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Risks identification in the production of flowers and ornamental plants: evidence from Holambra/SP

Identificação dos riscos na produção de flores e plantas ornamentais: evidências a partir da região de Holambra/SP

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Abstract

The purpose of this study is to identify the main risk events that impact flower and ornamental plant activities. Data were collected from interviews with producers in the region of Holambra-SP, exploring the most frequent risk events and those with the greatest financial impact on the activity. Using descriptive statistics and the Mann-Whitney U test (nonparametric), results show that the most prominent risk events were: fluctuation in flower prices and exchange rate, pest incidence, plant diseases, lack/disqualification of labor, and wind, which have a significant impact on the income of the rural producer. Three events are linked to production risk, two to market risk, and one to operational risk. The evidence obtained has the potential to support the elaboration of risk management strategies by the producers, as well as it can guide the formulation of integrated risk management policies and the design of instruments by the insurers.
Keywords*:* flowers; ornamental plant; risk events.

Resumo

O objetivo deste trabalho é identificar os principais fatores de risco existentes no segmento produtor de flores e plantas ornamentais. A partir de entrevistas com produtores da região de Holambra-SP, foram avaliados os eventos de risco mais frequentes e aqueles de maior impacto financeiro na atividade. Com o uso de estatísticas descritivas e testes não paramétricos U de Mann Whitney, os resultados mostram que os eventos de risco que tiveram maior destaque foram: oscilação do preço da flor e da taxa de câmbio, incidência de praga, doenças na planta, falta/desqualificação da mão de obra e ventania, os quais possuem significativo impacto na renda do produtor. Desses, três eventos estão atrelados ao risco de produção, dois ao risco de mercado e outro ao risco operacional. As evidências obtidas têm o potencial de servir de apoio para elaboração de estratégias de gestão risco por parte dos produtores, bem como podem orientar a formulação de políticas de gestão integrada de riscos e o desenho de instrumentos por parte das seguradoras.
Palavras-chave: flores; plantas ornamentais; riscos.

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1. Introduction

Over the last 30 years, floriculture has gained a relevant position in Brazilian agribusiness. Biodiversity, associated with the diversity of climate and Brazilian biomes, offers conditions to produce a wide variety of flowers and foliage. Such characteristics have contributed to the development of the flower market in Brazil. In this period, floriculture increased its participation in national agribusiness and its contribution to the Brazilian economy. During the period 2012-2020, according to the Brazilian Institute of Floriculture – IBRAFLOR (2021), the revenue of the flower production chain in the country grew from R$4.8 billion to R$9.6 billion, equivalent to an average annual increase of 9.05%.

Brazilian floriculture is fundamentally structured around the domestic market, which absorbs 98% of production. Even so, the country is among the 15 largest producers of flowers and ornamental plants in the world. It is worth noting that floriculture is the agricultural activity that registers the highest percentage of formal and permanent work, as well as the highest formal occupation per hectare. On average, it employs approximately 15 to 20 people per hectare. It must also be noted that the sector is responsible for maintaining a high number of fixed jobs, which is unusual in other types of crops. Anefalos and Guilhoto (2003) observe that, for every R$ 1 million invested, floriculture is capable of employing 404 new workers – this result is four times the number of jobs observed in Brazilian agribusiness as a whole. Despite being labor intensive, the cultivation of flowers and ornamental plants also requires considerable capital investment, but, as Claro (1998) points out, the activity provides high profitability per cultivated area and a quick return on capital employed.

Despite the importance of the flower chain, it is necessary to consider that there are bottlenecks that need to be assessed and risks to be mitigated. Floriculture is an activity marked by spatial characteristics and seasonal events. Plants are extremely delicate and highly perishable and, therefore, susceptible to losses during the production process (from production to commercialization). Furthermore, some segments are marked by strong seasonality, with demand associated with specific events and certain special celebration days. Additionally, the consumer market is quite demanding, which increases the pressure for quality and the requirement for precision in the entire production process. This implies costs, whether on the investment side or in working capital and transforms floriculture into a "management-intensive" activity. In this context, important questions arise to be evaluated, such as: what are the main risks of floriculture from the point of view of the producer? Is it possible to order them according to their severity, considering their frequency and economic impact of the occurrence? The answers to these questions would enable producers to better analyze and implement risk management strategies, improving the design process and formulating actions linked to integrated risk management policies for the activity in question.

Despite the presence of risks that threaten the results and, in some cases, the sustainability of the floriculture activity, the analysis of agricultural risks in Brazil has focused on some crops, especially grains. In this context, the objective of this work is to identify the main risk factors existing in the flower and ornamental plant production segment, based on the analysis of the region of Holambra-SP. This study is unprecedented for this activity in Brazil. The method of the analysis follows recent research that addresses the stages of integrated risk management in agricultural activity - OECD (2009), World Bank, Mapa and Embrapa (2015), and Buainain and Silveira (2017) -, focusing on the initial stage of this approach, in which existing risks are identified and measured. Based on interviews with agents working in this chain, especially with producers, we seek to understand the most frequent risk events and those with the greatest economic impact, also observing which risk management strategies have been prioritized by agents. By hypothesis, it is assumed that, in addition to the price and production risks, which are traditionally identified as the main risks of agricultural activities, the

operational risk also stands as an important factor of income fluctuation in this activity, given the necessary care in the production process and the flowers' high perishability.

The study focuses on the analysis of the region of Holambra-SP. The choice for the analysis in this region is based on the importance of the floriculture activity to the local and regional economy. In addition to the expressive participation in the national production of flowers, the activity stimulates tourism and cultural events associated with the Dutch colony that lives there.

2. Literature review

Agricultural activity is exposed to a series of risk events, with different origins and different potential impacts – Table 1 (Buainain et al., 2014). Faced with this situation, Buainain and Silveira (2017, p.7) point out that "agriculture has been characterized as an island surrounded and covered by risks". Research carried out by the World Bank, Mapa, and Embrapa (2015) points out that Brazil loses, on average, approximately 1% of agricultural GDP per year due to extreme risk events, that is, something around R$11 billion, according to IBGE (2015) presented by The World Bank, Mapa and Embrapa (2015). There is evidence that, in general, poorer regions are more prone to losses since they have restricted access to mitigation mechanisms. This same study also points out that Brazilian and international experiences indicate that the cost incurred in dealing with the consequences of climate events is much greater than the cost of adopting and implementing an integrated risk management strategy and policy. In fact, "if losses occur in several agricultural products at the same time, the fiscal impacts, both on fiscal revenue and expenditure, are significant" (World Bank, Mapa, & Embrapa, 2015, p. 24). The fact that agriculture has complex intersectoral relationships, downstream and upstream (Saes, Souza Filho & Silveira, 2019), makes the effects of these unfavorable occurrences spread to other sectors of the economy, enhancing and multiplying the impacts that directly affect it.

