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ANALYSIS OF PRODUCTIVITY AND COMPETITIVENESS IN BEEKEEPING: A CASE STUDY OF CUNDINAMARCA, COLOMBIA

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ABSTRACT

Purpose: The objective of this article is to analyze the productivity and competitiveness of beekeepers located in the department of Cundinamarca, Colombia.

Theoretical framework: Measuring productivity and competitiveness is a fundamental aspect of business management. In the case of beekeeping in Colombia, which has artisanal nature based on local knowledge and traditional practices, there is usually a lack of records and information that would allow this type of study.

Design/Methodology/Approach: We designed a questionnaire related to productive factors and competitiveness in beekeeping and applied it to members of the Association of Environmentalist Beekeepers. We determined the productive index and the profitability of assets and equity -identified as measures of the beekeepers' productivity and competitiveness- for the year 2020 using a quantitative analysis.

Findings: The depreciation of fixed assets is the highest production cost. The organizational and technological management implemented by the producers, as well as the time dedicated to beekeeping, are relevant factors to achieve productivity and business competitiveness.

Research, Practical & Social implications: This research has expanded the comprehension of beekeeping as an activity with profound economic, social, and environmental impacts. This study can be a basis for other research works and policy design oriented to achieve a comprehensive measurement of business performance and make programs to impulse the beekeepers in the country.

Originality/Value: This research broadens the understanding of the importance of cost management in the productivity and competitiveness of the beekeepers studied. We do not approach productivity as the quantity of honey and pollen produced but as the production efficiency. Competitiveness was evaluated using globally accepted indicators and easily interpreted to measure business performance.

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ANÁLISE DA PRODUTIVIDADE E COMPETITIVIDADE NA APICULTURA: UM ESTUDO DE CASO DE CUNDINAMARCA, COLÔMBIA

RESUMO

Objetivo: O objetivo deste artigo é analisar a produtividade e competitividade dos apicultores localizados no departamento de Cundinamarca, Colômbia.

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Quadro teórico: Medir a produtividade e a competitividade é um aspecto fundamental da gestão empresarial. No caso da apicultura na Colômbia, que tem caráter artesanal baseado em conhecimentos locais e práticas tradicionais, geralmente há falta de registros e informações que permitam esse tipo de estudo.
Design/Metodologia/Abordagem: Projetamos um questionário relacionado a fatores produtivos e competitividade na apicultura e aplicamos aos membros da Associação de Apicultores Ambientalistas. O Tribunal determinou o índice de produtividade e a rentabilidade dos ativos e do capital próprio - identificados como medidas de produtividade e competitividade dos apicultores - para o ano de 2020, utilizando uma análise quantitativa.
Constatações: A depreciação de ativos fixos é o custo de produção mais alto. A gestão organizacional e tecnológica implementada pelos produtores, bem como o tempo dedicado à apicultura, são fatores relevantes para alcançar produtividade e competitividade empresarial.
Investigação, Implicações práticas e Sociais: Esta investigação expandiu a compreensão da apicultura como uma atividade com profundos impactos econômicos, sociais e ambientais. Este estudo pode ser uma base para outros trabalhos de pesquisa e concepção de políticas orientadas para alcançar uma medição abrangente do desempenho do negócio e fazer programas para impulsionar os apicultores no país.
Originalidade/Valor: Esta pesquisa amplia a compreensão da importância da gestão de custos na produtividade e competitividade dos apicultores estudados. Não abordamos a produtividade como a quantidade de mel e pólen produzida, mas como a eficiência da produção. A competitividade foi avaliada utilizando indicadores globalmente aceitos e facilmente interpretados para medir o desempenho do negócio.

Palavras-chave: Produtividade, Competitividade, Apicultura, Países em Desenvolvimento, Administração de Empresas.

