



MANAGEMENT AND CONDUCT OF HOP VARIETIES FOR CRAFT BEER PRODUCTION IN CAMPOS DE CIMA DA SERRA / RS

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ABSTRACT

Objective: The general objective of this research was to evaluate the adaptation of hop plants (*Humulus lupulus* L.) in an experimental area located in the Campos de Cima da Serra region - RS, specifically in the municipality of Vacaria.

Theoretical Framework: Hop flowers are small and wind pollinated. Female plants have cone-like structures, 2.5 to 5 cm long, that develop shortly after pollination. They consist of overlapping, yellowish-green bracts attached to an axis. Mature strobili contain various chemicals in their lupulin glands (glandular trichomes) at the base of the bracts, which can be used in various industries, the best known, but not the only, being beer.

Method: The methodology was organized by hop cultivation, seedling production, vegetative evaluations, post-harvest evaluations and production of craft beer styles.

Results and Discussion: The cultivars analyzed are in their first year of production and have not yet reached their full potential. Appropriate management was implemented at the different growth stages, after which the crop was harvested and processed, and the production of craft beers was completed with sensory testing. Furthermore, additional seedlings were prepared for the next planting. Therefore, this project is still under development and aims to bring various relevant information to this production chain for the Southern region of Brazil.

Research Implications: Although small hop crops are already occurring throughout the country, there is little information about production, quality and factors faced by producers.

Originality/Value: This study contributes to the dissemination of hop culture in the State of Rio Grande do Sul.

Keywords: Experiment, Sustainability, Innovation, Adaptation.

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MANEJO E CONDUÇÃO DE VARIEDADES DE LÚPULO PARA PRODUÇÃO DE CERVEJAS ARTESANAIS NOS CAMPOS DE CIMA DA SERRA / RS

RESUMO

Objetivo: O objetivo geral dessa pesquisa foi avaliar a adaptação de plantas de lúpulo (*Humulus lupulus* L.) em uma área experimental localizada na região dos Campos de Cima da Serra – RS, especificamente no município de Vacaria.

Referencial Teórico: As flores do lúpulo são pequenas e polinizadas pelo vento. As plantas femininas têm estruturas semelhantes a cones, que têm 2,5 a 5 cm de comprimento e se desenvolvem logo após a polinização. Eles consistem em brácteas sobrepostas verde-amareladas presas a um eixo. Os estróbilos maduros contêm diversas substâncias químicas em suas glândulas de lupulina (tricomas glandulares) na base das brácteas, que podem ser utilizadas em diversas indústrias, sendo a mais conhecida, mas não a única, a indústria cervejeira.

Método: A metodologia foi organizada pelo cultivo do lúpulo, produção de mudas, avaliações vegetativas, avaliações pós-colheita e produção de estilos de cervejas artesanais.

Resultados e Discussão: As cultivares analisadas encontram-se no seu primeiro ano de produção, e ainda não expressaram todo seu potencial. Foi realizado o manejo adequado nos diferentes estágios de crescimento, após foi feita a colheita e o beneficiamento da cultura, e pôr fim a produção de cervejas artesanais com os testes sensoriais. Além disso, foram organizadas mais mudas para o próximo plantio. Portanto, esse projeto ainda está em desenvolvimento e pretende trazer várias informações relevantes para essa cadeia produtiva para a região Sul do Brasil.

Implicações da Pesquisa: Apesar de pequenos cultivos do lúpulo já estarem ocorrendo pelo país, são poucas as informações sobre a produção, qualidade e desafios enfrentados pelos produtores.

Originalidade/Valor: Este estudo contribui para a disseminação da cultura do lúpulo no Estado do Rio Grande do Sul.

Palavras-chave: Experimento, Sustentabilidade, Inovação, Adaptação.

GESTIÓN Y CONDUCCIÓN DE VARIEDADES DE LÚPULO PARA LA PRODUCCIÓN DE CERVEZA ARTESANAL EN CAMPOS DE CIMA DA SERRA / RS

RESUMEN

Objetivo: El objetivo general de esta investigación fue evaluar la adaptación de plantas de lúpulo (*Humulus lupulus* L.) en un área experimental ubicada en la región de Campos de Cima da Serra - RS, específicamente en el municipio de Vacaria.

