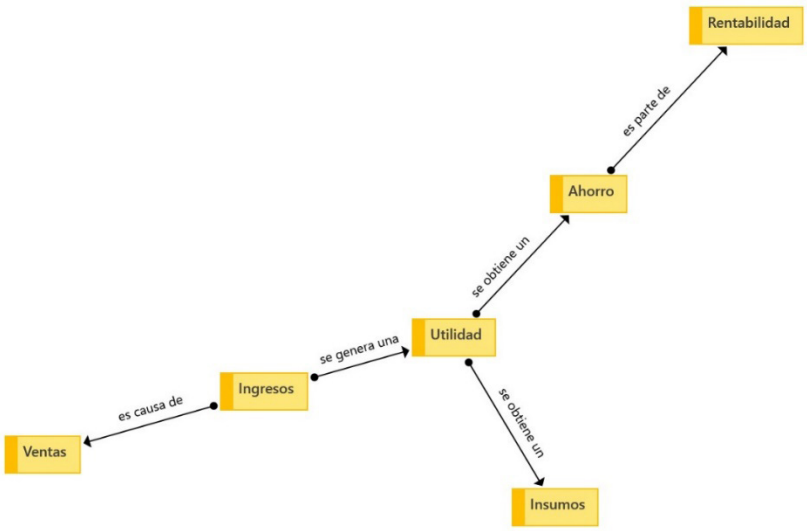

Figure 2. Network production economy.

Productive family

Given that a small-scale fish production system is as important for family food security as it is for the economic advancement of the municipality's agricultural sector, it requires a series of components that stand out in its proper functioning. Accordingly, for the interviewee, all fish farming depends mainly on the *diet* provided to the animals, and this, in turn, can be subject to the direction that the producer wants to give to his crop. Conventional feeding has the advantage that the crop's harvesting time will be faster than the implementation of an alternative diet in which the period will be considerably more extended, affecting the production system if the latter is intended purely for commercialization. [21] describe this decrease in the harvest period precisely because only commercial systems implement conventional complete feeds, which have the necessary dietary requirements for the rapid growth of fish in an intensive system. In contrast [22] argue that alternative diets can also achieve efficient nutritional parameters with an adequate combination of organic raw materials, generating important productive responses similar to the conventional ones.

From this point of view, for the fish farmer, an alternative feeding method in small fish farming systems can also be based on the cultivation of the Californian red earthworm (Eisenia foetida) since he knows that this practice is multipurpose because, as confirmed by [23] vermiculture produces organic fertilizers rich in nutrients for plants and high percentages of animal protein that can be used as feed for fish farming projects. In this way, better results are offered regarding *the* quality and flavor of fish meat. Hence, the producer still provides an alternative feed for his crop.

Following the producer's account, a productive system that is of a family nature and for small-scale commercialization through alternative food provides self-consumption when the farmer wishes and at the time he/she likes*; in* addition, as [24] states, the assurance that the fish fed is healthy, is beneficial because fish consumption becomes part of food sovereignty and the family's sense of belonging (figure 3).

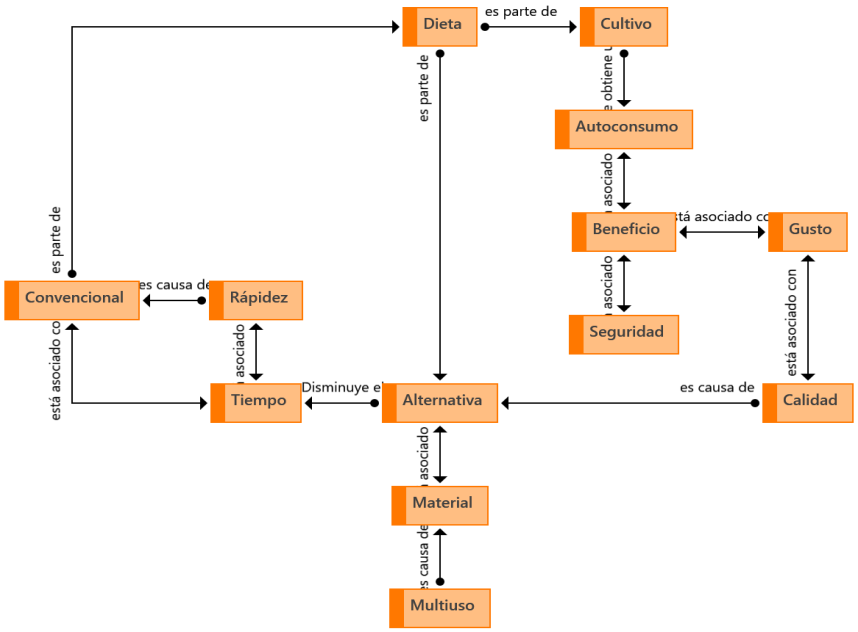

Figure 3. Network fish production.

