Productive Capacity of the Department of Quindío within the Framework of Sustainability

Lorena Villegas Muñoz[1], Cindey Bermudez Agudelo[2], Andrés Felipe Aristizábal Toro[3]

[1]Economista Universidad la Gran Colombia sede Armenia, Magíster en Administración de Empresas con Énfasis en Sistemas Integrados de Gestión y Medio Ambiente. Universidad del Quindío Armenia, Colombia lvillegas@uniquindio.edu.co
[2]Economista Universidad del Quindío, Magíster en Ciencias Sociales. Universidad del Quindío Armenia, Colombia cbermudeza@uniquindio.edu.co
[3]Economista Universidad del Quindío, Magíster en Desarrollo Regional. Universidad del Quindío Armenia, Colombia afaristizabalt@uniquindio.edu.co

Abstract

The purpose of the research was to determine the productive capacity of the department of Quindío, taking as a reference the analysis of the productive vocation of the territory for the period 2021; for which, a type of exploratory research was proposed following an analytical method from a quantitative approach; from the use of descriptive statistics for the treatment of information, as well as georeferencing tools to locate the natural and created vocation in the municipalities of the department. The results prove that the predominant crop in the department is bananas, followed by coffee and oranges. In addition, 25% of the municipalities in the department have overexploited land use and 50% are underutilized. In terms of productivity, it is evident that citrus crops have the highest yields at the national level, while bananas, even though they have a yield above the national average, are below the departments with the highest yields at the national level.

Keywords: Productive vocation, primary sector, agriculture, crops.

1. Introduction

The main objective of the study is to determine the productive capacity of the department of Quindío based on the availability of resources, in this sense it begins with the analysis of population location, where it is evident that by 2050 seven out of ten people will be in urban areas (World Bank [WB] 2020) demonstrating that it is necessary to join efforts for the planning of food production in accordance with the growing demand; On the other hand, considering the availability and sustainable use of natural resources, it is essential to include in the process the

natural vocation of the soils, since the productivity, sustainability and sustainability of the crops depend on it, thus guaranteeing the food security of the territory and at a global level.

In accordance with the above, Figure 1 shows the global production of fundamental foods in the diet of the population, such as rice, eggs, among others; in the same way, the main producing countries of these are presented, evidencing Continental China as the main producer of essential foods in the diet of the population, likewise, India occupies the second place as a producer of rice, additionally, it is the second producer of milk worldwide, surpassed only by the United States, demonstrating how food production is concentrated in Asian countries; finally, it is evident that in Latin America, Brazil is the main producer of eggs and milk, highlighting the fact that the Colombian countryside limits its production to meet domestic demand, which could represent a comparative disadvantage for the country compared to countries in the region and the world.

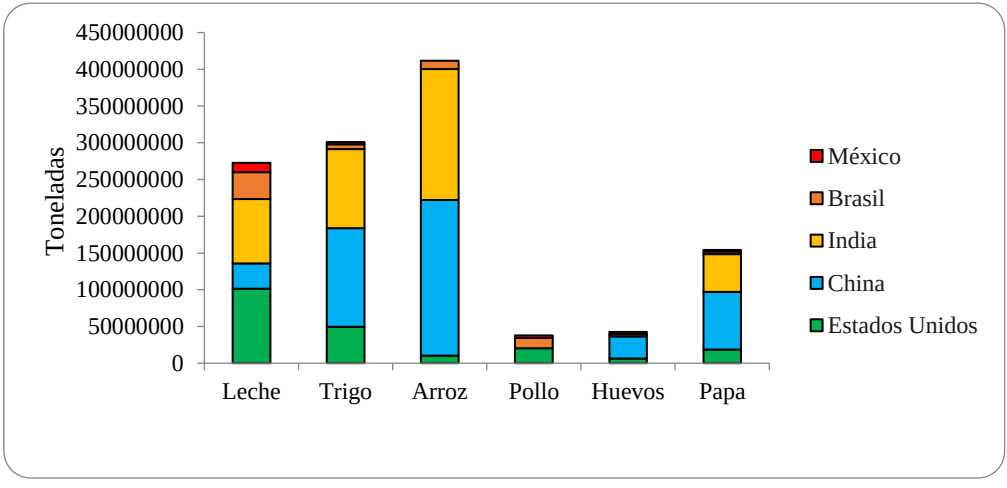

Figure 1. Food production worldwide. In original language Spanish

Source: Bermudez (2022, in Excel) with data taken from the Food and Agriculture Organization of the United Nations ([FAO]2020)

On the other hand, it must be understood that Colombia has a varied food production, due to the geographical and climatological characteristics that make its soils ideal for various agricultural activities.