Marco Teórico: Las flores del lúpulo son pequeñas y se polinizan por el viento. Las plantas hembra presentan estructuras cónicas, de 2,5 a 5 cm de largo, que se desarrollan poco después de la polinización. Consisten en brácteas superpuestas de color verde amarillento unidas a un eje. Los estróbilos maduros contienen diversas sustancias químicas en sus glándulas de lupulina (tricomas glandulares) en la base de las brácteas, que se pueden utilizar en diversas industrias, siendo la más conocida, aunque no la única, la cervecera.

Método: La metodología se organizó por cultivo de lúpulo, producción de plántulas, evaluaciones vegetativas, evaluaciones post-cosecha y producción de estilos de cerveza artesanal.

Resultados y Discusión: Los cultivares analizados se encuentran en su primer año de producción y aún no han alcanzado su máximo potencial. Se implementó un manejo adecuado en las diferentes etapas de crecimiento, tras lo cual se cosechó y procesó el cultivo, y se completó la producción de cervezas artesanales con análisis sensoriales. Además, se prepararon plántulas adicionales para la siguiente siembra. Por lo tanto, este proyecto aún está en desarrollo y tiene como objetivo traer diversas informaciones relevantes a esta cadena productiva para la región Sur de Brasil.



Implicaciones de la investigación: Aunque ya se producen pequeños cultivos de lúpulo en todo el país, hay poca información sobre la producción, la calidad y los factores que enfrentan los productores.

Originalidad/Valor: Este estudio contribuye a la difusión de la cultura del lúpulo en el Estado de Rio Grande do Sul.

Palabras clave: Experimentación, Sostenibilidad, Innovación, Adaptación.

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1 INTRODUCTION

Humulus lupulus L. occurs in temperate regions around the globe. It is currently concentrated in nine countries, and approximately two-thirds of the current area and three-quarters of world production is attributable to the US and Germany. Hops are very important for agriculture in Germany, the Czech Republic and, in particular, Slovenia. These countries have the highest values of monitored hops indicators per capita, including the export of hops (Kubeš, 2021).

The plant grows clockwise around any available support with the help of its robust downturned trichomes (hair), and can reach a height of more than 10 meters (Korpelainen; Pietiläinen, 2021). The leaves are opposite or alternating and have 3 to 5 lobes with serrated margins. The root system is large and requires a deep and well-drained fertile soil (Amoriello, 2019; Amoriello *et al.*, 2020).

The plant is perennial, can live about 50 years, its root system can penetrate 4 meters deep into the soil. It is considered a climbing plant, that is, in its growth stage, the plant rests on structures that are around it (Dagostim, 2019).

Its root system is permanent and its part of the area is renewed annually (Sposito *et al.*, 2019), but a study conducted by Acosta-Rangel, Agehara and Rechcigl (2024) demonstrated that, by manipulating the photoperiod to control the timing of flowering, it was possible to produce hops twice a year. The cultivar "Cascade" showed high phenological plasticity, allowing two annual growth cycles in subtropical climatic conditions. This discovery is remarkable because hops are harvested only once a year elsewhere. For producers, this implies the potential to raise additional revenues and improve land-use efficiency. For craft breweries, this means that newly harvested hops will be available twice a year, providing more opportunities for wet-hops beer production, which often boasts premium values due to its seasonality and unique flavors.



Hops flowers are small and wind-pollinated. Female plants have cone-like structures that are 2.5 to 5 cm long and develop soon after pollination. They consist of yellowish-green overlapping bracts attached to a shaft, which contain various chemicals in their lupulin glands (glandular trichomes) at the base of the bracts, which can be used in various industries, the best known, but not the only, brewing industry (Korpelainen; Pietiläinen, 2021).

The vegetative propagation of hops occurs when using parts of the mother plant for the formation of seedlings. "The seedlings produced in this way are plants similar (clones) to the mother plant, bringing with it all the characteristics of the variety and providing the formation of a uniform and productive orchard" (Sposito *et al.*, 2019, pg. 51). Vegetative propagation is essential to ensure that the resulting plants are clones of the chosen parent (Dodds, 2017).

According to Almeida and Conto (2024), currently hops are grown in 14 states in Brazil, especially Santa Catarina, Rio Grande do Sul and Paraná, totaling 75,000 plants throughout the country. Righi *et al.* (2024a), point out that in Serra Gaúcha and Serra Catarinense it is where high quality hops with high content of essential oils should be obtained, due to characteristics such as climate and altitude. Righi *et al.* (2023; 2024b), also point out that cold temperatures in winter, low wind intensity, high altitude and specific latitudes, however, crops in divergent conditions show that this crop has production potential even outside the conditions considered ideal.