ANÁLISIS DE LA PRODUCTIVIDAD Y COMPETITIVIDAD EN LA APICULTURA: UN ESTUDIO DE CASO DE CUNDINAMARCA, COLOMBIA

RESUMEN
Objetivo: El objetivo de este artículo es analizar la productividad y competitividad de apicultores ubicados en el departamento de Cundinamarca, Colombia.
Marco teórico: La medición de la productividad y la competitividad es un aspecto fundamental de la gestión empresarial. En el caso de la apicultura en Colombia, que tiene un carácter artesanal basado en el conocimiento local y las prácticas tradicionales, suele faltar un registro e información que permita este tipo de estudio.
Diseño/Metodología/Enfoque: Diseñamos un cuestionario relacionado con factores productivos y competitividad en apicultura y lo aplicamos a los miembros de la Asociación de Apicultores Ambientalistas. Se determinó el índice productivo y la rentabilidad de activos y patrimonio -identificados como medidas de la productividad y competitividad de los apicultores- para el año 2020 mediante un análisis cuantitativo.
Hallazgos: La depreciación de los activos fijos es el costo de producción más alto. La gestión organizacional y tecnológica implementada por los productores, así como el tiempo dedicado a la apicultura, son factores relevantes para lograr productividad y competitividad empresarial.
Investigación, Implicaciones prácticas y Sociales: Esta investigación ha ampliado la comprensión de la apicultura como una actividad con profundos impactos económicos, sociales y ambientales. Este estudio puede servir de base para otros trabajos de investigación y diseño de políticas orientadas a lograr una medición integral del desempeño empresarial y realizar programas de impulso a los apicultores del país.
Originalidad/Valor: Esta investigación amplía la comprensión de la importancia de la gestión de costos en la productividad y competitividad de los apicultores estudiados. No nos acercamos a la productividad como la cantidad de miel y polen producido sino como la eficiencia de la producción. La competitividad se evaluó utilizando indicadores aceptados globalmente y se interpretó fácilmente para medir el desempeño empresarial.

Palabras clave: Productividad, Competitividad, Apicultura, Países en Desarrollo, Administración de Empresas.

INTRODUCTION

Worldwide, beekeeping is an activity that encompasses the three pillars of sustainability: ecological, social, and economic (Paula et al., 2016; Zuluaga, 2015). Concerning the ecological or environmental pillar, bees are the main pollinators of native and cultivated

species, representing 70% of the crops established for food production. In addition, the vegetation is conserved because for beekeeping production it is not necessary to deforest (Laverde et al., 2010; Sommer, 1998; Zuluaga, 2015). In terms of the social pillar, beekeeping intensifies the occupation of family labor reducing the rural exodus. It is worth noting that a significant portion of honey production comes from developing countries (Bislimi, 2022; Diktas-Bulut et al., 2022; Kumar Gupta et al., 2014; Paula et al., 2016). From an economic pillar, beekeeping serves as a source of supplementary income for rural communities through the production of various products such as honey, bee pollen, wax, and royal jelly (Tesema & Adugna, 2023). This practice offers several advantages, such as low investment requirements and no need for complete attention. Consequently, beekeeping proves to be a competitive system, generating employment opportunities, ensuring food production, and enhancing the overall quality of life for those involved in the industry (Ntawuzumunsi et al., 2021; Paula et al., 2016; Vásquez et al., 2012).

Although the importance of beekeeping in developing countries has been demonstrated (Kumar Gupta, 2014; Paula et al., 2016; Wakgari & Yigezu, 2021), beekeepers in many parts of the world face challenges due to climate variability, traditional management practices, poor technological practices, and an unstructured beekeeping sector (Ntawuzumunsi et al., 2021; Wakgari & Yigezu, 2021). These factors contribute to low yields per hive, poor product quality, and colony losses.

