ANALYSIS OF THE EFFECTS OF THE COVID-19 PANDEMIC ON COFFEE AGRIBUSINESS: A CASE STUDY OF A FARM IN TRIÂNGULO MINEIRO, BRAZIL

ANÁLISE DOS EFEITOS DA PANDEMIA DE COVID-19 NO AGRONEGÓCIO DO CAFÉ: UM ESTUDO DE CASO DE UMA FAZENDA NO TRIÂNGULO MINEIRO, BRASIL

Tamira Alessandra Barbosa Fernandes Leal
Mestranda em Ciências Contábeis, Universidade Federal de Uberlândia, UFU
Endereço: Faculdade de Ciências Contábeis, Universidade Federal de Uberlândia, Av. João Naves de Ávila, 2121 - 1F - Santa Mônica, Uberlândia - MG, 38408-100, Brasil
Telefone: (34) 3230-9470
E-mail: tamira.leal@ufu.br

Sérgio Lemos Duarte
Doutor em Controladoria e Contabilidade (FEA-USP). Professor adjunto da Universidade Federal de Uberlândia, UFU.
Endereço: Faculdade de Ciências Contábeis, Universidade Federal de Uberlândia, Av. João Naves de Ávila, 2121 - 1F - Santa Mônica, Uberlândia - MG, 38408-100, Brasil
Telefone: (34) 3230-9470
E-mail: sergiold@ufu.br

Recebido: 12/04/2024 Aprovado: 20/08/2024
Publicado: 20/08/2024

Denize Lemos Duarte
Doutora em Ciências Contábeis, Universidade Federal de Uberlândia, UFU
Endereço: Faculdade de Ciências Contábeis, Universidade Federal de Uberlândia, Av. João Naves de Ávila, 2121 - 1F - Santa Mônica, Uberlândia - MG, 38408-100, Brasil
Telefone: (34) 3230-9470
E-mail: denize.duarte@ufu.br

Lara Cristina Francisco de Almeida Fehr
Doutora em Controladoria e Contabilidade (FEA-USP). Professora adjunta da Universidade Federal de Uberlândia, UFU.
Endereço: Faculdade de Ciências Contábeis, Universidade Federal de Uberlândia, Av. João Naves de Ávila, 2121 - 1F - Santa Mônica, Uberlândia - MG, 38408-100, Brasil
Telefone: (34) 3230-9470
E-mail: lara.fehr@ufu.br

RESUMO

O café é uma das commodities mais comercializadas no agronegócio, com o Brasil consolidado como o maior produtor e exportador dessa cultura. Nesse contexto, o cultivo do café tem sido amplamente investigado no campo dos estudos de gestão devido à sua vulnerabilidade a externalidades e fatores contingenciais, como a pandemia de COVID-19. Este estudo teve como objetivo identificar os principais impactos causados pela pandemia de COVID-19 sobre os custos, preços e processos de gestão na produção de café. Adotando uma abordagem de métodos mistos, com natureza aplicada e objetivos descritivos, foi realizado um estudo de caso em uma fazenda produtora de café localizada na região do Triângulo Mineiro. A metodologia envolveu a condução de uma entrevista semiestruturada com o gestor da fazenda, observações in loco e a aplicação de testes estatísticos aos dados de custos de produção das safras entre 2016 e 2021. Os resultados revelaram impactos significativos da pandemia em aspectos relacionados aos

custos, preços e processos de gestão na produção de café. Entre os itens mais afetados, destacaram-se pesticidas, fertilizantes, despesas com maquinário, peças e manutenção, além de óleo diesel. Esses achados destacam uma forte conexão entre o agronegócio e o mercado internacional, uma vez que as variáveis de custo mais impactadas foram aquelas cotadas em moedas estrangeiras ou negociadas no exterior, incluindo o próprio preço de venda do café. Em resposta a essas contingências, o gestor da fazenda implementou estratégias para garantir a rentabilidade da atividade. A relevância desta pesquisa é justificada pela lacuna existente em estudos relacionados, pela importância do setor cafeeiro para a economia nacional e pelo potencial de auxiliar os produtores na preparação para desafios futuros associados a contingências semelhantes.

Palavras-chave: *Agronegócio. Produção de café. Contabilidade gerencial. COVID-19.*

ABSTRACT

Coffee is one of the most traded commodities in agribusiness, with Brazil established as the largest producer and exporter of this crop. In this context, coffee cultivation has been extensively investigated in the field of management studies due to its vulnerability to externalities and contingency factors, such as the COVID-19 pandemic. This study aimed to identify the main impacts caused by the COVID-19 pandemic on costs, prices, and management processes in coffee production. Adopting a mixed-methods approach, with an applied nature and descriptive objectives, a case study was conducted on a coffee-producing farm located in the Triângulo Mineiro region. The methodology involved conducting a semi-structured interview with the farm manager, on-site observations, and applying statistical tests to production cost data from harvests spanning 2016 to 2021. The results revealed significant impacts of the pandemic on aspects related to costs, prices, and the management processes in coffee production. Among the most affected items were pesticides, fertilizers, machinery expenses, parts and maintenance, and diesel oil. These findings highlight a strong connection between agribusiness and the international market, as the most impacted cost variables were those quoted in foreign currencies or negotiated abroad, including the selling price of coffee itself. In response to these contingencies, the farm manager implemented strategies to ensure the profitability of the activity. The relevance of this research is justified by the existing gap in related studies, the importance of the coffee sector to the national economy, and the potential to assist producers in preparing for future challenges associated with similar contingencies.