Fagherazzi *et al.* (2023), analyzed several hop cultivars in the municipalities of Lages and São Joaquim, in the state of Santa Catarina. The observed results demonstrate that the hops develops in latitude 27° South, there was a difference in the behavior in the phenological cycle of the cultivars, characterizing Yakima Gold as early, with 143 days and Columbus with 191 days, late. Since the first agricultural harvest, there is production of cones. With an average solar luminosity of 5.87 hours per day, in Lages, 3,300 kg of fresh hops per hectare were produced. In São Joaquim, with an average solar luminosity of 5.53 hours per day, 6,000 kg of fresh hops per hectare were produced.

The main purpose of hops today is to be used as one of the fundamental ingredients in the manufacture of beers worldwide, this fact eventually aroused the interest of Brazilian producers, since most of the product used is imported. Thus, it is worth noting that the beers are divided according to the fermentation, and to each one, the hops confer a specific characteristic in measure of bitterness (Fergus; Graham, 2006).

These characteristics, such as aroma and bitterness of a beer are directly related to the quantity and quality of the hops dosage and the technology of brewing *the beer*. It is important to highlight that factors such as the variety of hops, the place and cultivation techniques, the



degree of maturation at the time of harvest, as well as post-harvest factors such as drying, *pelletizing* and storage can lead to variations in the proportion of the chemical composition of hops (Durello *et al.*, 2019).

Regarding the authors who work with the concept of craft beer, the most accepted definition is that they are produced on a small scale, by a relatively slow fermentation process (greater than 21 days), being the most refined manufacturing process, based on noble raw materials, selected and with high added value. A central element of the work of artisanal beverage producers is the organization of cultural value and participation in communicative and performative acts that attribute this value to the products and people involved in their manufacture (Thurnell-Read, 2019).

In the approach of craft beer production in Brazil, one of the biggest problems refers to the scarcity of theoretical information, scientific definitions and updated and coherent statistical data on its size and form of insertion in the economy, which constitutes a serious difficulty for the formulation of policies to stimulate the growth of this sector.

Therefore, although small hop crops are already occurring throughout the country, there is little information on production, quality and factors faced by producers. Knowing this, this work intends to evaluate the adaptation, together with the production, and characteristics of the hop culture in the state of Rio Grande do Sul.

In addition, the advancement of hop production in the coming years will be conditioned to the introduction of new high-yield varieties and the dynamics of the cultivated area, which may be expanded or reduced due to fluctuations in price, crop profitability and brewery demand (Kubeš, 2021).

In this sense, the general objective of this research is to evaluate the adaptation of hop plants (*Humulus lupulus L.*) in an experimental area located in the region of Campos de Cima da Serra - RS, specifically in the municipality of Vacaria.

2 METHODOLOGY

2.1 HOPS CULTIVATION

The experiment was conducted in the experimental area of Uergs. The experiment began in 2024/2025, to carry out the project, 36 seedlings of 4 varieties of the plant were planted, namely: Chinook, Northern Brewer, Saaz and Hallertauer Perle.



For this, an area of 30 meters long by 10 meters wide was previously prepared, occurring liming of the soil according to the technical recommendation. For the conduction of the plant, a support structure was installed. Where 9 posts were used. As it was the first harvest, there was a significant loss in the experimental area, requiring the production of seedlings and again the replanting in the experimental area for the 2025/2026 harvest.

2.2 TECHNIQUES TO BE PERFORMED FOR SEEDLING PRODUCTION

The vegetative material was collected from mother plants (mother) maintained in the experimental area. The herbaceous cuttings were conducted in plastic pots. The irrigation system was done manually inside the University Unit greenhouse. The substrate used was commercial organic.

Thus, it was possible to observe the percentage of survival, number and length of budding and the length of the largest root per cutting.