Colombia is no stranger to these problems. According to sectoral figures from the Ministry of Agriculture and Rural Development (Minagricultura, 2020), there are slightly over 135,000 hives in Colombia, but researchers such as Laverde et al., (2010); Martínez, (2006); Vargas, (2014) state that the capacity is more than 1,000,000 hives. They also conclude that Colombian beekeeping has been characterized as artisanal (Velandia et al., 2012), relying on local knowledge and traditional practices. Unfortunately, there is a significant gap in productivity and competitiveness due to issues with the technologies applied in harvesting, hygiene, processing, and product preservation (Zuluaga, 2015).

Therefore, due to the lack of research on beekeeping productivity and competitiveness in countries like Colombia, this study aims to analyze the productivity and competitiveness of beekeepers in the region of Cundinamarca, Colombia. It contributes to a deeper understanding of this highly relevant and promising activity in developing nations. The research focuses on one association of beekeepers in Cundinamarca and includes an analysis of productivity and competitiveness for the year 2020. This document provides a comprehensive explanation of the

research methodology, which is based on productivity and competitiveness indicators, as well as statistical techniques applied to the data collected from 16 beekeepers affiliated with the Association of Environmental Beekeepers (ASOAPIAM) in the Department of Cundinamarca, Colombia. The following section presents and discusses the results, which, overall, demonstrate the evaluated and total productivity levels and competitiveness indicators for each producer. Lastly, the document presents concluding remarks that highlight the research findings and provide insights into the association's technological and financial prospects. Despite the limited scope of this research, as it pertains specifically to the studied beekeepers' association, it contributes to the existing body of literature on the subject and facilitates the formulation of public policies that foster the development of this sector and promote beekeeping entrepreneurship in Colombia.

THEORETICAL REFERENCE FRAMEWORK

Productivity and Why Measure It

All organizations, regardless of their size, utilize resources to produce outputs in the form of products or services (Misterek & Anderson, 1992). The relationship between output and resources used to achieve it is known as productivity. Various definitions of productivity have been proposed, and although there are some discrepancies, in general, productivity is simply defined as the ratio of output to inputs used (Felsinger & Runza, 2002; Mohanty, 1998; Shahin, 2008; Sumanth, 1990; Syverson, 2011; Tangen, 2005).

Why measure business productivity? This question can be answered by pointing out that productivity measures serve as an objective source of information on long-term operating trends and act as tools for company diagnosis, revealing the factors contributing to changes in productivity (Chew, 1988). They also function as early warnings of changes in productivity (Grossman, 1984) and are valuable indicators of costs and operating problems (Misterek & Anderson, 1992). Business performance indicators are crucial for making decisions regarding investments, disinvestments, hiring personnel, exploring new markets, and more. For this research, the total productivity measurement model was chosen as it is considered the most appropriate and holistic approach for the case of the selected beekeeping association, as described in more detail in the methodology section of this document.

Business Competitiveness and Its Aspects

Competitiveness is considered synonymous with success, which in a company can be perceived as the achievement of its objectives and is reflected in improved results in sales, market shares, profitability, low costs, or productivity (Depperu & Cerrato, 2005; Liargovas & Skandalis, 2004). Cabrera et al., (2011) add that an indicator of a company's competitiveness is its ability to generate partnership networks. From the customer's perspective, an organization is competitive if it can offer better value compared to its rivals. This can be achieved through lower prices for equal benefits or better benefits that justify higher prices, shorter delivery times, post-sale warranties, among others (Feurer & Chaharbaghi, 1994). Romo & Musik (2005) advocate that managers should focus on competitiveness; otherwise, there will be a decrease in sales, reduced market share, and eventually the closure of the company.

Some currents on business competitiveness can be classified into three groups: those researchers who focus the concept on the market, those who assert that business competitiveness is directly related to the good or service offered by the company, and a last group that directly relates it to performance, considering it as an indicator of overall performance.