Table 1

Types of risks of agricultural activity

Type of risk	Examples
Weather-related risks	Periodic deficit and/or excess rainfall or temperature, hail storms, strong winds
Natural disasters (including extreme weather events)	Major floods and droughts, hurricanes, cyclones, typhoons, earthquakes, volcanic activity
Biological and environmental risks	Crop and livestock pests and diseases; contamination related to poor sanitation, human contamination and illnesses; contamination affecting food safety; contamination and degradation of natural resources and environment; contamination and degradation of production and processing processes
Market-related risks	Changes in supply and/or demand that impact domestic and/ or international prices of inputs and/or outputs, changes in market demands for quantity and/or quality attributes, changes in food safety requirements, changes in market demands for timing of product delivery, changes in enterprise/ supply chain reputation and dependability
Logistical and infrastructural risks	Changes in transport, communication, energy costs, degraded and/or undependable transport, communication, energy infrastructure,

	physical destruction, conflicts, labor disputes affecting transport, communications, energy infrastructure and services
Management and operational risks	Poor management decisions in asset allocation and livelihood/ enterprise selection; poor decision making in use of inputs; poor quality control; forecast and planning errors; breakdowns in farm or firm equipment; use of outdated seeds; lack of preparation to change product, process, markets; inability to adapt to changes in cash and labor flows
Public policy and institutional risks	Changing and/or uncertain monetary, fiscal and tax policies; changing and/or uncertain financial (credit, savings, insurance) policies; changing and/or uncertain regulatory and legal policies and enforcement; changing and/or uncertain trade and market policies; changing and/or uncertain land policies and tenure system; governance-related uncertainty (e.g., corruption); weak institutional capacity to implement regulatory mandates
Political risks	Security-related risks and uncertainty (e.g., threats to property and/or life) associated with politico-social instability within a country or in neighboring countries, interruption of trade due to disputes with other countries, nationalization/confiscation of assets, especially for foreign investors

Source: Jaffee, Siegel, and Andrews (2008).

Analyzing the diversity of existing risks, it is possible to point to two main groups of events that directly and significantly impact the financial return of agricultural activity. The first is production risk. Dependence on climate and biological aspects differentiate agriculture from other sectors of the economy, bringing unique and high uncertainty regarding crop productivity. With this aspect, the current climate change scenario points to an even greater relevance of this variable (Assad, 2011; OECD, 2009). The second group is associated with fluctuations in the prices of inputs, *commodities,* and macroeconomic indicators (such as exchange rates and interest rates), which comprise price risk (also called market risk). It is worth noting that undesirable fluctuations in the exchange rate, for example, have the potential to impact not only the producer's revenue - since in some cases it impacts the formation of the commodity's price -, but also the cost of production, due to changing the prices of imported inputs. Changes in the interest rate, in turn, interfere with the producer's indebtedness cost.
From the classifications pointed out by Jaffee, Siegel, and Andrews (2008), indicated in Table 1, operational, credit and institutional environment risks are also relevant. While the first is associated with the possibility of human errors and/or of technologies applied to the production and management of the activity, the second is based on the possibility that the producer does not capture the financial amount necessary to carry out the stages of the production process. Finally, the risk arising from the institutional environment "is based on the possibility of unforeseen changes in laws/regulations in a certain region or even on changes in the regulatory framework that governs the national economy and world trade" (Buainain & Silveira, 2017, p. 31).

A detailed examination of the above-mentioned risk factors shows that, in addition to several of them being inherent to agricultural activity, they are, in many situations, interrelated. In this sense, integrated risk management requires a holistic analysis, as proposed by the study developed by The World Bank, Mapa, and Embrapa (2015). Five steps form this method, starting with the assessment of risk events, with subsequent analysis of the management mechanisms and their respective operationalization, implementation, and monitoring of operations - Figure 1.

Figure 1 - Method proposed by the World Bank for integrated risk management in agricultural activities
Source: The World Bank (2016).

As already noted, the first stage of an integrated risk management policy is based on the assessment of risk factors. To this end, such events are identified, measured, and, thus, prioritized for later adoption of management mechanisms. It is worth noting that, concerning measurement, the frequency of adverse events is compared vis-à-vis the potential for generating financial losses, to express the magnitude of the losses and, thus, measure the importance of the factor. The work by Gazzola, Pereira, Souza, and Guiducci (2016) uses this method to assess the order of importance of the different risk factors that the agricultural activity is exposed. Based on interviews with 502 agents participating in different production chains, events related to animal health (foot-and-mouth disease, mad cow, and avian flu) and international trade (changes in non-tariff barriers) were highlighted in terms of economic loss.
After evaluating the risk events, the stages of the solution, operationalization, implementation, and monitoring of management strategies are placed, which can be grouped according to their purpose: prevention, mitigation, and transfer (OECD, 2009) - Figure 2. Preventive actions, such as the adoption of certain technology, training of human resources, and/or the design and adoption of policies aimed at preventing diseases and disasters, have the goal of reducing the probability of occurrence of risk events. Mitigation strategies, on the other hand, occur after the risk event takes place and aim to mitigate the impact of losses on the agents involved – examples: diversification of production, work outside the agricultural activity, vertical integration, use of agricultural insurance, and derivative contracts, among others. Finally, risk coping seeks to face the losses already made, with the most common actions being obtaining loans, selling assets, and executing government social assistance programs.

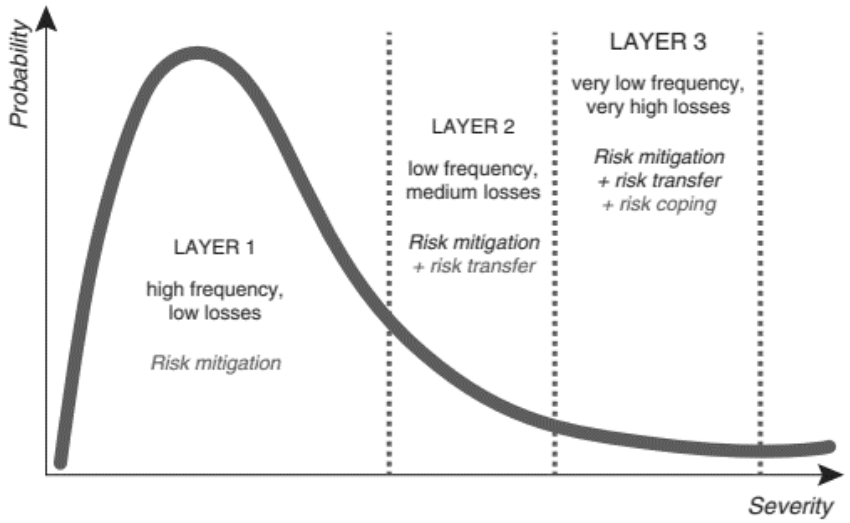


Figure 2 – Risk management strategies according to the severity of the impact of the event's occurrence.
Source: The World Bank (2016).

Several studies have evaluated the adoption of different risk management mechanisms in Brazil. To a large extent, the focus of the studies is on production risk and price risk. In this first group of analyses, investigations have been carried out to observe how production risk is mitigated through the adoption of production techniques and assistance to face climate risks (Burney, Cesano, Russell, La Rovere, Corral, Coelho, & Santos, 2014; Pires, Abrahão, Brumatti, Oliveira, Costa, Liddicoat, Kato, & Ladle, 2016), information technologies and systems (Carrer, Silveira, &Souza Filho, 2017), specific production systems (Osaki &Batalha, 2014), agricultural insurance (Fornazier, Souza, &Ponciano, 2012; Osaki, 2008), among others.