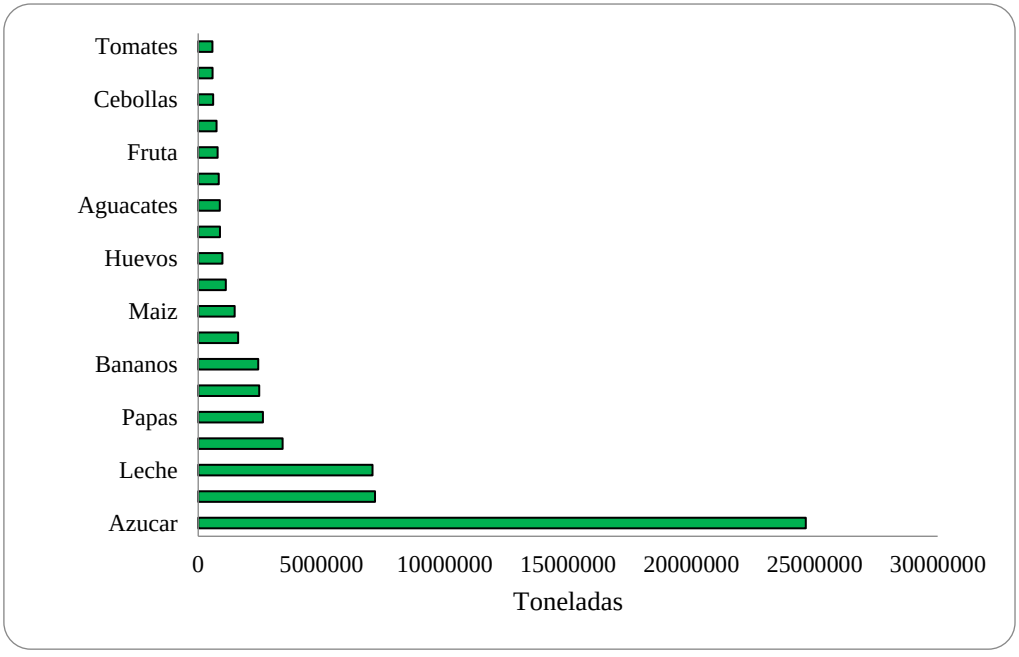

Figure 2. Production per ton of food in Colombia 2020. In original language Spanish

Source: Bermudez (2022, in Excel) with data taken from FAO (2020)

Figure 2 shows that sugar is the main agricultural product in the Colombian economy, followed by the production of palm oil, milk and rice, the latter two being fundamental in the diet of the global population; Regarding animal protein, the production of chicken meat and eggs stands out in the country, however, such production during 2020 did not reach two million tons, considering that according to the National Administrative Department of Statistics ([DANE] 2020) the Colombian population for the year 2020 was projected at 51,049,000, it can be inferred that the production of animal protein in Colombia is limited to domestic demand, therefore, if producers decide to allocate this production to the international market, it would generate a rise in food prices, violating the population's access to adequate food.

Now, with regard to the department of Quindío, it must be recognized that it stands out for the diversity of its soils, given the privileged geographical position in the middle of the central coordillera, however, this richness of soils can represent a disadvantage for the productivity of the primary sector due to the inadequate use of the soil, which can generate conflicts in production that would trigger a decrease in productivity in the medium and long term.

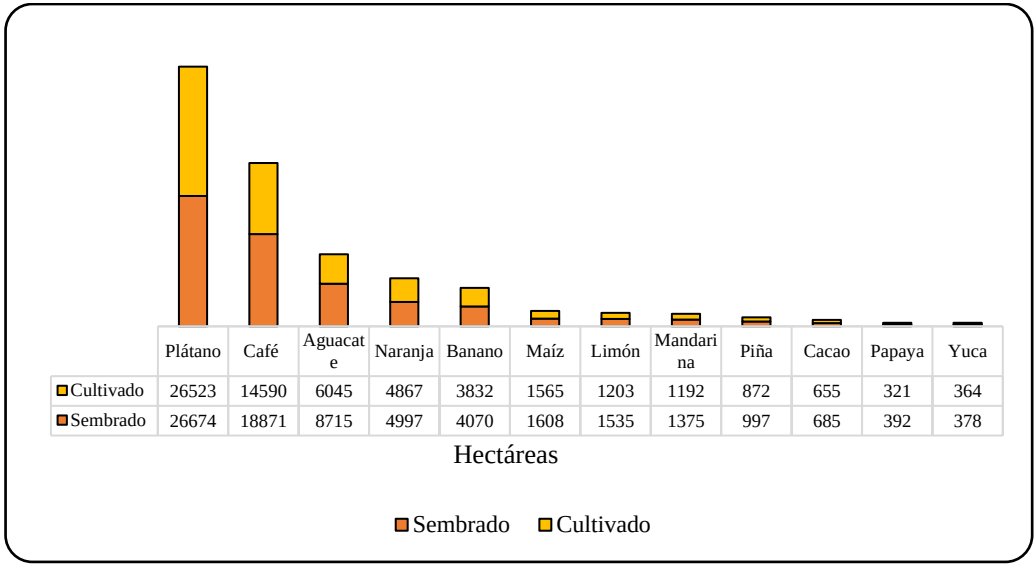

Figure 3. Food production by hectare in Quindío. In original language Spanish

Source: Bermúdez (2022, in Excel) with data taken from the Ministry of Agriculture and Rural Development (2021)