METHODOLOGY

The study was conducted during the years 2020 and 2021, a period in which the members of the Beekeepers Association of Cundinamarca were surveyed, considering their trajectory, the diversity of its members, and their total disposition to facilitate the information for the execution of the research. The investigation of primary sources was carried out using an information-gathering instrument, adapting and retaking elements of the case study methodology (López González, 2013; Stott & Ramil, 2014; Yin, 2003). The survey focused on members who had produced and marketed honey or bee pollen in the last 12 months from the time the survey was conducted, that is, the production and sale of products for the whole year 2020 were analyzed, so the beekeepers surveyed were 16, which allowed to characterize each producer and precisely know their production level and current financial position.

The data collection instrument was developed based on CORPOICA's Technical Manual on Bee Apiculture (*Apis mellifera*) (Vásquez et al., 2012), which contained 30 questions designed to gather information on production systems and best practices. The objective was to assess the productivity and business competitiveness of beekeepers. Following the guidelines provided in the manual, the necessary considerations for the installation and

maintenance of an apiary were determined, irrespective of the desired products. Additionally, the requirements for materials and fixed assets for honey and bee pollen production were defined.

Furthermore, the determination of the productivity level was established based on the Total Operating Productivity Model of Sumanth (1990):

$$\textbf{Total productivity} = \frac{(PrKM\ x\ CKmPV) + (PrKp\ x\ CKpPV)}{Cenv + Alim + M.O + Depre + Ct + Celect}$$

Being:

PrKm = Unit selling price per kilogram of honey in the period under analysis.
CKmPV = Quantity of kilograms of honey produced and sold in the period analyzed.
PrKp = Unit selling price per kilogram of bee pollen in the period under analysis.
CKpPV = Quantity of kilograms of bee pollen produced and sold in the period analyzed.
Cenv = Monetary value of packaging consumption in the period under analysis.
Alim = Monetary value of food consumed in the period under analysis.
M.O = Monetary value of labor paid in the period analyzed.
Depr = Monetary value of fixed asset depreciation in the period analyzed.
Ct = Monetary value of transportation consumption in the period analyzed.
Celect = Monetary value of electric energy consumption.

To calculate the index, it is crucial to know the production costs for each production unit during the analyzed period. These costs were gathered and evaluated based on the data obtained through the applied instrument.

For the calculation of depreciation, the Colombian Tax Statute (DIAN, 2021) was consulted, which provides suggested estimated useful lives for fixed assets in Colombian companies. To ensure accuracy, a residual value of zero was assumed for the fixed assets, and the straight-line depreciation method was employed. The calculation process is explained below:

$$\textbf{Straight} - \textbf{line depreciation} = \frac{\text{Cost of fixed asset} - \text{Salvage Value}}{\text{Useful Life}}$$

For assets that are not exclusively acquired for use in the productive unit, such as vehicles, a proration was conducted based on the information gathered through the data collection instrument.

Furthermore, the cost structure was analyzed for each respondent, specifically examining the production costs of bee pollen and honey separately. This was achieved by

prorating the costs based on the income generated from each product. The total production costs for each beekeeper were calculated, along with the following indicators: unit profit for each product, gross margin, operating margin, and profit margin. The formulas used for these calculations are indicated below:

$$\boldsymbol{Profit\ per\ Kg\ of\ product} = Selling\ price\ per\ Kg\ - Production\ cost\ per\ Kg$$

$$\boldsymbol{Gross\ Margin} = \frac{Operating\ income}{Total\ Income}\ x\ 100$$

$$\boldsymbol{Operating\ margin} = \frac{Operating\ Margin}{\text{Total Income}}\ x\ 100$$

$$\boldsymbol{Profit\ margin} = \frac{\text{Earnings Before Interest and Taxes}}{\text{Total Income}}\ x\ 100$$

To assess competitiveness, the return on assets and return on equity were utilized. These metrics provide insights into the profitability of assets and equity.

Return On Assets:

$$\boldsymbol{Return\ On\ Assets} = \frac{Net\ Income}{Total\ assets}$$

Return on assets (ROA) is a financial metric that evaluates the efficiency of asset utilization. It is calculated by assessing the proportion of earnings before interest and taxes generated in relation to the total assets employed. A higher ROA indicates greater efficiency in utilizing assets, without relying heavily on other sources of income (Córdoba Padilla, 2014).