Keywords: Agribusiness. Coffee farming. Managerial accounting. COVID-19.

1 INTRODUCTION

According to data from the Center for Advanced Studies in Applied Economics (CEPEA), in 2021, Brazilian agribusiness contributed significantly to the country's GDP, growing by 8.36% and reaching a historic share of 27.4%, equivalent to approximately R$2.4 trillion. This performance underscored its role in driving economic growth and enhancing Brazil's prominence in the international community. Among these agribusiness products, coffee stands out as a crop deeply rooted—both literally and figuratively—in the country’s history. As a commodity, coffee was Brazil's leading export during the 19th and 20th centuries, with political systems even shaped around its culture (TAUNAY, 1959).

In Brazil, coffee planting and cultivation occur across 15 micro-regions in nine states. Although it is no longer the primary grain exported by the country, coffee remains one of the most traded commodities in agribusiness, with Brazil being the world's largest producer and exporter of this crop (Ministério da Agricultura, Pecuária e Abastecimento - MAPA, 2020). Furthermore, data from MAPA indicate that, as of January 2022, Brazil had an estimated 2.23 million hectares planted with coffee, distributed among more than 300,000 rural properties.

In addition to the so-called specialty coffees—produced with an emphasis on quality, traceability, and sustainability (SOARES; DUARTE; NETO, 2021)—coffee, when produced on a large scale, retains its characteristics as a commodity. Large-scale production allows for easy storage without significant quality loss (SANCHEZ, 2007). While the price paid to producers of commodities is determined exclusively by market forces, the value of specialty coffees is also influenced by customer perception and certifications (SOARES; DUARTE; NETO, 2021).

Given its role as a fundamental raw material, cost management is crucial in coffee cultivation, as sales prices are determined by the international market. Effective cost control and management are therefore essential to achieving expected yields (PEREIRA; RIBEIRO; SECURATO, 2012). Consequently, coffee-focused agribusiness serves as a rich context for managerial studies, as the activity is exposed not only to external factors such as climate and exchange rate variations but also to its substantial export volume (MOROZINI et al., 2012).

This research will be conducted under the framework of contingency theory, which posits that no single, absolute model of organizational management can be universally applied. Instead, management models must be adapted to specific contingency factors (BERTERO, 1998). These factors can be internal, such as the technology employed, management strategies, or the entity's size, or external, such as market environments, societal trends, and consumption patterns (ESPEJO; FREZATTI, 2008).

In the context of contingency factors, during the first quarter of 2020, the World Health Organization declared a pandemic caused by SARS-CoV-2, a respiratory virus capable of causing severe clinical symptoms (WERNERK; CARVALHO, 2020). The pandemic necessitated restrictive measures such as quarantine and lockdowns in several regions, which quickly began to affect economic sectors, including agribusiness (GARCIA, 2020; BARROS, 2020).

Given the influences of the COVID-19 pandemic, this research explores the following question: What are the effects of the COVID-19 pandemic on cost, price, and management variables in the coffee agribusiness? The objective is to identify the primary impacts of the pandemic on costs, prices, and management processes from the perspective of rural producers. Soares, Duarte, and Neto (2021) emphasize the growing need for a deeper understanding of coffee production costs and their relationship with influencing factors.

The theoretical justification for this research lies in the scarcity of studies focusing on cost and management variables in coffee production under extreme conditions such as the COVID-19 pandemic. Its practical justification is rooted in the relevance of Minas Gerais as Brazil's largest coffee producer, accounting for 54.9% of national production, of which 25.4% originates from the cerrado region (CEPEA, 2021). By selecting a coffee farm in this region, the study aims to provide insights that help rural producers anticipate and address contingencies related to costs, prices, and management.

2 LITERATURE REVIEW

Since its onset, the COVID-19 pandemic has generated widespread uncertainties across numerous countries, leading to shortages, rationing, and long lines in food stores, raising concerns about a potential agri-food crisis (SÁNCHEZ, 2021). Sánchez posits that this phenomenon resulted from a surge in production costs, which subsequently led to higher sales prices. This escalation triggered inflation within the sector, producing unfavorable outcomes for agricultural trade and jeopardizing global food security.

Contrary to these projections, Brazil's agribusiness demonstrated resilience during the pandemic. This success is attributed to the production of essential goods and increased exports, particularly to countries such as China (BASTOS, 2020), reinforcing its role as a global food supplier and positioning Brazil as a key player in maintaining global food security (SOENDERGAARD et al., 2020).

Costa (2021) emphasizes that, given agribusiness's critical role in Brazil's economy, the COVID-19 pandemic introduced significant market insecurities, particularly on the international stage. These

uncertainties resulted in several negative outcomes for the agricultural sector, including rising input costs, shortages of production resources, and challenges in securing a qualified labor force for field operations. At the domestic level, job losses caused by the pandemic (ECLAC, 2021) disrupted Brazil's economic dynamics, affecting purchasing power. Internationally, however, exports of food and basic commodities selectively increased during this period, particularly in agribusiness sectors such as grains, meat, and derivatives (SCHNEIDER et al., 2020).