Figure 3 shows that the main crop in the department of Quindío during 2021 was bananas, followed by coffee, it is also observed that citrus crops have gained ground in the primary sector of the department, which in sum represented the third most representative crop of the department, similar to avocado cultivation, however, it can be seen in the figure that these crops are not productive, as is the case with bananas, because the difference between planted and cultivated area is 200 hectares in citrus crops and 150 hectares in banana crops.

In addition to the above, the Agustín Codazzi Geographic Institute [IGAC] and the Colombian Corporation for Agricultural Research ([Agrosavia] 2002) consider the natural vocation as those soils with the greatest capacity for the intensive and semi-intensive development of agricultural activities, therefore, it is essential to investigate the productive capacity of the department considering the natural vocation of the soil and the availability of resources to guarantee food security. so that the productivity and participation of the department's producers in the international market can be increased.

Finally, it is highlighted that this study is based on the importance of agriculture as the basis of economic growth and development with the purpose of guaranteeing the food security of the population, for this it is necessary to determine the productive capacities based on the natural vocation of the territory, allowing progress in the achievement of the second Sustainable Development Goal [SDG] "Zero Hunger" proposed by the United Nations Organization ([UN] 2015) this considering the demographic increase, which generates pressure on food production.

Ecology and Economy

For the development of the research, the postulates of Barber (1967) were addressed from the physiocratic approach, considering that the prosperity of economies depends on the production of the primary sector (cited by Domínguez, 2004) in addition to this, Smith (1776) argued that the growth and prosperity of the population is presented thanks to the surplus generated by agricultural activities (cited by Otero, et al. 2010), the above highlights the importance of the primary sector, especially agricultural activities, for the growth and development of economies, in this sense, the Brundtland Report (1987) highlights the importance of the rational use of natural resources, so that current generations can meet their needs without compromising the capacity and resources of future generations to meet theirs.

Additionally, Nussbaum (1999) considers that the possibility of being productive is part of human development (cited by Sahuí, 2014) evidencing the importance of studying and strengthening the productive capacities of the primary sector as an engine of development of nations, in addition to the above, from the approach of sustainable development it is proposed that the primary sector as a fundamental base, since the production of this promotes collective progress, for this reason Johnston and Mellor (1972) propose a broader analysis of the agricultural sector from the strengthening of small productive structures based on innovation and public policies for the increase of productivity in the territories contributing to the improvement of the socioeconomic conditions of the population.

Considering the importance of the primary sector, the postulates of ecological economics are addressed, from which the viability of the different economic activities is studied according to the carrying capacity and physical limits of the plant (Pérez, 2017), in the same way, the postulates of the bioeconomy are addressed, highlighting innovation and research as fundamental elements in the productive processes, guaranteeing the conservation and preservation of the environment (Urrego-Sandoval, 2022), focusing this research on the appropriate use of resources in order to guarantee food security.

From another perspective, different studies on productive capacities are investigated from the natural vocation of the territories, for this a first study by Mercado-Salgado, et al. (2020) is presented in their research "Mini-production chains with an agricultural vocation from the social capital approach" in which they started from the identification of two mini-productive chains in southern Mexico; To this end, they developed a qualitative approach based on the observation of the different production processes for the collection of information from interviews with producers, evidencing coffee cultivation as one that allows the creation of networks and links between each link in the production chain of this, concluding that productive chains generate collectivity and improve social capital.

For their part, Coral, et al. (2021) in their study "Exportable supply of cocoa in the department of Nariño (2010-2018)" applied a quantitative approach based on the use of databases of the Directorate of National Taxes and Customs [DIAN] on foreign trade, so that they were able to identify the exportable capacity of cocoa; their respective production chains and the added value of the product, highlighting the importance of strengthening each of the links of the production

chain in the department of Nariño, so that it can venture into the global market with food products such as cocoa.

Finally, the importance of studying the productive capacities of the departments in order to strengthen the primary sector while guaranteeing the proper use of natural resources is highlighted, so that agriculture is configured as an articulating axis for the development of communities and a driver of the national economy.