Return on equity (ROE) is a ratio that assesses the return on investment for business owners. A higher ROE indicates a higher return on investment for business owners (Córdoba Padilla, 2014). The calculation of ROE is based on the following formula:

Return On Equity:

$$\boldsymbol{Return\ On\ Equity} = \frac{Net\ income}{Shareholder´s\ Equity}$$

It should be noted that to determine both ROA and ROE, the values of Earnings Before Taxes and Interest, Net Income, Total Assets, and Equity are required. These calculations were performed using the information obtained from the data collection instrument.

However, it is important to clarify that obtaining accurate information on total equity for some producers can be challenging. Therefore, an alternative formula was used to calculate the return on equity:

$$\boldsymbol{Total\ Equity} = Total\ Assets - Total\ liabilities$$

In cases where beekeepers did not report any debt, the total assets and equity values are considered to be the same.

For financial calculations, the average market representative rate of the U.S. dollar was used as a reference. In the year 2020, this rate was 3,693.36 Colombian pesos per dollar.

RESULTS

Firstly, the preliminary data obtained through the applied instrument are presented. The production levels of honey and bee pollen, as well as the breakdown of production costs, are shown below.

Honey Production

The findings of this study reveal that the average honey production per hive per year among the beekeepers studied is 6.9 kilograms. Furthermore, the average production cost for the association´s members is estimated to be USD 8.11/Kg.

Among the cost components, the largest share of costs is attributed to the depreciation of fixed assets such as vehicles, hives, bee nuclei, centrifuges, etc. This item accounts for an average impact of 55% of the total costs.

Table 1 illustrates the percentage breakdown of the average production costs for the Association of Environmental Beekeepers in honey production.

Table 1: Honey Production Cost Structure for the Association of Environmental Beekeepers

Item	Percentage weight in honey production costs
Depreciation	55%
Labor	13%
Transportation	11%
Packaging	10%
Feeding	7%
Lease	3%
Energy	1%
Total	100%

Source: Prepared by the authors

Bee Pollen Production

The findings indicate an average production of 5.2 kilograms per hive per year.

The average production costs for bee pollen among the selected beekeepers are estimated to be USD 7.83/Kg. Depreciation emerges as the cost component with the highest share, accounting for 50% of the total costs.

Table 2 provides a breakdown of the percentage weights for each cost component in bee pollen production.

Table 2. Bee Pollen Production Cost Structure for the Association of Environmental Beekeepers

Item	Percentage weight in bee pollen production costs
Depreciation	50%
Labor	19%
Transportation	10%
Feeding	9%
Packaging	7%
Lease	4%
Energy	2%
Total	100%

Source: Prepared by the authors

Productivity

This section focuses on presenting the calculated productivity of each member of the Association of Environmental Beekeepers. It begins with the productivity for honey production, followed by the productivity for bee pollen production, and concludes with the total productivity of each production system. The separation is based on the significant dispersion of the data, with a standard deviation of 2.1.

Productivity for honey

The productivity for honey production was calculated for each beekeeper, and the results are presented in descending order based on their productivity indicator in Table 3.

Table 3. Honey Productivity Indices

Beekeeper	Productivity Index	Interpretation
Beekeeper 15	7,73	Productive
Beekeeper 8	5,78	Productive
Beekeeper 16	4,20	Productive
Beekeeper 11	3,30	Productive
Beekeeper 10	1,78	Productive
Beekeeper 9	1,63	Productive
Beekeeper 13	1,25	Productive
Beekeeper 2	1,20	Productive
Beekeeper 5	1,06	Productive
Beekeeper 7	0,87	Non-productive

Beekeeper 12	0,80	Non-productive
Beekeeper 3	0,78	Non-productive
Beekeeper 6	0,69	Non-productive
Beekeeper 1	0,68	Non-productive
Beekeeper 4	0,42	Non-productive

Source: Prepared by the authors

As shown in Table 3, out of the 15 beekeepers who produced honey during the analyzed period, six of them (40%) have a productivity indicator below 1. This indicates that their total costs exceeded the income generated from honey sales. On the other hand, nine beekeepers (60%) have a productivity indicator above 1, indicating that their income from honey sales exceeded the production costs. It should be noted that some of the beekeepers were highly productive, reaching productivity indicators with a value equal to or higher than 3, which indicates that they made good use of resources (efficiency) and managed to ensure that the cost was used to generate income in their processes (effectiveness).