2.3 VEGETATIVE ASSESSMENTS

For these analyzes it was verified:

- Plant height (m): measured with the aid of a tape measure, covering the length of the base of the plant until the insertion of the last leaf produced, evaluated once per month.
- Height of insertion of the first lateral branch containing cone production (m): measured with the aid of a metric tape measure, covering from the base of the plant to the first insertion of the lateral branch containing cone production;
- Cone index (cone.cm-): counting the number of cones of a lateral branch, divided by the length of the lateral branch, with the aid of a metric tape measure;
- Possible damage to leaves or cones, caused by insects: observation during all stages of the plant cycle.

2.4 POST-HARVEST EVALUATIONS

For these analyzes it was verified: - Fresh mass of ten cones (g); - Number of cones; - Production per plant (kg plant⁻¹); and, - Estimated productivity (kg ha⁻¹).



2.5 PRODUCTION OF CRAFT BEER STYLES

The *Beer Style Guidelines*, version 2024, released the 2024 Beer Style Guidelines (BJCP, 2024). In this sense, some styles were chosen and manufactured with hops produced in the experimental area.

3 RESULTSS AND DISCUSSÕES

In October 2024 began the process of maintenance and control of hops in the experimental area. Adequate management was carried out at the different stages of production in the crop and periodically evaluated the development of the plants. The fertilizer used was the organomineral throughout the cycle of the plants, so we can say that the production was more sustainable. The organic part of the fertilizer improves the soil structure, increases the ability to retain water and nutrients, and stimulates the activity of beneficial microorganisms.

Proper management was also carried out at the different stages of the plants and no disease or pests were verified. The good health observed may be related to the fact that this was the first year of hop cultivation in the experimental area, reducing the initial pressure of pests and pathogens.

The Field Guide "*Field Guide for Integrated Pest Management in Hops*" developed by several technicians from different universities in the United States (Gent *et al.*, 2010), describes some pests that cause damage in hop crops. Noteworthy are mites, aphids, California prionus beetles, caterpillars, root beetles and slugs.

Irrigation was done manually with hoses, drip was not installed because there are few plants in this first year of planting. Guimarães (2020), stresses that the importance of water supply in the development phase of hops by irrigation, has been used in growing areas since the nineteenth century. In the context of irrigation, water quality is an important factor and, when not given due attention, can cause deleterious effects on the irrigation system, soil and plant.

In this sense, in his work Guimarães (2020), emphasizes that the cultivation of hops requires an adequate supply of water, especially in the development phase, which involves the formation and growth of lateral branches, flowering, formation of inflorescences and maturation of cones.

Gonzalez-T (2025), investigated the effects of irrigation on hops in the Yakima Valley in the United States. The author concluded that a failure in irrigation at the end of the season caused significant physiological changes in plants, including reduction of stomatal



conductance, transpiration and photosynthetic efficiency, despite soil water levels remaining above critical levels. The suspension of irrigation 15 days before harvest reduced productivity moderately (9.5%), while at 30 days, the failure caused more severe declines (28.8%), emphasizing the vulnerability of hops to a failure in irrigation at the beginning of the stage of formation of the lupulina gland. Despite these challenges, bitter compounds such as α -acids and β -acids showed exceptional stability in all irrigation regimes, suggesting that stress due to a failure in irrigation or drought conditions do not significantly compromise beer quality.

In November 2024, the area was maintained and the truss system was installed, consisting of galvanized wires fixed on the wooden poles, to which wires that support the hops plants were connected. This system makes it possible for the plants to wrap themselves around the threads and to grow in a vertical direction, favoring the development of cultivation.

According to Creuz and Kretzer (2022), the "V" high truss conduction systems vary in height, line spacing, spacing between plants, according to the location, variety and intended harvesting method. The vigor of the cultivars and the growing conditions determine the height at which the hops will grow and, consequently, determine what should be the upper height of the trellis. There is no specific rule to determine the spacing between plants on the line and between planting lines. Experiments with the culture, cultivar and the place of cultivation, play a significant role in this decision.

Marceddu *et al.* (2024) evaluated the productive performance of the "Cascade" and "Chinook" hop varieties in "V" systems at different heights (2.60, 3.60 and 4.60 m above ground) in the climate and in the Mediterranean soil conditions of Sicily. The results highlighted the significant impact of height on several parameters, with Cascade showing exceptional adaptability to low system cultivation. Key factors such as stem and leaf weight emerged as crucial determinants of cone yield, emphasizing its importance in hop cultivation.