2. Methodological Strategy

The study was carried out from the type of exploratory research because it investigated a phenomenon that has been little studied from the economic field, according to the type of research an analytical method was implemented, which allowed to study the relationships between the productive capacities of the department and the natural vocation of the soil in Quindío. In accordance with this, the research followed a quantitative approach because the results were obtained from information collected from secondary sources, which allowed the implementation of statistical analysis techniques.

In this sense, a non-probabilistic sampling technique was used for convenience, because the variables are delimited by the periodicity of the research; the area sown and harvested; as well as the different crops of the department of Quindío, for this databases were obtained from the Ministry of Agriculture and Rural Development, DANE and the National Planning Department [DNP]; on the other hand, to achieve the proposed objectives, the Excel database was built and descriptive analyses were carried out based on the construction of bar figures; circular maps and some heat maps in Q-gis that allowed to evidence the spatial distribution of the crops; its planted area and productivity by municipalities, to draw conclusions about the department; To close, it presents the dictionary of variables considered for the development of the research.

Table 1. Variable Dictionary

Variable	Description	Fountain
Agricultural frontier	Distribution by hectare between agricultural activities, reserves and forests	Ministry of Environment and Sustainable Development [MADS]
Crop cycle	It is divided between transitory crops and permanent crops, the former being whose sowing and harvesting period is less than one year, contrary to the latter which in their first year are usually unproductive, however once harvested it is not necessary to plant again.	
Planted area	It is the total per hectare that is used to plant some type of crop.	
Harvested area	It refers to the hectares from which production was obtained.	

Crops	They are those who, thanks to the intervention of people on the land, arrange the planting process.

Source: Bermúdez (2022, in Word) with information from MADS (2022)

3. Results and Discussion

In this section the results of the research are presented, starting with the identification of crops and productivity by municipalities, followed by production according to the vocation and use of the soil, and finally, the possibilities of production by municipalities in the department of Quindío are characterized based on a real analysis between the use of the land and the natural vocation of it.

Productive structure by municipalities in the department of Quindío

In order to understand the productive structure of the department, it is necessary to start from the distribution of land, for this the agricultural frontier and the areas of exclusion evidenced in Figure 4 presented below are identified.

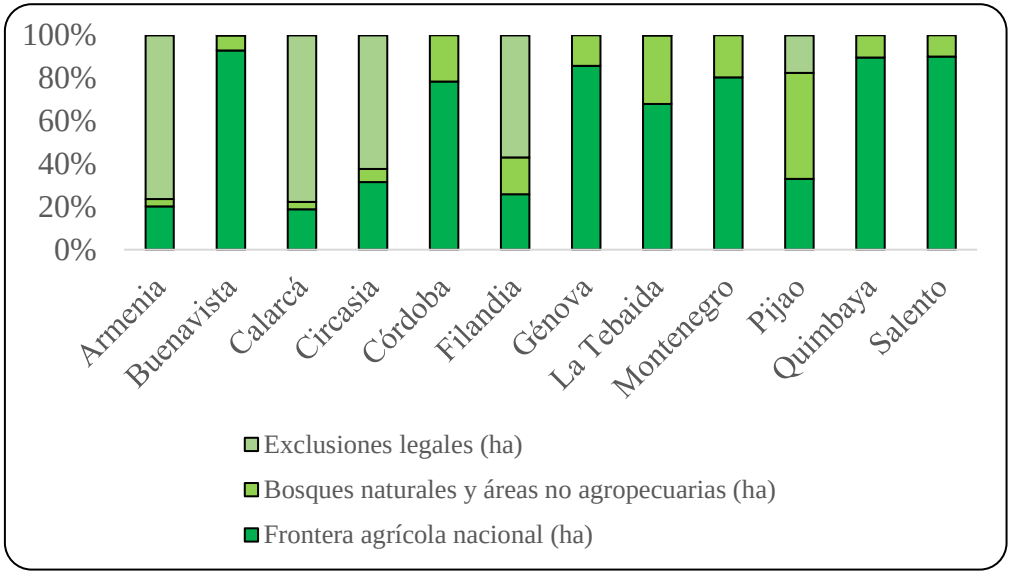

Figure 4. Agricultural frontier of Quindío. In original language Spanish

Source: Castillo (2022, in Excel) with data taken from MADS (2021)

According to the figure above, it can be seen that the municipalities of Córdoba such as Génova, Buenavista and Córdoba concentrate their territory on the agricultural frontier, followed by La Tebaida, Montenegro and Salento; on the other hand, the municipality of Pijao has a larger area

of natural forests and non-agricultural areas per hectare, while Armenia, Calarcá, Circasia and Filandia concentrate their territory in areas of legal exclusion, indicating that the soils cannot be used for agricultural activities. Regarding the productive structure of the department, the following conditions were identified for the department:

Table 2. Agricultural production structure of the department of Quindío

Crop Cycle	Total Departmental Participation	Crops	Share of harvested area (ha)
Permanent	96,03%	Plantain	26.524
		Coffee	14.591
		Avocado	6.045
		Banana	3.832
		Cocoa	656
		Cane	334
		Fruit	45.476
		Total	61.057
Transitory	3,97%	Corn	1.566
		Vegetables	393
		Manioc	364
		Total	2.323

Source: Castillo (2022, in Excel) with data taken from MADS (2020-2021)

Table 2 expresses the productive structure and land use in 2021, showing a marked trend in the department of Quindío with permanent cycle crops, where most of the departmental total is represented by the municipalities of Quimbaya, Calarcá, and Montenegro in 14.12%, 12.20% and 10.90% respectively. This trend is also explained by the focus that has been given within the development plans of the municipalities due to the conditions and location of the soils.

In this sense, the data expressed above reflect the conditions of land use, and when contrasted with the data in table 2, they reflect the maximum use by category for each municipality of the department of Quindío, demonstrating in the first place, the national agricultural frontier by hectares and the amount used for agricultural activities in the year 2021, Considering the above, a comparative analysis is carried out between the difference in use.

Table 3. Analysis of the use of planted area by municipalities in Quindío

Municipality	National agricultural frontier (ha)	Planted Area (ha) 2021	Real Difference	Proportional Difference
Armenia	8.125	7.300	825	89,84%
Buenavista	3.410	3.712	- 302	108,84%
Calarcá	6.913	8.526	- 1.613	123,33%
Circasia	7.178	3.043	4.135	42,39%
Córdoba	1.921	3.496	- 1.575	181,98%
Filandia	8.344	4.828	3.516	57,86%
Genoa	7.549	7.881	- 332	104,40%
The Thebaid	7.794	5.140	2.654	65,95%
Montenegro	13.506	8.790	4.716	65,08%
Pijao	4.769	6.943	- 2.174	145,59%

Quimbaya		11.957	9.909	2.048	82,88%
Salento		11.451	2.400	9.051	20,95%
Total, overall	92.917	71.966		20.951	
				Overuse	

Source: Castillo (2022, in Excel) with data taken from MADS (2021)

In the above table, the color scale expresses the variable of difference, overuse and underutilization, evidencing the level of use of planted hectares by municipality in the department of Quindío, highlighting, in the first place, Calarcá, Córdoba and Pijao, as municipalities that overuse the soils, above the range of the maximum allowed by the national agricultural frontier. On the other hand, it is observed that the municipalities highlighted in light color represent those that are not making use of their potential hectares for the agricultural sector, since they have a different approach to the agricultural vocation in their municipal development plan, as is the case of the municipality of Salento in which there is evidence of a dispersion in land use. given the boost that has been given to tourism, creating in effect a decrease in its agricultural production.

Productivity by municipalities in the department of Quindío

Regarding the yield of each product, eight crops were found that had the highest yield, which are: sugarcane; pineapple; tomatoes; mandarins; oranges; lemon; papaya and cassava. An analysis of its yield is carried out at the departmental level, using in each analysis of the crops, graphs that explain the position of the department of Quindío (in green) with respect to the participation and yields obtained with each of the products grown per hectare compared to the yield per crop at the national level.

Table 4. Average crop yield

Crops	Production (Thousands of tons)	Harvested area (Thousands of ha)	Departmental Yield (Tn/ha)	National Yield (Tn/ha)
Cane	19660	334	58,8	89,1
Pineapple	40535	872	46,5	40,5
Tomato	8095	229	35,3	46,7
Tangerine	27906	1193	23,4	15,6
Orange	100421	4867	20,6	15,1
Lemon	24614	1204	20,5	12,7
Papaya	5964	321	18,6	21,1
Manioc	6445	364	17,7	11,4
Banana	61043	3832	15,9	23,7
Gulupa or cholupa	366	31	12,0	15,5
Paprika	238	22	11,0	19,8
Lettuce	220	20	11,0	22,7
Ahuyama	710	68	10,4	10,8
Guava	211	21	9,9	13,2
Plantain	256925	26524	9,7	9,9
Passion fruit	796	88	9,0	16,6
Avocado	53040	6045	8,8	10,4
Other vegetables	300	39	7,8	11,8
Macadamia	2145	353	6,1	5,9
Blackberry	222	47	4,8	10,2
Lulo	207	48	4,3	9,8

Corn	6003	1566	3,8	3,1
Soy	227	81	2,8	2,5
Coffee	15352	14591	1,1	1,1
Cocoa	424	656	0,6	0,6
Total, overall	632070	63416		

Source: Escobar (2022, in Excel) with data taken from MADS (2021)

The above table shows that the most representative crops in terms of planted and harvested area in the department compared to the national average are citrus fruits, as well as pineapple, papaya and cassava, which are concentrated in municipalities closer to the department of Valle del Cauca.