Limiting family

The correct functioning of the fish farming system depends on multiple factors that can limit the level of productivity at harvest time, one of which is associated with the *altitude* at which the producer's property or farm is located. La Palma is located at an altitude of 787 meters above sea level, a characteristic that, according to [25] causes the level of atmospheric pressure to decrease, so the concentration of dissolved oxygen in the water also decreases as the altitude increases, resulting in difficulty for some fish to *breathe* and assimilate the *oxygen* available at those altitudes.

In this sense, from the fish farmer's perception, this agricultural activity in the municipality of La Plata is subject to the fact that the type of fish to be cultivated responds to the climatic, edaphic, and altitudinal conditions of the municipality, which is parallel to what [26] mentioned concerning the edaphoclimatic requirements that each specimen may need about the region. The above, assuming that [27] argues that species such as the white cachaca (*Piaractus brachyurous*), black cachaca (*Colossoma macrosomia*), and tarpon (*Tarpon atlanticus*) are prone to development and growth difficulties in the low temperatures that are associated with the municipality of La Plata, a different case from the species known as tilapia or red mojarra (*Oreochromis spp.*). This explains the *diverse loss of* cachama and shad crops implemented by the producer during the first stages of his experience, which caused the *unproductiveness* of the fish farming system.

At the same time, [28] mentions that species from tropical regions of the country have a greater *susceptibility* to develop and survive in those *regions where* temperatures above 25 °C are measured and where there is no *deficit* in the water requirement but a constant source of water (figure 4).

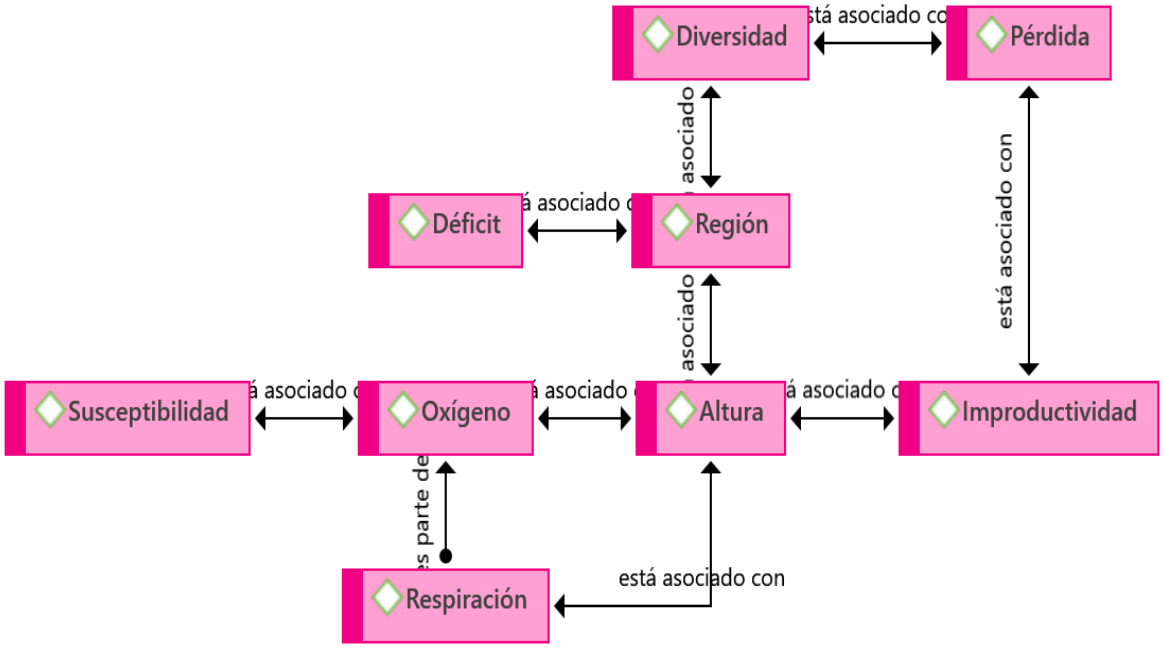

Figure 4. Network production limiting factors.