Data from the Ministry of Economy (2020) indicate that the economic crisis triggered by the COVID-19 pandemic had minimal impact on Brazilian exports, primarily due to the agricultural sector's high productivity. Supporting this perspective, Mattei (2020) highlights the competitive strength of Brazilian agribusiness, which he argues is capable of fostering development independently of government policies or economic crises, including those as severe as the COVID-19 pandemic. Schneider et al. (2020) further argue that, despite its challenges, the pandemic acted as a catalyst for the international promotion of Brazilian agribusiness. Increased global food demand and trade disputes among countries created opportunities for the export of Brazilian agricultural products.

Several studies have analyzed coffee farming in the context of the COVID-19 pandemic, focusing on its operational vulnerabilities, which were already evident before the crisis and have since been exacerbated (GUIDO; KNUDSON; RHINEY, 2020). The authors argue that the inherent risks of coffee farming, combined with pandemic-related shocks, have heightened producers' sensitivity and exposure to future crises.

Rhiney et al. (2021) identify the COVID-19 pandemic as an additional challenge for global coffee farming, with potential consequences extending beyond government-imposed lockdowns and restrictions. These include prolonged impacts, cascading effects, and the risk of new outbreaks of detrimental coffee crop diseases. Moreover, the reliance of many coffee-producing countries on seasonal migrant workers during harvests adds complexity to the situation (GUIDO; KNUDSON; RHINEY, 2020). For example, in Costa Rica—where the area under coffee cultivation is considerably smaller than in Brazil—migrant workers account for two-thirds of the coffee labor force (RHINEY et al., 2021).

During the initial weeks of government-imposed lockdowns, coffee sales surged due to the replacement of out-of-home consumption (FROMM, 2022). However, by late 2020, the visible impact of COVID-19 on global coffee production appeared minimal, leading some forecasters to predict only slight increases in output (RHINEY et al., 2021). Nevertheless, Fromm (2022) cautions that declining disposable incomes, driven by unemployment, are likely to prompt consumers to reevaluate their spending patterns, potentially reducing demand for premium items like specialty coffees. Fromm emphasizes that innovation will be critical for producers seeking to mitigate the impacts of external shocks, advocating for collaboration among research organizations, government institutions, and producers' associations to develop effective solutions.

Wulandari, Djufry, and Villano (2022) underscore that the adoption of field technologies in coffee farming is hindered by factors such as limited income and restricted access to credit. They suggest that these constraints have slowed the sector's restructuring in response to the COVID-19 pandemic. Although the pandemic's effects vary across countries—depending on epidemic curves, harvest cycles, and production systems—it has broadly impacted food security and supply chain stability, particularly in underdeveloped and developing nations (WULANDARI; DJUFRY; VILLANO, 2022). Nonetheless, the authors contend that agriculture will remain one of the most resilient sectors, capable of withstanding economic contractions.

Research conducted by Wulandari, Djufry, and Villano (2022) on coffee farms in Indonesia found that the pandemic significantly affected access to agricultural inputs, such as chemical and organic fertilizers and pesticides. This impact stemmed from internal factors, including producers' declining financial capacity, and external factors, such as government-imposed movement restrictions that disrupted input distribution. While the consequences may not be immediately visible in productivity or

quality, disruptions in the production system—such as shortages of inorganic fertilizers—reflect the broader challenges faced during the pandemic.

In agreement with Schneider et al. (2020), who examined Brazilian agribusiness, Guido, Knudson, and Rhiney (2020) argue that the COVID-19 pandemic, despite the challenges it imposed, could also serve as a catalyst for making coffee farming more equitable—addressing disparities between small and large producers—and more efficient through the adoption of innovative practices.

3 METHODOLOGY

This research is classified as descriptive because, according to Gil (2002), it aims to describe the characteristics of a population or phenomenon, establishing relationships between the variables involved. Regarding its approach to the problem, this study is mixed-method research, combining quantitative and qualitative methods. It incorporates quantification in the modalities of data collection and the subsequent statistical treatment of the gathered information (RICHARDSON, 1999). Furthermore, it considers the interactional dynamics among the subjects and variables within the studied context, focusing on their mutual influences and the meanings attributed by the subjects to their actions (SILVA; MENEZES, 2005).

In terms of procedures, the study employs a case study methodology, which, according to Gil (2002), is characterized by an in-depth and exhaustive investigation of a limited number of objects, enabling comprehensive and detailed understanding of the case in question. By triangulating data sources, including documents, interviews, and on-site observations, multiple perspectives are analyzed, avoiding a narrow viewpoint and ensuring richer insights (TUZZO; BRAGA, 2016).

A semi-structured interview was utilized, which, as described by Manzini (2012), is based on a script of open-ended questions. This method allows flexibility in how questions are presented to the interviewee, enabling the inclusion of follow-up questions to deepen the understanding of the subject matter.

The study's object of analysis is a rural property located in Minas Gerais, specifically in the micro-region of Patrocínio in the Triângulo Mineiro, within the rural area of the municipality of Romaria. The property encompasses 802 hectares, of which 642 hectares are dedicated to coffee plantations, with the remainder allocated to legally protected areas or infrastructure. The farm employs 30 permanent workers and maintains production cost and sales price records dating back to the 1999 harvest.

Regarding temporal delimitation, given that the COVID-19 pandemic was declared in March 2020, the study focuses on cost and price data for coffee production from October 2016 to September 2021. These dates correspond to the start and end of the coffee harvest cycles. Three scenarios were analyzed: production unaffected by the pandemic, production partially influenced by pandemic-related factors, and production fully occurring under pandemic conditions.