Regarding price risk, different studies have explored the intensity of use of derivative contracts to manage price risk, also evaluating the determining factors of such adoption. Marques and Aguiar (2004) and Cruz Júnior, Irwin, Marques, Martines Filho and Bacchi (2011) studied this topic in the grain market, while Silveira, Cruz Júnior and Saes (2012), Silveira, Maia, Cruz Júnior and Saes (2014) and Costa, Castro Júnior, Callegario, Andrade and Oliveira (2015) focused this analysis on coffee production. The studies by Carrer, Silveira, Souza Filho, and Vinholis (2013) and Carrer, Silveira, and Souza Filho (2019) investigated these issues in beef cattle and citrus farming, respectively. In general, it was observed that price risk management instruments are little used in agricultural activity, and many of these tools are unknown to producers.

Finally, two World Bank studies (2015a, 2015b) applied and analyzed an integrated risk management method in agricultural activities, using two Brazilian states (Bahia and Paraíba) and a city (Piquet Carneiro – Ceará). To identify the risk factors, expert opinions were evaluated to understand the extent of the damage caused by the different dimensions of risk to the farmer's income. To quantify potential losses, an electronic survey was applied to more than 5,000 representatives of the agricultural sector, to verify their perception of the potential for loss and the frequency of occurrence of events related to each of the pre-existing risks. The study obtained 700 responses. In addition, 25 programs and public policies were evaluated, considering their scope and cost to the government, according to the dimensions of risks considered. The results pointed to the existence of a strong interrelationship of agricultural risks, making the vulnerability of small and medium producers evident, given the inability of mapped public policies and programs to protect the income of such groups.

3. Methodology

To identify the main risk factors to which the flower and ornamental plant producing segment is exposed, in addition to characterizing the producer, the property, and the activity in the Holambra-SP region, the present work was supported by the studies of Gazzola, Pereira, Souza, and Guiducci (2016) and the World Bank (2015a and 2015b). In this context, the research was guided by the realization of a panel, in which specialists and managers helped to delimit an environment of relevant risk events and develop a structured questionnaire, later applied to a group of 45 flower producers and ornamental plants from the region of Holambra-SP. It is worth emphasizing that the selection of participants was random and the sample corresponds to approximately 25% of the producing establishments in the city, according to the Agricultural Census (IBGE, 2017). Although Holambra has only 2% of the country's flower and ornamental plant production establishments, this municipality contributed to 20% of the sales value generated by the Southeast - a region responsible for about 70% of the sales value of flowers in the country in 2017, according to IBGE (2017). Such numbers reinforce the relevance of the sample.

Thus, it can be observed that the study is based on an empirical method, generating useful information for the formulation of management strategies by producers and the design of public policies with a view to an integrated risk management. As for the approach, qualitative and quantitative techniques were combined (Lakatos & Marconi, 1996). In this last point, it is worth noting that, on the one hand, information was obtained about the main risks that the producer believes he/she is exposed to and how he/she manages them. On the other hand, the study also obtained quantifiable elements, as will be shown below, which were evaluated using descriptive statistics and hypothesis tests. Finally, the research has an exploratory nature, and the procedures are based on field research.

The questionnaire consisted of two parts. The first set of questions sought to characterize the producer - concerning socioeconomic aspects, his/her property, and his/her business. In this block, questions such as schooling, time of experience in the activity, size of the property, the volume of production consolidated in the year 2017, and if it was a member of a cooperative, among other points, were included. The second part investigated which were the most expressive risks, with the highest frequency of occurrence and which added up to greater financial losses when the adverse event associated with it materialized. Its application also sought to investigate whether risks were being managed and what mechanisms were being adopted. It also evaluated the history of production drop and the producer's perception of the price oscillation of the three main products over four quarters.

A list of 29 risk events, drawn up from discussions with different players in the floriculture supply chain, was presented, covering risks related to production, price, operations, credit, and the business environment. From this set of events, the risk factors were measured and ordered according to their importance, taking into account the degree of severity of the event – equation (1). The dimension of the severity level was, in turn, obtained by the perception of producers regarding the frequency of the event and its potential for financial loss.

$$\text{Severity degree} = \text{Event frequency} \times \text{Financial loss} \quad (1)$$

The frequency of the event and the potential for financial loss were calculated from questions that involved a Likert scale, from 1 to 5, in which (1) indicated a very low level and (5) a very high level. As an example, the producer indicated, from (1) to (5), the level of frequency of occurrence of pests in his/her activity, as well as signaling the magnitude of a financial loss if the event took place. It is thus observed that, according to equation (1), the degree of severity has a scale of 1 to 25 points.

Based on the responses of the producers, the probabilities of the event having a high frequency of occurrence (P_{af}) and a high potential for financial loss (P_{ap}) were calculated – equations (2) and (3), respectively.

$$P_{af} = \frac{Number\ of\ answers\ with\ a\ scale\ of\ 3\ to\ 5\ for\ frequency}{Total\ number\ of\ responses} \quad (2)$$

$$P_{ap} = \frac{Number\ of\ responses\ with\ a\ scale\ of\ 3\ to\ 5\ for\ economic\ loss}{Total\ number\ of\ responses} \quad (3)$$

Based on the responses obtained, the risk events that have high-frequency probabilities and high-potential for monetary loss were identified and ordered, which were evaluated using descriptive statistics. In this sense, events that, for example, presented, simultaneously, high values of P_{af} and $P_{ap,}$ had a high degree of severity.

Additionally, the degree of severity, given by equation (1), was dimensioned for each of the 29 risk events among the 45 producers. Based on these results, nonparametric Mann-Whitney U tests were performed (Mann & Whitney, 1947; McKnight &Najab, 2010; MacFarland &Yates, 2016), considering pairs of variables related to the degree of severity of risk events. Under this test, the study evaluated whether the median of the severity degree of an event was statistically different from the median of another event (that is, the null hypothesis to be evaluated in the test consists of the equality of the medians of the pair of variables under analysis). This method was used due to the small sample size and the fact that the variables based on the degree of severity of the risk events do not, in general, follow a normal distribution.

3.1. Study sample

As already highlighted, the sampled producers were located in Holambra-SP, a city located in the administrative region of Campinas-SP - Figure 3, with a total area close to 65 km² and a population of about 14 thousand inhabitants (IBGE, 2019). Data from the Agricultural Census (IBGE, 2017) show that the city has 219 agricultural establishments, approximately 75% of which are dedicated to the cultivation of flowers. Therefore, the sample of the study is quite significant, given that it represents approximately 25% of the establishments that produce flowers and ornamental plants in this municipality.