Turning to bee pollen productivity (Table 4), out of the 12 beekeepers involved in bee pollen production, seven (58%) had productivity indices below 1, indicating unprofitable operations. Conversely, 42% of the beekeepers achieved productivity above 1. Comparing honey production with bee pollen production, it is evident that more beekeepers in this association are productive in honey production than in bee pollen production.

Table 4. Bee Pollen Productivity Indexes

Beekeeper	**Productivity Index**	**Interpretation**
Beekeeper 15	6,23	Productive
Beekeeper 16	3,67	Productive
Beekeeper 10	1,65	Productive
Beekeeper 9	1,54	Productive
Beekeeper 13	1,23	Productive
Beekeeper 5	0,98	Non-productive
Beekeeper 2	0,93	Non-productive
Beekeeper 3	0,72	Non-productive
Beekeeper 7	0,72	Non-productive
Beekeeper 6	0,69	Non-productive
Beekeeper 4	0,38	Non-productive
Beekeeper 14	0,22	Non-productive

Source: Prepared by the authors

Lastly, Table 5 summarizes the information regarding the total productivity of each analyzed production system. It reveals that seven producers (43.75%) did not achieve a productivity indicator higher than 1, indicating unfavorable results. Conversely, nine producers (56.25%) attain a favorable productivity indicator. The data presented demonstrate significant

dispersion in the productivity indicators, with productive beekeepers exhibiting high levels of efficiency, while unproductive beekeepers display profound inefficiencies.

Table 5. Total productivity of the beekeeping production system analyzed.

Beekeeper	Productivity Index	Interpretation
Beekeeper 15	7,73	Productive
Beekeeper 8	5,78	Productive
Beekeeper 16	4,20	Productive
Beekeeper 11	3,83	Productive
Beekeeper 10	1,84	Productive
Beekeeper 9	1,66	Productive
Beekeeper 13	1,27	Productive
Beekeeper 2	1,20	Productive
Beekeeper 5	1,06	Productive
Beekeeper 7	0,88	Non-productive
Beekeeper 12	0,82	Non-productive
Beekeeper 3	0,78	Non-productive
Beekeeper 6	0,69	Non-productive
Beekeeper 1	0,68	Non-productive
Beekeeper 4	0,42	Non-productive
Beekeeper 14	0,23	Non-productive

Source: Prepared by the authors

Competitiveness indices

According to the methodology described earlier, the indicators for assessing the competitiveness of beekeepers were based on financial ratios. Table 6 provides a summary of the key calculated data related to business competitiveness.

When considering the return on equity indicator, which reflects the profitability of the partners' investment, it is observed that seven beekeeping companies are profitable. This indicates that these companies have generated returns that exceed the invested equity, contributing to the overall financial viability of their businesses.