The semi-structured interview conducted with the property manager used a research instrument developed by Leal, Duarte, and Soares (2021). This instrument consists of 31 essay-style questions divided into four sections: characterization of the property, analysis of the pandemic’s impact on costs, assessment of its impact on sales prices, and examination of other managerial variables, such as production technologies and strategies implemented by the producer to address the challenges posed by the pandemic.

Ethical compliance was ensured by submitting the research project to the Ethics Committee on Research with Human Beings at the Federal University of Uberlândia (CEP/UFU), as required by Resolution No. 510/2016 of the National Health Council (CNS, 2016). The study received approval under identification number 52629021.9.0000.5152.

After initial contact via phone and the participant’s preliminary agreement, a site visit was scheduled to conduct the semi-structured interview and on-site observations. During the visit, the

interview process was explained, emphasizing confidentiality measures, including anonymizing both the participant and the property. Upon agreement, the participant signed an Informed Consent Form (ICF), with copies retained by both the researcher and the participant.

Permission to record the interview was sought and granted. The interview, conducted on February 23, 2022, lasted 1 hour and 20 minutes, from 3:00 pm to 4:20 pm. It was audio-recorded and subsequently transcribed into a nine-page document. Following the interview, the property was observed to validate and complement data collected through cost and price spreadsheets, enabling data triangulation. On-site observation included an assessment of the farm's infrastructure, coffee planting and cultivation processes, input storage and application, machinery used for processing beans, and cost control procedures.

For the quantitative analysis of production costs and sales prices, the statistical software applications Stata and RStudio were used to perform econometric analyses. The Shapiro-Wilk test was employed to assess normality, using a 0.05 significance level, with the null hypothesis (H0) asserting that the sample approximates a normal distribution (YAP; SIM, 2011). This test, noted by Razali (2011) for its strong adherence to normality in small samples, provided a foundation for subsequent analyses.

The F-test for homogeneity of variances was performed at a significance level of 0.05, with H0 assuming equal variances (homoscedasticity). Based on normality results, the T-test for independent samples was conducted for data following a normal distribution, applying corrections for homoscedastic or heteroscedastic samples as indicated by the F-test. For non-normal distributions, the non-parametric Mann-Whitney test was utilized.

4 RESULTS AND DISCUSSION

In Table 1, it is evident that the terms "coffee," "costs," and "price" predominate, appearing 50, 21, and 24 times, respectively. This suggests that the primary topics anticipated for discussion during the interview with the manager were comprehensively addressed.

Table 1 - Most frequent terms and their respective number of insertions in the text

Term	Frequency of occurrence	Term	Frequency of occurrence
coffee	50	labor	10
costs	21	increase	8
price	24	changes	6
relationship	19	employees	6
harvest	16	inputs	5
fertilizers	15	change	4
cooperative	20	availability	4
defensives	12	machinery	4

Source: Survey Results.

Additionally, the occurrence of terms such as "relationship" (19 times), "increase" (8 times), and "changes" (6 times) provides insight into the producer's perception of the direct impacts of the Covid-19 pandemic on production costs, sales prices, and other elements related to cost management and strategic decision-making processes. This data underscores the influence of the pandemic on the producer's operational and managerial strategies, aligning with the research objective of exploring these dynamics in depth.

4.1 Production Costs

Considering the frequency of terms in the transcript related to production inputs, the words "fertilizers" and "pesticides" appear prominently, with 15 and 12 mentions, respectively. This highlights these cost items as the most impacted within the analyzed period. In relation to the purchasing and sales policies of the sector for pesticides, the producer highlighted a substantial increase in their cost, attributed to purchases made through barter arrangements: "[...] last year, during the harvest period, coffee practically doubled in price, but the quantity of bags given in exchange for pesticides remained the same, causing the price of pesticides to also double."

From this statement, it is evident that, in the interviewee's view, the primary factor driving the increase in pesticide costs is linked to the sector's purchasing policy. Barter transactions, in essence, involve using the agricultural product itself as payment for inputs supplied by manufacturers or retailers. Although these operations theoretically incorporate mechanisms such as price locking on commodity exchanges via hedge instruments and credit securities, in practice, they may expose producers to significant financial risks. These risks are particularly heightened in volatile scenarios, such as the economic uncertainty brought about by the COVID-19 pandemic.

Regarding fertilizers, the producer attributes the cost increases to the sector's exposure to the international market, stating: "[...] as well as fertilizers that have undergone major changes, even more so after there was that issue of Russia holding their core raw material. In less than 60 days, comparing two purchases we made, in October 2021 and December 2021, fertilizer practically doubled in price".

To determine which inputs experienced the greatest impact during the analyzed period and to identify the underlying causes, the interviewee highlighted the composition of production costs. According to the interviewee, pesticides account for 15% to 20% of the total harvest costs, compared to fertilizers, which represent less than 10%. Although the unit cost increase for fertilizers was higher, their overall impact on production costs was more subtle, leaving pesticides as the primary driver of increased production expenses. These findings align with the conclusions of Wulandari, Djufry, and Villano (2022), who observed significant effects of the COVID-19 pandemic on inputs such as chemical and organic fertilizers, as well as pesticides, in coffee production in Indonesia.