Family recommendations

The interviewee provided a step-by-step guide based on his history and experience on the *farm* to adequately develop a small-scale fish farming system such as the one he is implementing. To this end, he mentioned that *land* suitability is a fundamental phase in which the *soil* must be sufficiently suitable; as stated by [29] its impermeable capacity must be adequate to prevent water from escaping through infiltration, and its texture must preferably be clay loam. Likewise, it is essential to distinguish these properties since the soil's and the crop's productivity depends on them.[30] Hence, he considers it essential to follow a *guideline* that goes hand in hand with the *maintenance of* the lake, where first, adequate *disinfection* with lime and other *compounds* such as salt, which is very useful for fish farming, is carried out. However, for him, it is necessary to have technical assistance to use any chemical *substance* within the fish farming system.

Thus, for the fish farmer, the lake must fulfill the role of a *reservoir*, assuming the *requirement* of providing a suitable *habitat* for the fish while at the same time performing a cleaning *control* to avoid the possible spread of diseases, fungi, and bacteria that, as related by [31] proliferation can generate a deficiency in water quality, increasing the possibility of mortality. Additionally, according to the interviewee, this monitoring should also be carried out to avoid the uncontrolled reproduction of fish that, in addition to generating competition for a time, do not show significant growth and then die due to the low availability of food they require, minimizing their metabolic rate and increasing their susceptibility to diseases.[32]

Finally, the farmer shared the knowledge he acquired empirically over the years as a result of the *trial and error* of the whole process carried out with this agricultural practice; he expressed his *inexperience* at the beginning of the implementation of the system, which had an impact on the improvement of his perception and practice regarding fish farming (figure 5).[33]

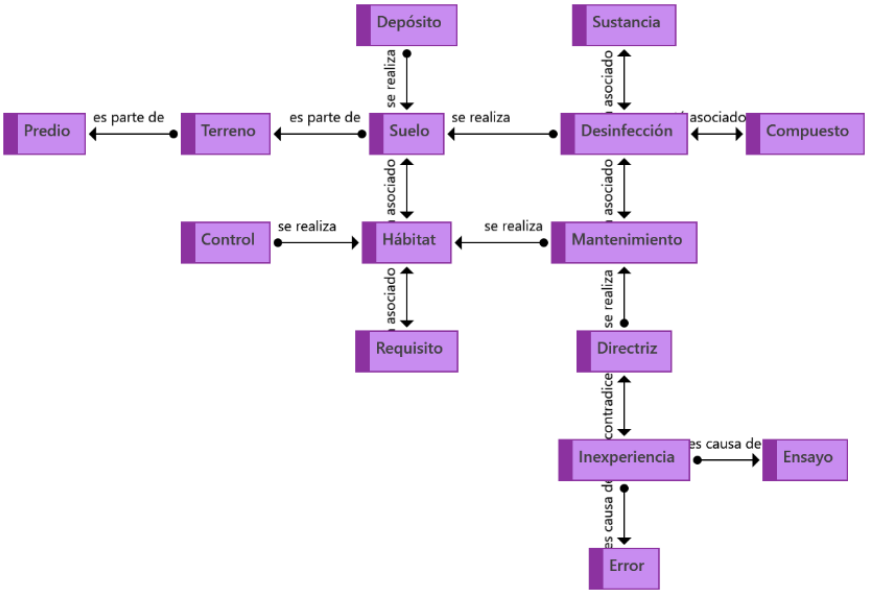

Figure 5. Network recommendations for fish production.

CONCLUSIONS

Within the semi-intensive system, particularities are recognized, such as small-scale sales and producers who intend to seek sustainability, which allows them to meet the basic needs of themselves and their families. Therefore, recommendations given by the fish farmer are proposed, which he has acquired empirically, allowing him to have a better view of how to manage and use different strategies for his production.

The small-scale production system is an important economic and food sustenance source for the farmer and his family. However, due to the region in which the farm is located, it is difficult for species diversification to be another production method. It is necessary to develop new research to broaden the perception of the benefits and costs of fish farming in the territory.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

CONTRIBUTION OF AUTHORSHIP

Conceptualization: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Data curation: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Formal analysis: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Research: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Methodology: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Project administration: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Resources: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Software: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Supervision: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Validation: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Visualization: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Writing – original draft: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.
Writing – review and editing: Marly Yulieth Arenas Gómez, Héctor Javier Flórez Diaz, Verenice Sánchez Castillo.

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