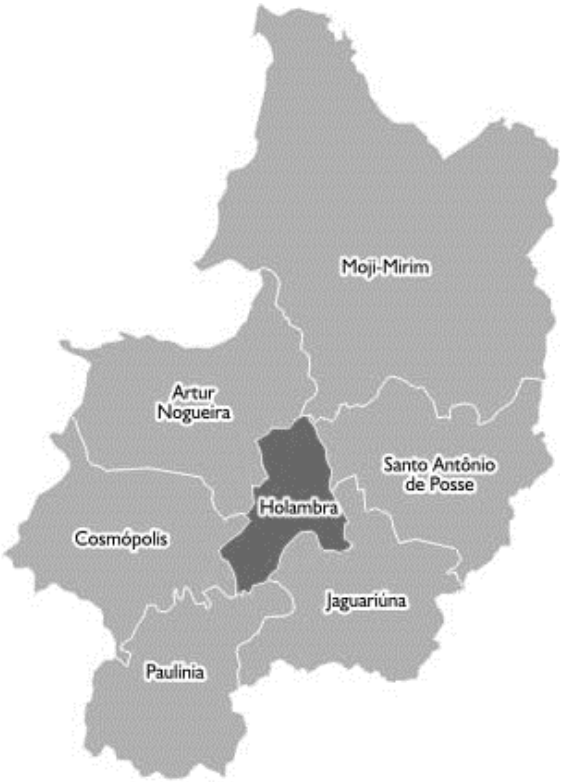


Figure 3 – Map of the Bordering Municipalities of Holambra.
Source: Portal de Holambra.

It is worth mentioning that Veiling Holambra is located in this region, the most important cooperative in the sector, constituting the largest wholesale center for the commercialization of flowers and plants in America. According to data published on its website, Veiling is responsible for 45% of the national market, has more than 600 active customers, and concentrates the production of around 400 suppliers.

4. Results

4.1. Sample characterization

From the interviews carried out, it was observed that the average age of the sample producer was 47 years. Another interesting fact is that the average time of experience in the floricultural activity is 24.31 years, that is, just over half of the average age of the producer – Figure 4, confirming the tradition of producing families in the region. In addition, more than 65% of respondents have a university degree, that is, this is a highly educated group.

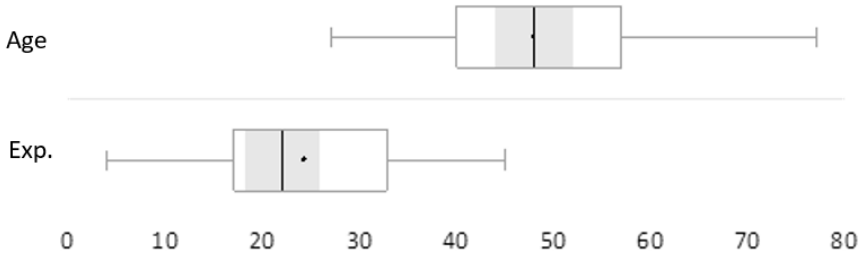


Figure 4 – Boxplot related to the age and years of experience of the sampled producers.

Source: Research Results.

For income, almost half of the producers had supplementary income, largely from other types of agricultural activity, in addition to being associated with the provision of services (11.11%), leasing (8, 89%), and rental of machinery and equipment (2.22%) – Table 2. Although 48.89% of producers point to having income from other activities, financial resources from floriculture represent an average of 89% (with a median 99%) of the producer's total income, thus emphasizing the significant importance of the activity to the agents interviewed.

Table 2. Data related to activities that complement floriculture activity.

Variable	*no*	%
Complementary activity	22	48.89
Livestock	4	8.89
Agriculture	8	17.78
Services provision	5	11.11
Pisciculture	-	-
Machinery and equipment rental	1	2.22
Leasehold	4	8.89
Poultry production	3	6.67

Source: Research Results.

Regarding the profile of the property, as shown in Table 3, the average area of establishments is 340,020 m ^{2} (median of 150,000 m ^{2}), with an average area dedicated to floriculture of 85,830 m^2 (median of 30 thousand m^2), which generates, on average, employment for 73.31 employees (median of 26), of which approximately 96% are non-family employees and 98% are permanent jobs. Thus, these numbers confirm the information previously mentioned that floriculture is an activity with high maintenance of permanent and formal jobs [4].

[4] Occupation is a fact that deserves a caveat. The discrepancy between the mean and the median is due to the strong influence of large producers – 12 interviewees employ 70 and/or more employees, with one producer employing 1,000 people.

Table 3. Data relating to the area and number of employees.

Variable	Average	Median	Detour pattern	Minimum	Maximum
Property area (thousand m ^{2})	340.02	150.00	572.51	6.00	2,800.00
Area dedicated to floriculture (thousand m ^{2})	85.83	30.00	184.66	1.50	1,200.00
Greenhouse area (thousand m ^{2})	63.94	25.00	118.93	0.40	700.00
Screened area (thousand m ^{2})	0.68	-	1.80	-	8.00
Open sky area (thousand m ^{2})	21.69	-	76.41	-	500.00
Number of employees	73.31	26.00	157.01	2.00	1,000.00
Number of family employees	2.68	2.00	1.61	0.27	9.00
Number non-family employees	68.91	22.00	155.23	-	997.00
Number of permanent employees	72.58	26.00	157.07	2.00	1,000.00
Number of temporary employees	1.18	-	3.52	-	20.00

Of the total area destined for the production of flowers and ornamental plants, 74% of the sample comprises productive activity carried out in greenhouses, 25% in the open air, and 1% refers to the screened area, popularly known as sombrite - Table 3. Although each producer interviewee had a specific and non-exclusive productive composition, with different species and varieties, sold in pots, or cut (in bundles, packages, stems, etc.), it was possible to observe that, on average, production encompasses about 13 different species, with orchids, roses, kalanchoê, and chrysanthemums being the main representatives of the flowers; and cacti, succulents and ferns the protagonists in the group of ornamental plants. Approximately 69% of respondents produce potted flowers, 33% work with cut flowers, and 31% ornamental plants. Regarding propagation material, around 13% produce seedlings, 4% seeds, and 2% bulbs.

Table 1 summarizes the main characteristics of the producer and his/her business. It also shows that the production of flowers and ornamental plants was financed, on average, with 78.47% of its own resources (median of 90%). Despite this, 68.89% of the agents surveyed guaranteed that they had access to credit at some point, which was used especially for investment and funding. Regarding the marketing process, 91% carry out such activities through a cooperative. In the sample, 37 of the 45 respondents were Veiling members. This institution, unlike the others, requires that the total production be negotiated via a cooperative, through reverse auction[5], intermediation, or online sales.

In the Holambra region, only producers who are not members of Veiling can have greater flexibility to sell their products through direct sales, in addition to marketing via other cooperatives (Cooperflora, Cooperplantas, etc.), associations, Ceaflor and Ceasas. In the sample, only four producers are members of cooperatives other than Veiling, and another four are independent. These data confirm the expression and importance of these institutions, not only to the local market but also in the national scenario, in the distributive link, and as a guide for price formation. As most of the interviewees participate in the reverse auction and intermediation through Veiling, not only the price is influenced, but also the strategic planning of the production of their plants. In the case of marketing through intermediaries and direct sales, 75% of these operations use a price-fixing contract in order to hedge against price risk.

[5] Unlike the ascending auction (of English origin, in which the bids made by the interested parties increase until the auctioneer concludes the sale at the highest offered price), the auction carried out at Veiling is based on a descending price system, which is why it is called an auction reverse.

Furthermore, the target market is mainly composed of supermarkets and distributors (Garden Centers and Flower Shops).

Table 1. The average profile of the interviewed producers.