Production possibilities for the department of Quindío

Regarding the actual production, it is addressed how the result that is obtained, after the entire process and the harvest stage, those foods that are in optimal conditions for consumption. On the other hand, land use corresponds to those hectares that are used for cultivation, in this case, the vocation of the soil and its yield per se are analyzed.

Evidencing that the total real production of the department of Quindío covers 632,863 (thousands of tons) according to data from municipal agricultural evaluations ([EVA] 2021), of which, within the eight crop groups analyzed, it was evidenced that fruit trees have the largest participation with 90.79%, with Montenegro being the municipality that leads the highest real production, since it has 110,315 (thousands of tons) within this group. 9.21% of the total real production of the department is made up of: Traditional tropical crops 5.60%; vegetables 1.55%; roots and tubers 1.04%; Cereals 0.95%; oilseeds 0.04%; legumes 0.03%; finally, the crop group that shows the lowest participation are crops for condiments; medicinal and aromatic beverages 0.01%.

Once the most representative crops in the agrarian structure of the department have been evidenced, the analysis of its productive vocation is carried out while considering the aptitudes of the soil and its availability for the production of avocado crops; coffee and banana, so that the natural vocation and the vocation created in the department can be identified.

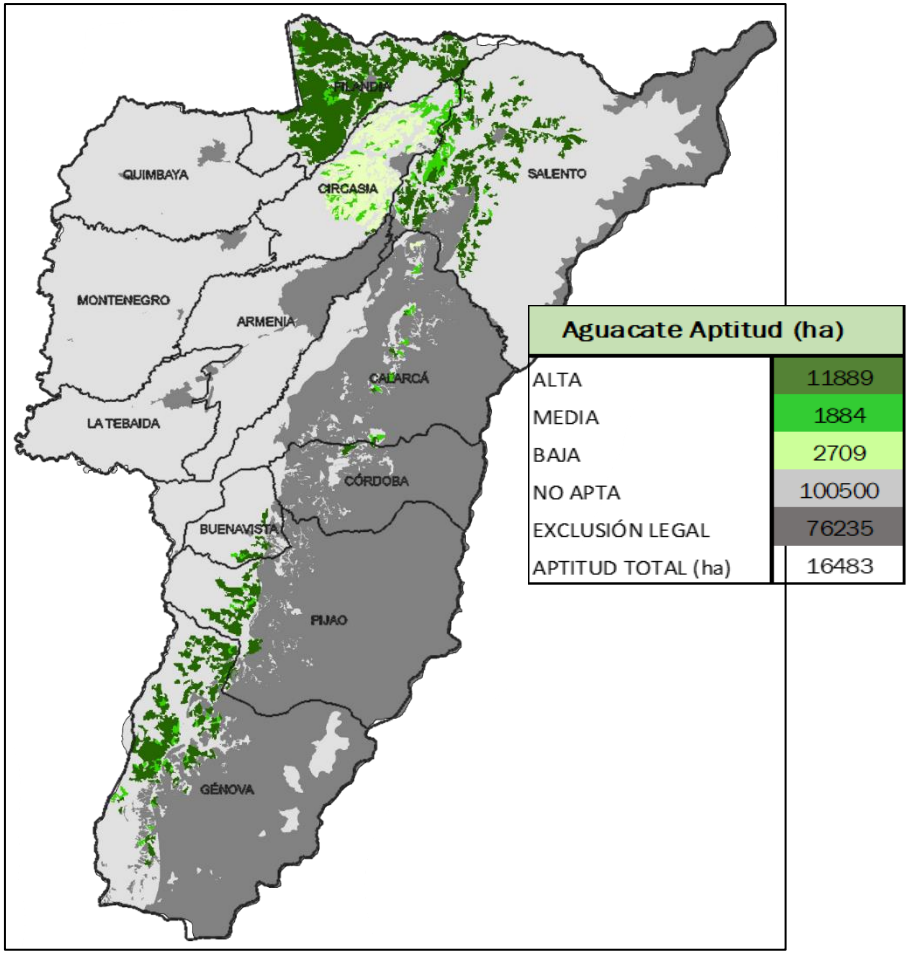

Figure 5. Aptitude for planting avocado cultivation. In original language Spanish

Source: Ramírez (2022, in Q-gis) with data taken from MADS (2021)

Regarding avocado cultivation, it is observed that in the municipalities of Filandia, Salento, Génova and Pijao they have a high aptitude for this type of crop, as well as some municipalities that make up medium and low aptitudes, passing near the central mountain range, however, at the national level the cultivation of avocado has a total aptitude of 2.8%, with Quindío participating in 9% of the total aptitude. reflecting the data that Colombian soils, including Quindío, are characterized by being mostly unsuitable.