Table 2 presents the results of statistical tests, including Shapiro-Wilk, F Test, T Test, and Mann-Whitney. The probability values indicate that the variables for harvest cost, vehicle and machinery maintenance, payroll, and fertilizer accept the null hypothesis, as they have p-values above the significance level of 0.05. This suggests significant statistical variance between the pre-pandemic and post-pandemic periods, partially corroborating the findings of Wulandari, Djufry, and Villano (2022) concerning fertilizers. However, for the other variables, the results diverge.

Conversely, the null hypothesis was rejected for the remaining variables, indicating no significant statistical variance between the periods analyzed at the 0.05 significance level. This suggests that there is no evidence of impact from the COVID-19 pandemic on cost variables such as operating expenses, investments, fuel, business expenses, irrigation expenses, harvest labor, and pesticides, as well as on total crop production and sales revenue.

Table 2 - Statistical Tests for Data Validation

	Shapiro-Wilk test (normality)	F-test (homoscedasticity)	T-test (assumed equal variances)	T-test (supposedly distinct variances)	Mann-Whitney test
TSP	0,1511	0,1561	0,3328		
OPE	0,0205	0,0233			0,3545
HAR	0,8765	0,2627	0,0136		
INV	0,8199	0,2880	0,5520		
FUE	0,0357	0,0095			0,0641
VMC	0,2095	0,1054	0,0206		
PAY	0,9882	0,5632	0,0394		
COM	0,8629	0,0659	0,5705		
IRR	0,1044	0,0302		0,3286	
LBC	0,1601	0,3766	0,2077		
FER	0,6320	0,5393	0,0557		
DEF	0,7384	0,1763	0,1156		
REV	0,0176	0,0290			0,3545

Caption: TSP: Total Production of Harvest; OPE: Operating Expenses; HAR: Harvesting Cost; INV: Investments; FUE: Fuel; VMC: Vehicle and Machine Maintenance; PAY: Payroll; COM: Commercial Expenses; IRR: Irrigation Expenses; LBC: Harvest Labor Cost; FER: Fertilizers; DEF: Pesticides; REV: Sales Revenue.
Source: survey results.

Table 3 presents the descriptive statistics of the sample, comparing the pre-pandemic period, which includes the harvests of 2016, 2017, 2018, and 2019, with the pandemic period, encompassing the harvests of 2020 and 2021.

Table 3 - Descriptive statistics (values considering annual intervals)

	Before the Pandemic			Pandemic Period		
	Average	Standard Deviation	CV	Average	Standard Deviation	CV
TSP	16.417,04	10.466,75	0,6376	20.100,82	2.245,52	0,1117
OPE	4.655.915,70	461.576,33	0,0991	5.811.214,71	1.980.876,78	0,3409
HAR	1.176.602,48	220.866,91	0,1877	1.896.502,74	303.792,60	0,1602
INV	714.123,47	398.210,92	0,5576	671.403,45	161.634,97	0,2407
FUE	374.560,41	14.602,12	0,0390	483.538,24	86.932,73	0,1798
VMC	226.603,97	54.412,01	0,2401	427.770,00	124.932,38	0,2921
PAY	1.161.674,70	123.641,84	0,1064	1.406.738,95	110.653,25	0,0787
COM	165.004,65	40.491,80	0,2454	153.968,18	114.782,86	0,7455
IRR	313.828,41	39.260,50	0,1251	376.276,45	152.587,79	0,4055
LBC	178.610,07	84.145,56	0,4711	245.349,75	87.133,93	0,3551
FER	1.292.923,43	258.316,41	0,1998	1.731.879,57	217.979,48	0,1259
DEF	1.227.579,20	545.042,39	0,4440	2.049.965,19	960.445,90	0,4685
REV	7.987.664,54	5.122.502,55	0,6413	12.547.885,46	201.910,78	0,0161

Caption: TSP: Total Production of Harvest; OPE: Operating Expenses; HAR: Harvesting Cost; INV: Investments; FUE: Fuel; VMC: Vehicle and Machine Maintenance; PAY: Payroll; COM: Commercial Expenses; IRR: Irrigation Expenses; LBC: Harvest Labor Cost; FER: Fertilizers; DEF: Pesticides; REV: Sales Revenue; CV: Coefficient of Variation
Source: survey results.

Reaffirming the results of the T-Test, a 34% increase in the average expenditure on fertilizers was observed, alongside a decrease in the coefficient of variation (CV). This indicates that during the pandemic, fertilizer costs exhibited greater uniformity while increasing significantly compared to the pre-pandemic period.

Further corroborating the hypothesis test results, in the context of transportation, the terms "harvest" and "machinery" appeared 16 and 4 times, respectively. This suggests that the harvest process became more costly for producers due to various factors, including the rising price of diesel and machinery costs, both for new acquisitions and repairs to existing equipment. Table 3 highlights a 61% increase in the average annual cost for harvest activities. This rise was coupled with an increase in standard deviation during the pandemic period, largely attributed to record-high harvest costs in 2020, which reached R$2,111,316.55.

In addition to the effects of bienniality, an intrinsic characteristic of coffee cultivation, this cost increase was linked to the onset of serial price hikes for critical inputs. For instance, fuel prices rose by 19% and 29% from the 2019–2020 and 2020–2021 harvests, respectively, while vehicle and machinery maintenance costs increased by 63% and 52% over the same periods. The producer emphasized fuel costs as the initial and most noticeable rise, alongside marked increases in machinery repair and maintenance expenses as well as the cost of acquiring new equipment. Regarding this, the producer stated, "The acquisition of the machines themselves, like a tractor, for example, practically doubled in price."