Age: - Mean of 47.91 years and median of 48 years; standard deviation equal to 11.20 years. **Education:** - 30 producers (66.67%) with higher education. **Experience:** - Average of 24.31 years; standard deviation equal to 10.97 years. **Floriculture Income:** - Mean of 89% and median of 99%. **Income from another activity:** - 22 producers (48.89%) have complementary activities. - Agriculture (17.78%); Provision of Services (11.11%); Lease (8.8%). **Production and property features:** - Average number of species produced was 13.89 with a median of 4.00. - 68.89% (31.11%) produce potted flowers (ornamental plants). - Average area of the property: 340.02 thousand m^2 (median of 150 thousand m^2). - Average area dedicated to floriculture: 85.83 thousand m^2 (median of 30 thousand m^2). - Greenhouse area 74%; open sky 25%; screened 1%. - Average number of employees: 73.31 people (median of 26). - Use of loans for funding or investment: 68.89% of the sample. - Marketing method: 91.11% is done through a cooperative. - Target Market: distributor (66.67%), supermarkets (67.78%) and flower shops (33.33%).

Source: Search Results

4.2. Risk identification

When measuring the perception of producers to the frequency of the event and the potential for financial loss, using the Likert scale (from 1 to 5 points), the degree of severity of each risk event was measured, using the equation (1). The evidence obtained, which is presented in Table 4, suggests 11 more relevant risk events when considering, especially, the median degree of severity. These comprise, mostly, the production risk (plant disease, pest incidence, wind, excess rain, drought/drought, and hail) and price risk (fluctuation in the price of the flower, the exchange rate, and the prices of inputs).

In addition, there was an event linked to operational risk (lack of qualification of the workforce) and institutional risk (strike and interruption of highways/airports). Although there is only one event linked to operational risk, it has one of the highest degrees of severity among the events studied.

Table 4. Degree of severity of risk events.

	Risk event	Average	Median	Maximum	Minimum	SD	Jarque -Bera	p-value
1.	Plant diseases	8.44	8.00	25.00	1.00	6.08	4.80	0.090
2.	Lack/Disqualification of the workforce	8.22	6.00	25.00	1.00	7.04	7.74	0.021
3.	Flower price fluctuation	7.89	8.00	20.00	1.00	5.36	2.88	0.237
4.	Prague	7.73	8.00	20.00	1.00	5.41	2.99	0.224
5.	Exchange rate fluctuation	7.04	4.00	25.00	1.00	6.66	6.15	0.046
6.	Wind	6.38	5.00	16.00	1.00	5.03	4.25	0.120
7.	Excess rain	5.80	6.00	16.00	1.00	4.25	3.64	0.162
8.	Drought	5.69	4.00	20.00	1.00	4.96	8.88	0.012
9.	Input price fluctuation	5.16	4.00	16.00	1.00	4.03	8.59	0.014
10.	Strikes and Interruption of highways/airports	5.16	4.00	16.00	1.00	3.41	16.31	0.000
11.	Hail	4.69	4.00	12.00	1.00	3.28	3.21	0.201
12.	Increase in guarantees for obtaining credit	4.16	1.00	25.00	1.00	5.43	54.26	0.000
13.	Inadequate handling of inputs	4.00	3.00	16.00	1.00	3.70	16.55	0.000
14.	Inadequate soil management	3.89	1.00	16.00	1.00	4.73	22.48	0.000
15.	Inadequate water management	3.60	1.00	16.00	1.00	4.28	17.85	0.000
16.	Change in the rigor of classification standards	3.58	1.00	16.00	1.00	3.94	31.92	0.000
17.	Farm management issues	3.51	1.00	12.00	1.00	3.38	9.00	0.011
18.	Invasive plants	3.49	1.00	25.00	1.00	4.57	260.48	0.000
19.	Change in the interpretation of environmental regulation	3.44	1.00	20.00	1.00	3.99	84.53	0.000
20.	Rigorous inspection of pesticides	3.33	1.00	25.00	1.00	4.38	372.42	0.000
21.	Inadequacy of transport	3.33	1.00	20.00	1.00	4.81	95.23	0.000
22.	Change in the interpretation of labor regulation	3.24	1.00	12.00	1.00	3.09	10.22	0.006
23.	Labor processes	3.09	1.00	15.00	1.00	3.65	37.73	0.000
24.	Credit insufficiency	2.96	1.00	16.00	1.00	3.72	45.79	0.000
25.	Difficulty in accessing technical assistance	2.93	1.00	25.00	1.00	4.76	422.12	0.000
26.	Inadequacy of storage	2.93	1.00	25.00	1.00	4.35	238.53	0.000
27.	Low quality of inputs	2.73	1.00	20.00	1.00	3.98	186.04	0.000
28.	Water contamination	2.20	1.00	12.00	1.00	2.56	77.09	0.000
29.	Default of suppliers and buyers	2.11	1.00	15.00	1.00	2.55	402.58	0.000

Subsequently, the nonparametric Mann-Whitney U test was performed, focusing on the 11 most relevant risk events, according to Table 4, in relation to the other events. Table 5 presents the p-values of the tests (performed with pairs of variables), confirming the evidence described above. The results also point to a greater relevance of the first six risk events, which presented, among their peers (between events 1 to 6), statistically insignificant differences in severity. On the other hand, the medians of such events were statistically higher in relation to the other events - especially from event 12 onwards - Table 5. In this group, three events refer to the risk of production (disease, pest, and wind), the other two are related to the market risk (fluctuation in flower price and exchange rate), and the other one is based on the operational risk (lack/disqualification of labor).

Table 5. Results related to the p-values of the Mann-Whitney U test

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Plant diseases	(1)	-										
Lack/Disqualification of the workforce	(2)	0.87	-									
Flower price fluctuation	(3)	0.75	0.77	-								
Prague	(4)	0.63	0.71	0.88	-							
Exchange rate fluctuation	(5)	0.13	0.42	0.25	0.34	-						
Wind	(6)	0.08	0.31	0.17	0.25	0.97	-					
Excess rain	(7)	0.04	0.21	0.07	0.10	0.87	0.78	-				
Drought	(8)	0.02	0.11	0.03	0.06	0.65	0.51	0.64	-			
Input price fluctuation	(9)	0.01	0.07	0.03	0.03	0.70	0.45	0.55	0.99	-		
Strikes and Interruption of highways/airports	(10)	0.01	0.11	0.03	0.04	0.75	0.53	0.68	0.84	0.78	-	
Hail	(11)	0.00	0.05	0.00	0.01	0.41	0.20	0.30	0.62	0.88	0.64	-
Increase in guarantees for obtaining credit	(12)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00
Inadequate handling of inputs	(13)	0.00	0.00	0.00	0.00	0.06	0.02	0.03	0.09	0.06	0.03	0.16
Inadequate soil management	(14)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.18	0.00	0.03
Inadequate water management	(15)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02
Change in the rigor of classification standards	(16)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.03
Farm management issues	(17)	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02	0.01	0.01	0.05
Invasive plants	(18)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Change in the interpretation of environmental regulation	(19)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02
Rigorous inspection of pesticides	(20)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
Inadequacy of transport	(21)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in the interpretation of labor regulation	(22)	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02
Labor processes	(23)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Credit insufficiency	(24)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Difficulty in accessing technical assistance	(25)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inadequacy of storage	(26)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Low quality of inputs	(27)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water contamination	(28)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Default of suppliers and buyers	(29)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6 presents the risk events, sorted by degree of severity, which is obtained from the multiplication between the probabilities of the event having a high frequency of occurrence (P_{af}) and a high potential for financial loss (P_{ap}) - equations (2) and (3). Considering the ten most severe events, which are present among the events highlighted in Table 4, five of them are associated with production risk, three with market risk, one with operational risk, and one with institutional environment risk.