Table 6. Business Competitiveness Indexes

	Unit profit honey	Unit profit bee pollen	Gross Margin	Operating Margin	Profit margin	ROA	ROE
Beekeeper 1	-$3.84	N/A	-53,9%	-53,9%	-53,9%	-10,5%	-10,5%
Beekeeper 2	$1.13	-$0.54	12,9%	-1,7%	-1,7%	-0,6%	-0,8%
Beekeeper 3	-$2.66	-$3.74	-36,1%	-36,1%	-36,1%	-11,5%	-17,4%
Beekeeper 4	-$12.00	-$9.02	-143,8%	-143,8%	-143,8%	-19,7%	-19,7%
Beekeeper 5	$0.51	-$ 0.19	3,5%	2,8%	2,8%	1,3%	1,6%
Beekeeper 6	-$2.99	-$3.52	-44,5%	-53,4%	-53,4%	-29,3%	-29,3%
Beekeeper 7	-$1.21	-$1.56	-18,6%	-22,0%	-22,0%	-7,8%	-7,8%
Beekeeper 8	$6.72	N/A	82,7%	82,7%	82,7%	74,3%	74,3%
Beekeeper 9	$2.29	$3.21	36,1%	27,5%	27,5%	23,2%	25,9%
Beekeeper 10	$4.75	$7.45	41,8%	41,8%	41,8%	24,3%	45,5%
Beekeeper 11	$7.55	N/A	69,7%	39,7%	39,7%	43,0%	-3,2%
Beekeeper 12	-$3.44	N/A	-25,9%	-25,9%	-25,9%	-4,6%	-4,6%
Beekeeper 13	$2.14	$1.11	19,6%	19,6%	19,6%	11,4%	11,4%

Beekeeper 14	N/A	-$ 93.86	-364,9%	-364,9%	-364,9%	-35,0%	-35,0%
Beekeeper 15	$8.25	$3.64	85,2%	85,2%	85,2%	112,3%	112,3%
Beekeeper 16	$6.19	$4.93	74,5%	74,5%	74,5%	63,5%	63,5%

Source: Prepared by the authors

DISCUSSION

This section compares the findings of this research with the data reported by the Ministry of Agriculture and Rural Development of Colombia, as well as with similar studies.

Honey Production

The average honey production found in this research (6.9 kg/hive/year) is well below the average production reported by the Ministry of Agriculture and Rural Development (Minagricultura, 2020), which found an average of 29 kg per hive per year. The same entity indicates that the production cost of bee honey in Colombia is approximately USD 1.54/Kg, clarifying that this value has a great dispersion depending on the production zone and the level of technification of the system, a value not in line with the present research, which found a value 5 times higher. This difference with the literature consulted can also be explained because the data used in this research are from the same region, whereas that presented by the Ministry of Agriculture and Rural Development (Minagricultura, 2020), are aggregated from a sample of several departments of Colombia, which have different climatic and floral characteristics, which has a direct impact on apiary production.

The Ministry of Agriculture and Rural Development (Minagricultura, 2020) indicates that labor is the cost component with the highest participation in the cost structure of beekeepers. However, the results presented here discovered that depreciation is the most significant production cost, consistent with the findings from a previous study by Sánchez (2014).

Bee Pollen Production

This research found that the average pollen production of the consulted beekeepers was 5.2 kg/hive/year, which is much lower than that reported by some studies which estimate the average pollen production in Colombia at 36 kg/hive/year (Martínez, 2006), 30 kg/hive/year (Sánchez et al., 2013), and 19 kg/hive/year (Vargas, 2014).

Turning to the pollen production costs, Fuenmayor, (2009) claimed that they ranged between USD 0.75/Kg and USD 4.54/Kg. It was also reported that by 2018, the average production cost for one kilogram was USD 2.65/Kg (Minagricultura, 2020). According to the

calculations made for this document, the production costs are USD 7.83/Kg. In terms of honey production, the item with the highest representation in the cost structure is depreciation. This finding aligns with the research conducted by Minagricultura, (2020). The disparity in reported production costs for pollen in Colombia may be attributed to variations in production volumes, management practices, and the availability of floral resources in the apiary, among other factors (Vasquez et al., 2015).

Regarding productivity, higher values were found for honey production compared to pollen production. This can be explained by Sánchez, (2014), who argues that there are significant differences between honey and pollen production. These differences include hive management and revisitation frequency, as honey production requires less frequent visits than pollen production.