Table 3 also shows an 89% increase in average expenses related to vehicle and machinery maintenance, accompanied by a significant rise in standard deviation. Expenditures for these activities increased from R$208,003.21 in the 2019 harvest to R$516,110.53 in the 2021 harvest, a peak period according to the producer. This trend reflects the sector's dependence on foreign currency, particularly the dollar, as key inputs such as pesticides, fertilizers, machinery, and diesel are subject to international market fluctuations.

The labor-intensive nature of the harvest process, compounded by the direct impacts of COVID-19 pandemic control policies, is evident from the frequent appearance of the terms "labor" and "employees," cited 10 and 6 times, respectively. The producer noted that emergency aid payments discouraged temporary workers from seeking employment, as accepting jobs would disqualify them from receiving the benefit. This created a labor shortage, leading to increased payroll costs as higher wages were necessary to attract workers. These findings are statistically validated by the hypothesis tests.

Labor dependence and associated high costs are critical challenges in rural activities, as highlighted by the interviewee. These issues, exacerbated during crises such as the COVID-19 pandemic, affect the entire value chain. To address this, the interviewee advocated for increased mechanization and automation in farming to reduce labor reliance while enhancing production efficiency and product quality. This perspective aligns with the findings of Guido, Knudson, and Rhiney (2020), who emphasize the vulnerability of coffee farming due to its dependence on seasonal labor, often sourced from neighboring regions or countries, which became scarce due to border closures. Payroll expenses showed a 21% increase when comparing the pre-pandemic period with the years following the pandemic's onset (as shown in Table 3).

At the management level, the term "cooperative," cited 20 times, underscores the importance of this support system in coffee production. Cooperatives offer members various services, including access to production inputs at below-market prices, low-cost storage, and brokerage services for coffee trade. These spaces enable categorization and commercialization within the same environment. According to the interviewee, cooperative services, such as storage, did not undergo significant changes during the pandemic.

Fromm (2022) highlights the critical role of local cooperatives in strengthening and strategically differentiating regions in the coffee market. These entities, alongside other stakeholders such as international traders and buyers, are instrumental in fostering a transparent coffee trade that ensures fair prices for quality beans. This aligns with the producer's acknowledgment of cooperatives as vital to sustaining production and mitigating market volatility during the pandemic.

4.2 Selling Price

Regarding the sales price charged by the producer, it is essential to revisit theoretical concepts. As a commodity, coffee's sales price is defined externally by international stock exchanges. However, in practice, additional value is added based on quality, which is determined through a series of tests evaluating the coffee bean and the characteristics of the beverage it produces. According to the manager, "The result of this quotation is an average price, and if the farm's production is higher or lower than the average production, marketing adjustments will be made."

The producer explains that pricing is carried out at the cooperative to which the property is affiliated. The cooperative manages a specialized sector responsible for conducting quality tests and marketing the beans. This highlights the pivotal role of cooperatives in coffee production, as these entities can act as either direct buyers or intermediaries in sales operations. The producer also identifies the 2021 harvest as the point at which the greatest impact of the pandemic was felt on both production costs and sales prices. During the 2019 and 2020 harvests, the average sales price per bag of coffee was R$585. However, this value increased to R$674 per bag in 2021. Anticipating this trend, the producer foresees even greater increases, as evidenced by the following statement:

> The big appreciation will occur for us now, in the sales of the 2022 harvest, since now, even at the beginning of the year, i.e., future sales made before the harvest, we already have sacks sold for R$750 to R$900. Even so, I would say that these sales were bad, considering that we already have physical sacks out there, i.e., for immediate delivery, sold for values above R$1,500 per sack.

These observations align with the studies of Fromm (2022) and Rhiney et al. (2021), which identified minimal, and when visible, positive changes in coffee consumption shortly after the onset of the COVID-19 pandemic. This was subsequently followed by declining consumption prospects as reduced household incomes led consumers to exclude high-standard items, such as premium coffee, from their shopping lists.

Beyond aggregated sales values, the producer highlights the importance of examining price variability and profit margins. According to the interviewee, pre-pandemic prices were more stable and exhibited fewer fluctuations. Reflecting on the industry's outlook in the context of cost management, the producer offers a less optimistic perspective:

> Although the value of the product has increased, the costs have followed this increase, and I believe that this will hardly decrease, that the costs will return to what they were, unlike the product, which I believe should return to a level more accessible to the consumer market. Considering the price and cost relationship, I believe that the tendency for the next harvests will be a reduction in the profit margin for the producer.

Table 4 - Average sales price, number of bags sold and sales revenue of coffee

Year/Crop	Price/bag	Total quantity of bags sold	Sales Invoicing
2015/2016	518,96	25.412	13.187.789,58
2016/2017	483,32	8.050	3.890.697,39
2017/2018	453,53	25.525	11.576.446,59
2018/2019	493,30	6.681	3.295.724,61
2019/2020	585,12	21.689	12.690.657,94
2020/2021	857,48	14.467	12.405.112,97

Source: Survey Results.

Considering the statistical analysis, it is important to note that, contrary to expectations, no significant variation in sales revenue was observed. Although the descriptive statistics indicate a 57% increase in the average receipts from coffee sales (Table 3), a closer examination of individual values reveals that similar above-average receipts had already occurred prior to the pandemic.