In the first year after planting hop cultivars, shoot growth tends to be limited, since the plant directs much of its energy to the establishment of the root system. Despite this, most plants exceeded 7 meters in height and all cultivars showed adequate adaptation to local conditions. The authors, Spósito *et al.* (2019, pg. 27), point out that "the branches of hops have indefinite growth and can reach a length of 8 to 9 meters. As the branches grow, they become thicker and lignified from the base of the plant."

Neves *et al.* (2024), found that for the region of São Paulo, the highest quantum yield and effective yield were obtained with the cultivars Comet and Nugget. Comet presented the best morphometric results related to vegetative development, but did not present such high productive performance, while Cascade was the variety with the best productivity.



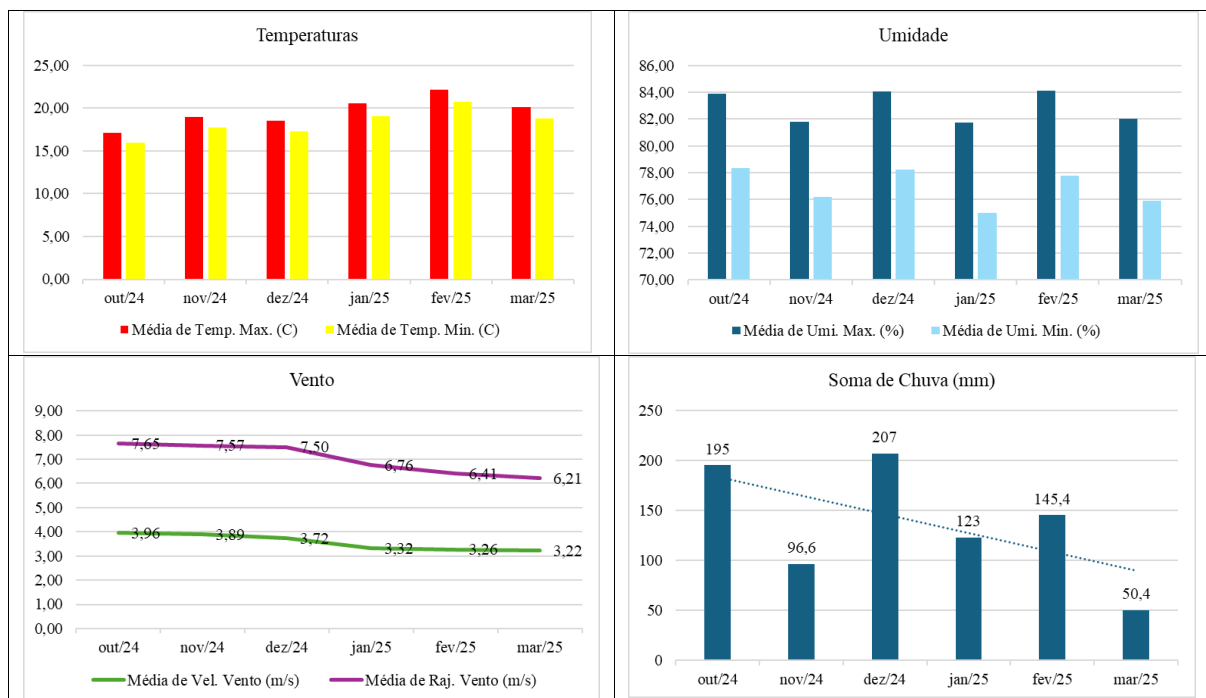
Thus, the images that illustrate the processes and follow-ups described in the experimental area are presented in Table 1.

Table 1

Management carried out in the experimental area in the 2024/2025 harvest.

	
Organization of the experimental area and planting of cultivars.	Installation of the guide wires.
	
Manual irrigation system.	Growth of cultivars.

Regarding the influence of local climatic conditions on plant growth, it can be noted that the main parameters were presented at optimal levels (Table 2). The daily data were obtained from the database of the National Institute of Meteorology (INMET), the automatic station VACARIA A880, through the link: <https://tempo.inmet.gov.br/TabelaEstacoes/A880>.

**Table 2***Climatic variables for the 2024/2025 season of the automatic station located in Vacaria.*

In some regions of the world, climatic variations in hop culture have been set as a warning. Potopová *et al.* (2020) found that more than 62.7% of total yield losses were due to high temperatures in dry conditions and that 21.5% of yield losses were due to dry-cold conditions in the main hop growing regions. Warmer European droughts caused reductions in noble aromatic hops by 29–68%. This indicates that hop yields are very vulnerable to these events due to a slower rate of adaptation of hops compared to field crops.