The results show that the risk of greater severity belongs to the group of market risks - Table 6. For any agricultural product, it is common to observe a strong instability in prices, given that they are very sensitive to any change in supply and demand. – as presented by Buainain, Pedroso, Vieira Junior, Silveira and Navarro (2014). Added to this, the market for flowers and ornamental plants is also influenced by the seasonality of consumption, greater on commemorative dates and festive periods – as highlighted in Marques and Caixeta Filho (2002), in addition to strong pressure due to its high perishability.

Table 6 - Risk assessment in the flower chain in the region of Holambra – SP, by the degree of severity.

	Risk Event	Risk type	Potential for financial loss	Frequency of occurrence	Financial loss × Event frequency
1	Flower price fluctuation	Market	60%	60%	36,00%
2	Prague	Production	56%	56%	30,86%
3	Plant diseases	Production	49%	58%	28,25%
4	Lack/Disqualification of the workforce	Operational	60%	47%	28,00%
5	Wind	Production	49%	40%	19,56%
6	Excess rain	Production	49%	40%	19,56%
7	Exchange rate fluctuation	Market	47%	33%	15,56%
8	Drought	Production	36%	38%	13,43%
9	Input price fluctuation	Market	33%	24%	8,15%
10	Strikes and Interruption of highways/airports	Institutional	78%	9%	6,91%
11	Inadequate handling of inputs	Operational	42%	16%	6,57%
12	Change in the rigor of classification standards	Institutional	27%	24%	6,52%
13	Inadequate water management	Operational	31%	18%	5,53%
14	Hail	Production	62%	9%	5,53%
15	Inadequate soil management	Operational	29%	18%	5,14%
16	Increase in guarantees for obtaining credit	Credit	22%	20%	4,44%
17	Farm management issues	Operational	31%	13%	4,15%
18	Labor processes	Operational	29%	11%	3,21%
19	Rigorous inspection of pesticides	Institutional	20%	16%	3,11%
20	Inadequacy of transport	Operational	16%	20%	3,11%
21	Change in the interpretation of environmental regulation	Institutional	27%	11%	2,96%
22	Credit insufficiency	Credit	27%	11%	2,96%
23	Invasive plants	Production	9%	33%	2,96%
24	Difficulty in accessing technical assistance	Operational	16%	16%	2,42%
25	Change in the interpretation of labor regulation	Institutional	24%	9%	2,17%
26	Low quality of inputs	Operational	9%	20%	1,78%
27	Inadequacy of storage	Operational	16%	11%	1,73%
28	Water contamination	Operational	16%	9%	1,38%
29	Default of suppliers and buyers	Credit	16%	2%	0,35%

Source: Search results.

According to the responses of flower producers, the first quarter, on average, is the period of lower prices, given that for almost half of the sample, the price of their main crop drops and settles down to a level below the average price – Figure 5. This point can be explained by the drop in market dynamism in this period due to the absence of commemorative dates and the incidence of extra expenses that impact the family budget. This lower dynamism does not apply to ornamental plants, since these, according to the sample, maintain the average price throughout the year. On the other hand, the second quarter was pointed out by 26 producers as the one characterized by above-average prices. Finally, in the last two quarters, most producers indicated that the price of their main product remained on average. Such evidence is in agreement with the results of Marques and Caixeta Filho (2002), who found a strong relationship between festive dates and the behavior of sales volumes and prices, reinforcing the signs of the producers interviewed in this research.

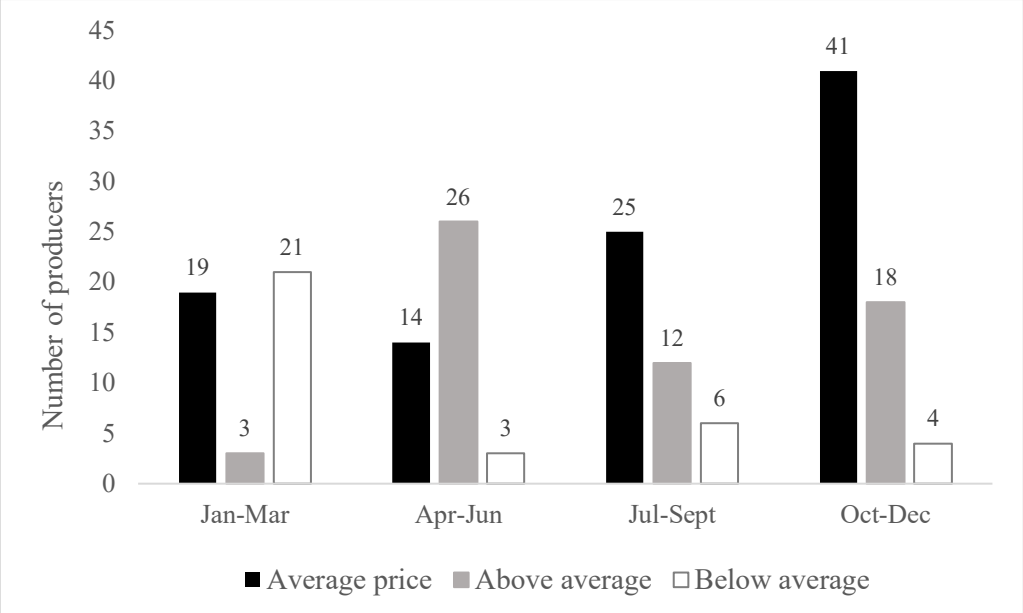
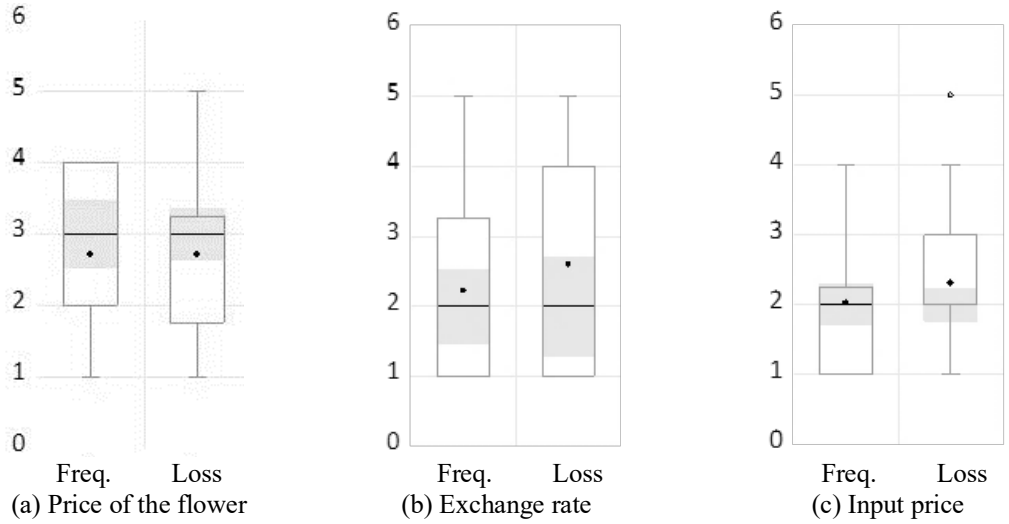


Figure 5 – Distribution of the number of producers according to the price level.