This outcome can be attributed to factors unrelated to the pandemic, such as bienniality—a characteristic of coffee production marked by alternating high and low yields in consecutive years. A high-yield year typically depletes the plants, leading to reduced production in the following year. Additionally, pandemic-related factors, such as the rise in coffee bag prices, have also contributed to this dynamic.

Table 3 illustrates how the interaction of these variables creates a scenario where, despite the apparent percentage increase in average sales revenue, the statistical analysis does not substantiate this increase as significant.

4.3 Strategic Management

In the quest to remain active in a sector highly exposed to risks—primarily due to the producer's inability to control the external variables surrounding operations—it is crucial for rural enterprises to leverage their field-specific expertise by applying effective cost management tools.

In this context, considering the challenges posed by the COVID-19 pandemic, the producer implemented strategies to mitigate labor-related challenges. To address the low availability of labor in the region, partly due to emergency aid payments, and to reduce idle labor costs, the property adopted a streamlined approach. The workforce was reduced to a smaller number of permanent employees, with temporary labor increasingly relied upon during peak activity periods, particularly during the harvest season.

Regarding the adoption of new production techniques and technologies, the producer emphasized the role of precision agriculture. This approach allows for the intelligent application of inputs, such as pesticides and fertilizers, ensuring that each area receives only the necessary quantities. This contributes significantly to cost reduction. Additionally, two new machines were acquired during this period. One is a processor designed for dry cleaning grains harvested directly from the ground, and the other is a harvester capable of operating on younger, smaller plants. According to the producer, these machines contribute to reducing labor dependency while expediting the storage process. With these innovations, the property now has the capacity to store up to 10,000 bags of coffee—half of its total harvest production.

These managerial innovations have facilitated a range of improvements. Some are direct and tangible, such as reduced labor dependence, while others are inferred, including enhanced grain quality, potentially leading to higher sales prices and improved negotiation capabilities. The increased storage capacity also allows the producer to strategically "wait for the best time to sell," as noted by the interviewee. This aligns with Fromm's (2022) findings, which emphasize the indispensability of innovation in contexts where external impacts and uncertainties significantly affect operations, such as in coffee farming.

Regarding production inputs, particularly pesticides and fertilizers, the producer highlighted the vital role of cooperatives. These organizations provide short-term financing aligned with the harvest cycle, offering financial flexibility that is critical for maintaining production activities.

> Unlike direct purchases from industry representatives, where payment is required even before the product is received, cooperatives allow us to purchase inputs with payment terms that often align with the harvest period. This arrangement means we can make payments only after receiving revenue from coffee sales.

In addition to other strategies, the adoption of alternative inputs has become a common practice to reduce costs. The interviewee highlights this approach, stating, "Considering, for example, the high price of fertilizers, we started to buy chicken bedding and mix it with the fertilizer, which reduces the overall cost of the fertilizer."

From a financial perspective, the manager emphasizes the importance of prioritizing the use of personal resources. Regarding this approach and considering the previously mentioned anticipated decline in profit margins, the producer explains that self-funding is preferred. Financing is used only when the terms are advantageous. For instance, financing is pursued in cases such as machinery acquisition, where government subsidies make the operation more favorable.

In this regard, the producer's strategy aligns with and proactively addresses the concerns highlighted by Wulandari, Djufry, and Villano (2022). These authors identify income availability and access to credit as significant barriers to adopting new technologies in agriculture. By leveraging personal capital and selectively financing under favorable conditions, the producer mitigates these limitations and positions the property to adopt necessary innovations.

5 CONCLUSION

To identify the main effects of the COVID-19 pandemic on coffee farming—specifically regarding impacts on costs, prices, and the management processes implemented by rural producers—this study revealed that the coffee agribusiness was significantly affected. These effects were observed both through increases in production costs and through the rise in bean sale prices.

By analyzing a coffee estate with over twenty years of production, located in Romaria, Minas Gerais, in the Triângulo Mineiro region, the study highlighted the vulnerabilities of the coffee agribusiness when faced with contingencies such as the COVID-19 pandemic.

In this context, within a sector where the producer's limited control over external variables—particularly the pricing of their product—is well known, it became imperative for the producer to apply strategic management practices. Leveraging their expertise in the specificities of the sector, producers sought to achieve greater control over costs, ensuring satisfactory profit margins and, consequently, the sustainability of their operations.

As a suggestion for future research, it is recommended to extend this analysis to other crops of importance to Brazilian agribusiness, using a similar approach. Additionally, expanding the analyzed period would provide insights into the short-, medium-, and long-term effects of the COVID-19 pandemic on agribusiness, contributing to a deeper understanding of its broader impacts.

REFERENCES

BARROS, G. **O agronegócio e as crises interna e externa**: desafios e oportunidades. CEPEA: ESALQ, 2020.

BASTOS, E. K. X. **Boletim de Expectativas**. Carta de Conjuntura número 48, Terceiro Trimestre de 2020. Instituto de Pesquisa Econômica e Aplicada - IPEA, 2020. Disponível em: https://www.ipea.gov.br/portal/images/stories/PDFs/conjuntura/200717_boletim_julho_2020.pdf. Acesso em: 12 jun. 2023.

BERTERO, C. O. Nota técnica: teoria da contingência estrutural. In: CLEGG, S. et al. **Handbook de estudos organizacionais**. São Paulo: Atlas, 1998.