On the other hand, in coffee cultivation it is evident that the municipality of Quimbaya has the highest concentration of area with a high level of aptitude for the cultivation of coffee and the

central mountain range; the total suitability of this crop in the department represents 33% of its area, which is suitable for planting and production of this crop, while coffee represents 5.4% of total suitability at the national level, with the department of Quindío being a place to highlight that has greater suitability within this national percentage.

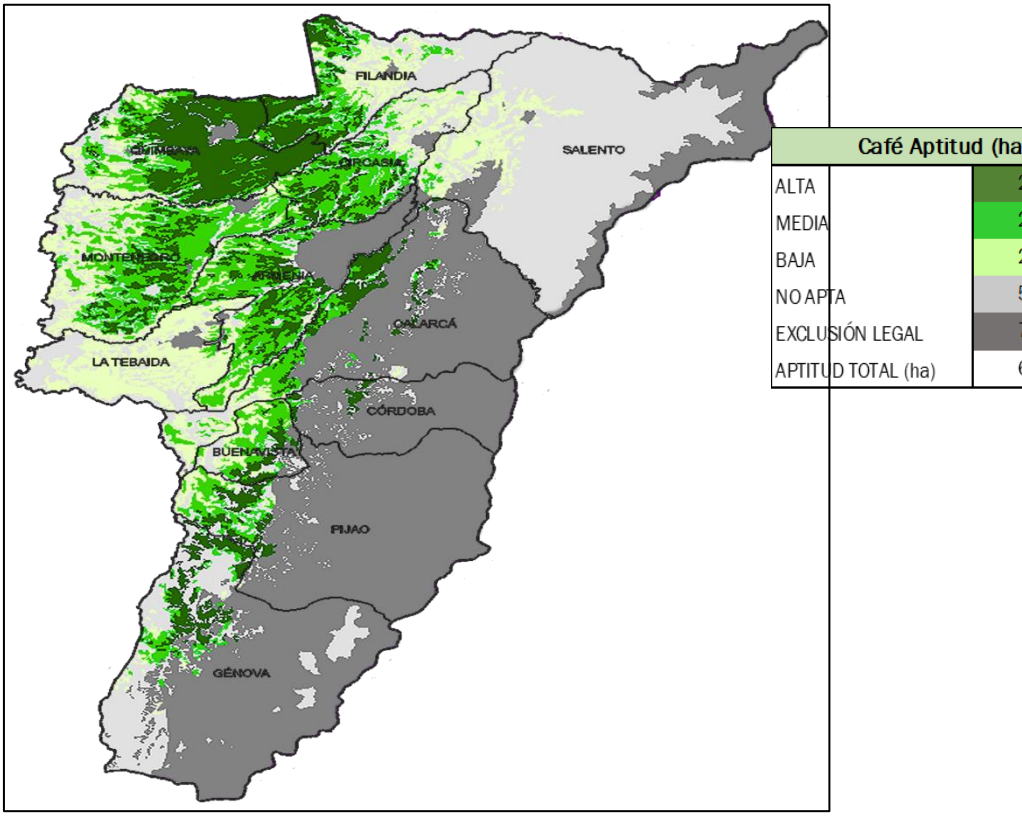

Figure 6. Suitability for sowing coffee cultivation. In original language Spanish

Source: Ramírez (2022, in Q-gis) with data taken from MADS (2021)

As for banana cultivation, it can be seen that the altitude is the one that has the largest area for this crop, the large part of its total suitability in hectares, which is equivalent to 35 %, are found in the municipalities near the central mountain range and the department of Valle del Cauca.

This shows that the department of Quindío has comparative advantages for the production of coffee and bananas, highlighting the importance that these crops have represented in the economy of the department given their ability to be planted intercropped, demonstrating that production processes are not always linked to monocultures, but also that there are ways to increase productivity from polycultures. For this reason, it is necessary to highlight the benefits

of these forms of production in economic and environmental matters, because this type of crops generate a symbiosis that allows them to be planted together and in many cases reducing production costs due to the environmental benefits they bring with them.