The seventh and ninth positions in Table 4 are also represented by market risks: exchange rate fluctuation and input price fluctuation, respectively. This result is explained by the fact that the fluctuation of the dollar impacts not only the direct import of material (seedlings, bulbs, etc.) but also inputs used in the national production of pesticides and fertilizers. In addition, the exchange rate fluctuation impacts flower exports, even though a large part of the product is sold in the domestic market. At this point, the study by Anefalos (2006) points, from simulations with an input-output model, the importance of the exchange rate on the performance of the activities of exporting cut flowers in the country.

Figure 6 shows the distribution of the producers' perception indicators in relation to the frequency and potential for economic loss of the three most severe market risk events: fluctuation in flower prices, exchange rate, and input prices. Analyzing such events, the greater severity of the first is verified, considering that it presents the highest indicators of frequency of economic loss.



(a) Price of the flower (b) Exchange rate (c) Input price

Figure 6 - Boxplot relative to the indicators of producers' perception in relation to the frequency and intensity of the economic loss of the three main market risk events.

Events related to production risks, in turn, showed a high degree of severity for five positions, among the top ten. If, on the one hand, it is common sense the exposure of agricultural production to weather conditions, on the other hand, it was expected that, due to the fact that a large part of the production of flowers and ornamental plants is protected by greenhouses and supported by an irrigation system, this perception of the degree of severity was attenuated.
Pest and plant diseases, in addition to being very frequent, also cause significant economic loss (Figure 7). Pontes (2007, p. 17) highlights this issue, noting that mites, tripods, whiteflies, aphids, and leafminers "compromise the quality and consequently the commercialization of the final product". In particular, the author highlights the significant damage that mites cause on roses, chrysanthemums, and gypsophila. Concerning windstorms and hail, the perception of damage is accentuated by the possibility of structural damage, in addition, to yield damage. Results also revealed that 100% of respondents had greenhouses and an irrigation system; approximately 60% in both cases were automated. In addition, almost 95% use crop protection and pest monitoring, and about 75% adopt biological control.

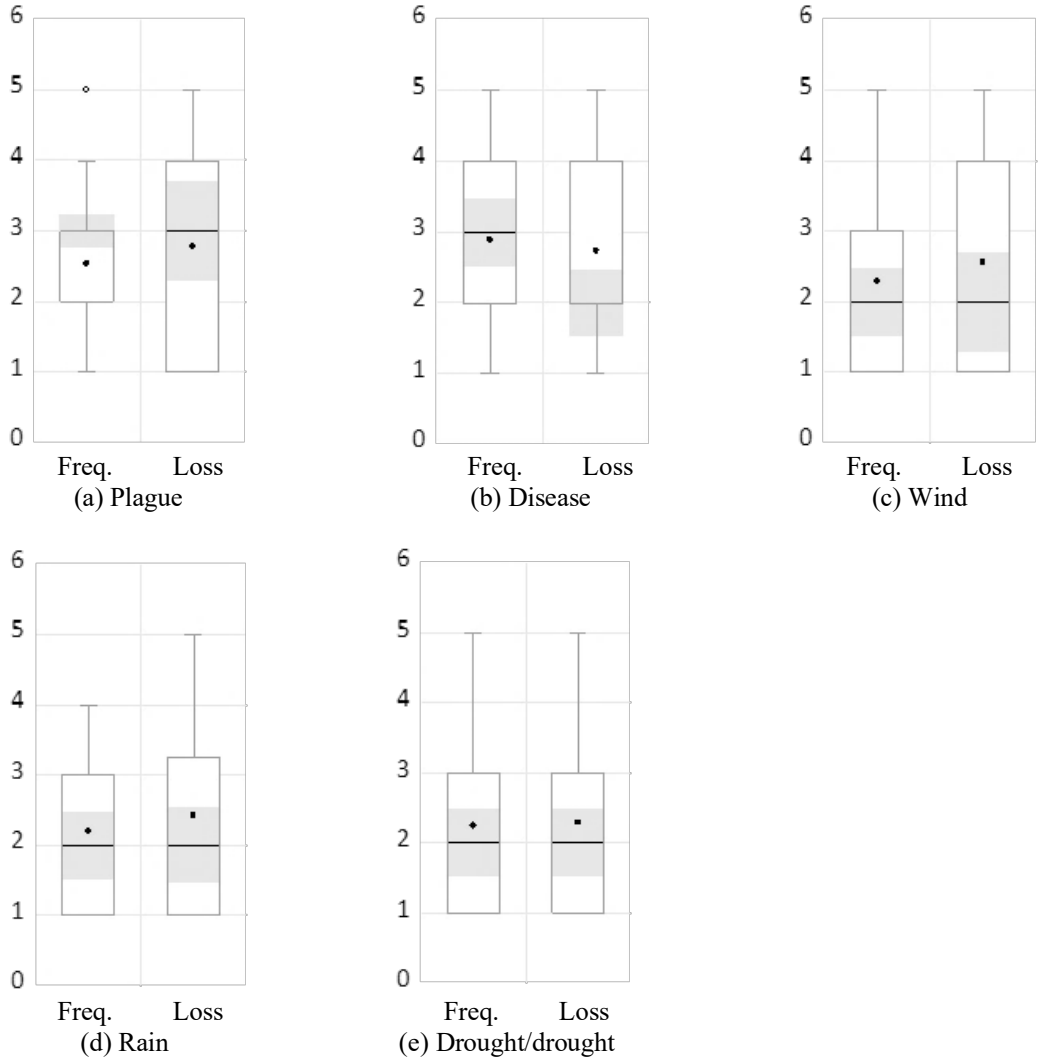


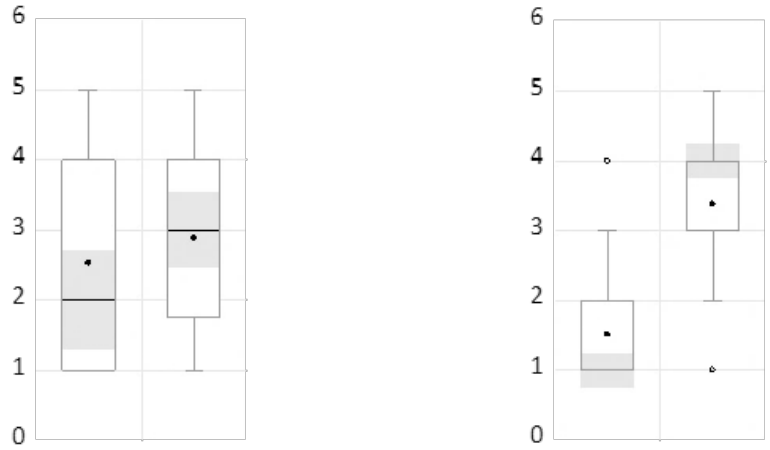
Figure 7 – Boxplot related to the indicators of producers' perception in relation to the frequency and intensity of the economic loss of the five main production risk events.