It is crucial to analyze the indicators presented in Table 6, as they demonstrate the business competitiveness of the selected beekeepers. Naturally, the profitability of equity is directly linked to the profit obtained per kilogram sold of each product. Therefore, it is expected that a producer with negative profits will also exhibit a negative return on equity. This situation is concerning, particularly for beekeepers with negative profitability, as it indicates that even at the basic level of unit profit per product, they failed to generate a positive value. This could be due to unit costs exceeding the unit sale price, possibly because not all production costs were considered, and producers do not adjust the price of their products correctly. Similar studies conducted by Beltrán et al., (2021) and Tubene et al., (2023), suggest that beekeepers with a small number of hives (less than 50) have lower production scales and consequently higher costs per hive.

There is a notable case in the study: beekeeper number 2, despite having a profit per kilogram of bee honey of USD 1.12/Kg, experiences a negative profit per kilogram of bee pollen, amounting to -USD 0.53/Kg. The gross margin, which reflects the efficiency at the most fundamental level of the company, is positive. However, when administrative and selling expenses are considered, the margin turns negative, resulting in an overall negative return on equity.

Table 6 also reveals that out of the profitable beekeepers (seven in total), six produce both honey and pollen, while one solely focuses on honey production. This observation can be explained by the earlier argument presented by Sánchez, (2014) that honey production requires less time to maintain acceptable yield standards. Another theory is that beekeepers need to produce and sell both products to generate sufficient income that justifies their operation. This

finding aligns with similar research conducted with beekeepers in Turkey (Diktas-Bulut et al., 2022), where it became evident that obtaining multiple products from the hives is necessary to diversify their customer base and increase their income.

An analysis based on direct observation is now presented, as certain issues require further detail to add value to this study.

Most beekeepers (56.5%) view beekeeping as a supplementary activity alongside their primary work. This aspect may partly explain the results obtained in this research, as other studies have indicated that when beekeeping is treated as a secondary activity, it often leads to lower profitability indicators (Beltrán et al., 2021). It was also evident that despite the belief of all beekeepers that they were profitable, many of them lacked technical or accounting records to substantiate this claim. Considering the findings of this research, it becomes clear that without such records, it is challenging to ascertain the true state of the enterprise.

Another significant factor to consider is the prevalence of depreciation as the primary cost incurred by the beekeepers under study. This is primarily due to their ownership of numerous inactive hives, resulting in increased depreciation without a corresponding increase in production. When asked why they did not activate more hives for production, they cited concerns about exceeding their capacity to effectively manage all the hives, which would ultimately lead to higher losses in the productive units.

Based on the above, it can be inferred that a lack of organizational and technological management significantly affects the productivity and competitiveness of the beekeepers studied. The absence of information necessary for making informed decisions within the company hampers its productivity and competitiveness. This finding aligns with the descriptions provided by Beltrán et al., (2021); Čavlin et al., (2023); Contreras & Magaña, (2017); Izquierdo et al., (2016); Lyubenov et al., (2021); Tubene et al., (2023) who have investigated the productivity of beekeepers and have highlighted the limitations imposed by managerial capacity and poor technological management.

CONCLUSIONS

In conclusion, depreciation has the highest contribution to the cost structure of the beekeepers studied. This finding is significant because depreciation is a cost that producers often overlook, leading them to make decisions that adversely impact the profitability of their production systems.

The research revealed that 43.7% of the consulted beekeepers were truly profitable, and within this percentage, 85.7% produced both honey and bee pollen during the analyzed period (Year 2020). This suggests that obtaining both products is necessary to achieve acceptable or satisfactory profitability in the case study.

Furthermore, it is worth noting that among all the beekeepers consulted, most achieved favorable productivity indicators through honey production, while not as much through pollen production. This disparity may be attributed to the fact that pollen production requires more time due to the need for more frequent harvesting.

Finally, organizational and technological management, along with a dedicated focus on beekeeping, emerged as crucial factors for attaining favorable productivity and competitiveness indicators. This finding aligns with the results of this research and similar studies conducted in the field.

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