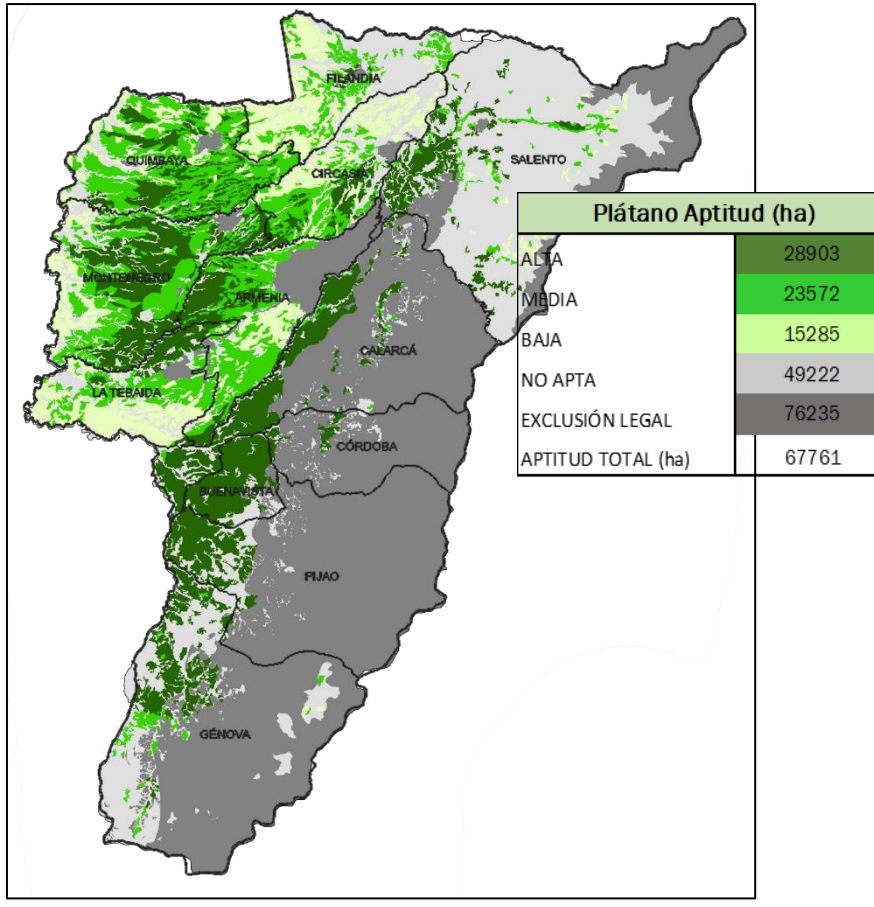

Figure 6. Suitability for sowing coffee cultivation. In original language Spanish

Source: Ramírez (2022, in Q-gis) with data taken from MADS (2021)

4. Conclusion

Considering the suitability, it can be concluded that the levels per hectare of each crop have different soil adaptations, that is, climates and geolocation are relevant when explaining the areas of the department of Quindío, their suitability and the large extensions for planting, each crop

group has different areas of greater adaptation, for example, the evidence of these crops is the area planted as a reference of the real use of the land and the area harvested, being the reflection that explains the valuable use of it, finally, in terms of yield, which connects the previous category (harvest) and departmental production, it shows the degree of efficiency in the previous categories or processes. Starting with the cultivation of bananas, it is evident that the number of planted areas is close to the area that has a high level of aptitude, however, the total suitability shows that there is more potential of hectares for cultivation of the same, because only 39% of the suitable hectares are used, likewise, this crop has a lower level of losses in hectares when seeing the difference between the planted areas and the harvested areas; the cultivation of Coffee has, in the same way, a closeness to the area with respect to the level of high aptitude and the number of hectares planted, however, of all the suitable areas only 29% of the total hectares are used, on the other hand, there is a great difference between the planted and harvested areas, since a loss of hectares is observed due to the harvesting process, explained by different crises such as externalities and migration to other crops that affected both the production and yield of this crop; Avocado is a crop that has been growing in terms of planting, reaching almost the top of the high level of suitability available in the department, making use of more than half (53%) of the total hectares suitable for this crop, in addition, the crop also presents losses between hectares planted and harvested.

Finally, considering the capacities of the soil, the high levels of suitability for various crops and natural biodiversity, a series of problems are identified that affect and influence the decrease in the participation of agricultural activity with respect to the departmental GDP, in addition, affecting productivity, marketing and communication between the different municipalities, especially, between rural and urban sectors. Highlighting the coverage, which is fundamental for the different processes of the value chains, around assistance from a technical side with respect to the institutions and government of Quindío with various parts of the territory, the Plan for the Productive and Social Ordering of Rural Property (POPSPR, 2021) states that a complete and efficient coverage of such technical assistance is not fulfilled, affecting the levels of planting, harvesting and finally quality of the products, in addition, the little information that is obtained and that is delivered, in an updated way, to use knowledge and tools that allow peasants and agricultural producers to improve conditions to increase quality levels and their value chains, to contribute to the local and national economy.

Knowledge.

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