Regarding production risk, it is also possible to point out that around 65% of the respondents plan their production based on agro-meteorological information and 60% hire specialized technical assistance. In the post-harvest, the main measures adopted are the use of germicide, and conservation in water and cold chambers. However, these are practices that are not always used in all types of cultivation.

When investigating the reason for the largest historic crop failure in the most important crop in the business, half of the producers pointed to pests and diseases as the most frequent. However, climatic events produced the greatest economic losses for the most important crops, with an average percentage of crop failure of 30.4%, 38.0%, and 25.5%, respectively. Six of the 45 interviewees said they had already had a total crop failure due to poor quality of input (substrate), hail, windstorms, and management problems.

Another important finding related to production risks is that, despite rural insurance being pointed out as one of the main risk management instruments, it is still very little explored. In the case of producers of flowers and ornamental plants in the region of Holambra-SP, only 35% of the sample makes use and, in general, they are aimed at covering machinery and structure, without production coverage. When asked about crop protection, almost all producers were categorical, denying the existence of this modality in the chain of flowers and ornamental plants. However, three producers pointed out that negotiated this type of insurance in 2018. It

is worth noting that, in the region, in 2019, only one insurance company sold rural insurance with coverage for the production of flowers and ornamental plants. In general, the premium is stipulated based on a self-declaration regarding the valuation of the structure (greenhouses and nurseries) and production. This modality is known as “closed gate insurance”. In this case, the evaluative parameters are the age of the structure, the type of cultivation, the type of structure (whether it is masonry, galvanized, or mixed), the value of the building, and the value at risk, that is, the value of the structure plus the estimated value of production. It is worth noting that this insurance excludes coverage of machinery and equipment. In addition to this, there is also harvest insurance. This modality is supported by an estimate of how much will be produced in the period. In the event of a claim, if the production declared as affected is much higher than the initial estimate (around three times more), even if 100% of the production is affected, only part consistent with the assumption will be covered. It is important to point out that, for both cases, there are several risks excluded from coverage, such as pests and diseases, for example. In addition, there is also a maximum indemnity limit, stipulated according to the cultivar.
The most expressive operational risk, according to the results, is the lack/disqualification of the workforce, occupying the fourth position in *the ranking* of the degree of severity. As shown in Figure 8, the frequency of this event and the potential for loss were high. Floriculture is a detailed activity that requires specific technical knowledge related to planting, pruning, harvesting, and storage, in accordance with each species.



(a) Lack/Disqualification of the workforce

(b) Strike or interruption of highways or airports

Figure 8 – Boxplot related to the indicators of producers' perception in relation to the frequency and intensity of the economic loss of the main operational and institutional risk event.

Furthermore, some producers reported that their heirs were not interested in continuing the activity and, for this reason, sometimes, the investment in professional qualifications did not return to the business. According to Maia and Buainain (2015), the rural exodus caused by the search for schooling is a recurring aspect of Brazilian agriculture. This factor is one of the main reasons for a new family configuration in the countryside, in which the increase in the average age of rural workers is observed.
Inadequate management of inputs, soil and water, farm management problems, and labor processes, although not very frequent operational risk events, present a considerable degree of economic loss and, therefore, must not be neglected. Regarding human resources, the evidence obtained indicates satisfactory management, given that all provide individual safety equipment, 95% supervise its use, 90% control their approval certificate, approximately 85% carry out admission and dismissal exams and approximately 75% carry out periodic examinations on

their employees. All these measures added to the categorization of the workforce result in a low frequency of labor lawsuits.
The risk of the institutional environment was also present among the ten events with the highest degree of severity. Although strikes and road interruptions are not considered frequent events, when they occurred the economic impact was very expressive – Figure 8. In floriculture, especially cut flowers, perishability occurs not only in the post-harvest; given the cut-off point, there is no way to "hold" the plant's life cycle – the flower will bloom and, in a few days, will lose the essential characteristics for its commercialization, even if this plant remains in the soil.
Regarding credit risks, these were not shown to be preponderant events, since part of the sample is a member of a cooperative. These guarantee support to producers in the face of situations of default and ease of access to financing. In addition, independent producers reported that it is common practice to receive payment in advance or in cash and, therefore, also do not have problems with default.

5. Conclusions

Risk events expose agricultural activities to the possibility of damages and losses, and these are especially due to price fluctuations, weather conditions, the occurrence of pests and diseases, losses during the production and logistics process, especially resulting from disqualification of the handwork, inadequate storage or transport, changes in terms of access to credit, regulations, among other factors. Considering this scenario, anticipating the recognition of the possibilities of adverse events, the prospection of economic impact, the instruments that can be used to avoid, mitigate or face them, and the degree of vulnerability of the agents involved, is part of a management modality with a holistic and integrated approach, proposed by the methodologies developed by the World Bank, Mapa and Embrapa (2015), World Bank (2015a and 2015b) and OECD (2009).
Given the importance of building solid foundations for planning and executing an integrated risk management strategy, through a holistic approach, this study evaluated the main risk events present in the production of flowers and ornamental plants in the Holambra region – SP, identifying them and ordering them by a degree of severity. With a sample of 45 producers, results show the main characteristics of the producer, the property, and the production.
The present study found that, on average, producers are relatively young, have high schooling, and diversified income. Despite this, in the composition of family income, floriculture is responsible for almost 90% of income. In addition, production is characterized by small establishments, and the level of formal and permanent occupation was greatly influenced by the few large producers. In this study, most of the producers were dedicated to the cultivation of potted flowers and were members of a cooperative, mainly Veiling.
The risk events that deserve more attention, in order of greater severity, were: fluctuation in the price of the flower, pest incidence, plant diseases, lack/disqualification of labor, and wind. Of these, three events are linked to production risk and one to market risk, confirming the results of so many previous studies, which portray these risks as those that cause greater variability in rural producer income. The lack/disqualification of manpower, in turn, points to the need for greater efforts to avoid high-severity events. Faced with the peculiar characteristic of the floriculture activity, the complexity of its production stages, which differ according to the type of cultivation, it is suggested that interest groups work towards the development of a training program, aiming to explore not only improved and competitive practices but also encourage the maintenance of man in the countryside.
This study consists a first step toward the planning and execution of integrated risk management strategies applied to the activity of flowers and ornamental plants. Evidence was obtained, which support the development of risk management strategies by producers, as well as guide the formulation of policies for the public sector and the design of instruments by insurers.

It is worth noting, however, that the research has some limitations, which may serve as a stimulus for future research. Although the 45 producers represent 25% of the establishments that produce flowers and ornamental plants in a region that is considered the largest producer of flowers and ornamental plants in the country, the sample can be expanded and better stratified to capture the diversity of products and national flower producers. Furthermore, it would be important to include producers from other states in order to capture the diversity that goes beyond the Southeast region. In addition, the information obtained is limited to a period between the end of 2018 and the beginning of 2019, which raises the idea of carrying out a follow-up of producers in different years, in order to build panel data. Additionally, future research can explore the determinants of producers' risk perception, the use of management instruments, the characteristics of commercialization, among other aspects, according to the characteristics of the producer and his business.

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