CENTRO DE ESTUDOS AVANÇADOS EM ECONOMIA APLICADA - CEPEA. PIB-AGRO/CEPEA: **PIB do Agro cresce 8,36% em 2021**; participação no PIB brasileiro chega a 27,4%. Disponível em: https://www.cepea.esalq.usp.br/br/releases/pib-agro-cepea-pib-do-agro-cresce-8-36-em-2021-participacao-no-pib-brasileiro-chega-a-27-4.aspx. Acesso em: 12 jun. 2023.

CEPAL. **Balanço Preliminar das Economias da América Latina e do Caribe 2021**. Resumo executivo, 2021.

FROMM, Ingrid. Building resilient value chains after the impact of the COVID-19 disruption: challenges for the coffee sector in Central America. **Frontiers in Sustainable Food Systems**, v. 5, p. 775716, 2022.

GARCIA, Leila Posenato; DUARTE, Elisete. Intervenções não farmacológicas para o enfrentamento à epidemia da COVID-19 no Brasil. **Epidemiologia e Serviços de Saúde**, v. 29, p. e2020222, 2020.

GIL, Antonio Carlos et al. **Como elaborar projetos de pesquisa**. São Paulo: Atlas, 2002.

GUIDO, Zack; KNUDSON, Chris; RHINEY, Kevon. Will COVID-19 be one shock too many for smallholder coffee livelihoods? **World Development**, v. 136, p. 105172, 2020.

LEAL, Tamira Alessandra Barbosa et al. Reflexos da pandemia da COVID-19 no agronegócio do café. In: CONGRESSO BRASILEIRO DE CUSTOS-ABC, 2022. **Anais...** 2022.

MANZINI, Eduardo José. Uso da entrevista em dissertações e teses produzidas em um programa de pós-graduação em educação. **Revista Percurso**, p. 149-171, 2012.

MATTEI, Lauro. A política econômica brasileira diante da COVID-19. **Cadernos de Ciências Sociais Aplicadas**, p. 172-183, 2020.

MOROZINI, J. F.; MARTIN, D. M. L.; CARDOSO, C. E. Teoria de opções reais para análise de risco e determinação dos preços de entrada e saída em uma lavoura de café no Brasil. **CEP**, v. 85100, p. 970, 2012.

PEREIRA, Leonel M.; DE OLIVEIRA RIBEIRO, Celma; SECURATO, José R. Agricultural commodities pricing model applied to the Brazilian sugar market. **Australian Journal of Agricultural and Resource Economics**, v. 56, n. 4, p. 542-557, 2012.

RAZALI, Nornadiah Mohd et al. Power comparisons of shapiro-wilk, kolmogorov-smirnov, lilliefors and anderson-darling tests. **Journal of statistical modeling and analytics**, v. 2, n. 1, p. 21-33, 2011.

RHINEY, Kevon et al. Epidemics and the future of coffee production. **Proceedings of the National Academy of Sciences**, v. 118, n. 27, p. e2023212118, 2021.

RICHARDSON, R. J. **Pesquisa Social**: Métodos e técnicas. 3ª Edição. Editora Atlas SA, São Paulo, 1999.

SANCHEZ, Alda Maria Napolitano. **Processo de produção e processo de trabalho na cultura do café**: uma comparação entre café commodity e café especial do sul de Minas Gerais. Dissertação (Mestrado) – Universidade Federal de São Carlos. 2007.

SCHNEIDER, Sergio et al. Os efeitos da pandemia da COVID-19 sobre o agronegócio e a alimentação. **Estudos avançados**, v. 34, p. 167-188, 2020.

SILVA, Edna Lucia da; MENEZES, Estera Muszkat. **Metodologia da pesquisa e elaboração de dissertação**. Florianópolis: UFSC, 4 ed., 2005.

SOARES, Diego Ricardo Lima; DUARTE, Sérgio Lemos; NETO, Morun Bernardino. O Impacto da certificação do café nos custos de produção e preço pago ao produtor rural: uma discussão sob a ótica da economia dos custos de transação. **Revista BASE–v**, v. 19, n. 2, 2022.

SOENDERGAARD, N.; GILIO, L.; DE SÁ, C. D.; JANK, M. S. Impactos da COVID-19 no agronegócio e o papel do Brasil. Insper-Centro do Agronegócio Global. Texto para discussão. n.2, jun. 2020. Disponível em: https://www.insper.edu.br/content/dam/insper-portal/legacy-media/2020/06/impactos-da-covid-19-no-agronegocio-e-o-papel-do-brasil-vf-a.pdf Acesso em: 10 abr. 2023.

TAUNAY, Afonso de E. O café e a economia brasileira. **A Defesa Nacional**, v. 46, n. 535, 1959.

TUZZO, S. A.; BRAGA, C. F. O processo de triangulação da pesquisa qualitativa: o metafenômeno como gênese. **Revista Pesquisa Qualitativa**, v. 4, n. 5, 2016, p. 140-158.

WULANDARI, Suci; DJUFRY, Fadjry; VILLANO, Renato. Coping strategies of smallholder coffee farmers under the COVID-19 impact in Indonesia. **Agriculture**, v. 12, n. 5, p. 690, 2022.

YAP, Bee Wah; SIM, Chiaw Hock. Comparisons of various types of normality tests. **Journal of Statistical Computation and Simulation**, v. 81, n. 12, p. 2141-2155, 2011.

This work was carried out with financial support from the Foundation for Research Support of the State of Minas Gerais (FAPEMIG). We thank FAPEMIG for their support and trust, which were essential for the completion of this research.