Harvesting of some plants started in March 2025. Then, the hop plants were cut. While the cones were harvested, dried and packaged for the production of craft beer in the laboratory, stems and leaves (hop biomass after harvesting) were used in the production of new seedlings.

Several harvests were carried out in the experimental area, respecting the time of ripening of the cones (Tables 3). A total of 4,842 cones were harvested from all cultivars, with an average of 3 centimeters in length, the wet weight was approximately 1.6 kg and the dry weight of approximately 350 g. The Northern Brewer cultivar was the one that stood out the most in this first year (Table 4).



Table 3

Harvest of hops in the 2024/2025 harvest.



The hops were stored in the form of flowers (cones) in appropriate packaging and kept under refrigeration, aiming at their later use in the production of craft beers. This format was the one used, because according to Ceola and Savaris (2024), the pelletizing process reduces key compounds such as essential oils and alpha acids, which contribute to the quality of hops for beer production.

Ceola and Savaris (2024), organized a comparison between hops stored in flower, powder and pellet, and found a consistent reduction in essential oil content, alpha acid percentage and moisture as the degree of processing of hops increased from flower to powder and pellet.

**Table 4***Hops harvest and post-harvest data for the 2024/2025 harvest.*

Northern Brewer					
Date of harvest	Fresh weight - g	Drying end date	Dry weight - g	Cone quantity	Medium size cones (cm)
March 2025	1217 g	01/04/2025	279	3247	3 cm
Chinook					
Date of harvest	Fresh weight - g	Drying end date	Dry weight - g	Cone quantity	Medium size cones (cm)
March 2025	67 g	01/04/2025	23	219	2 cm
Saaz					
Date of harvest	Fresh weight - g	Drying end date	Dry weight - g	Cone quantity	Medium size cones (cm)
March 2025	67	01/04/2025	16	208	2
Hallertauer Perle					
Date of harvest	Fresh weight - g	Drying end date	Dry weight - g	Cone quantity	Medium size cones (cm)
March 2025	206	01/04/2025	34	570	2.5

Hops seedlings were also made by cuttings, because they guarantee plants identical to the matrix and it is already known that they are productive females (Table 5). In this way, a significant number of high quality seedlings with organic fertilization were produced, without insertion of chemicals or hormones, in a greenhouse and manual irrigation, which were used in the replanting of the experimental area.

Silva *et al.* (2023), evaluated the influence of different light supplements on the production of hop seedlings in the greenhouse. The authors found that the responses are different among the cultivars used, but light supplementation increases variables related to physiological processes and seedling growth.

Dementiev, Ivanova and Fadeev (2020), applied tests of biological fungicides and growth stimulators. The number of surviving seedlings increased by at least 11%, on average, during 2 years when exposed to cuttings with water, and by up to 32.8% with the use of biofungicide.



Table 5

Seedling production and replanting in the experimental area.

 Seedlings in March 2025.	 Seedlings in March 2025.
 Replanting in September 2025.	 Replanting in September 2025.

From the *Beer Style Guidelines*, a craft beer style was produced, which was the American IPA. In this first test, 19 liters were produced, which underwent the maturation process within the fermenters, in order to stabilize the beverage. This process lasted on average 7 days at room temperature, more approximately 6 days at low temperatures (zero degrees), and finally, another 10 days inside the bottle.

A questionnaire was applied to evaluate sensorially two beers produced according to acceptance tests for the students of the Agronomy course. The questionnaire was presented to the participants as well as the Informed Consent Form (TCLE), duly authorized by the Research Ethics Committee (CEP) of UERGS. The project and approved documents are registered under CAAE number: 56814022.6.0000.8091 and opinion number: 5.419.880.



Therefore, it was found that beer has technical rigor of production, flavor and aroma. Thus, demonstrating the economic viability of hops in the experimental area (Table 6).

Table 6

Artisanal beer production with hops in the 2024/2025 harvest.



Ferreira *et al.* (2019) found that by analyzing the meanings and emotions attributed by consumers to craft beers, the act of consuming and themselves as connoisseurs and consumers of the beverage, it was possible to identify themes to be addressed in marketing campaigns by companies in the field. Other studies comparing consumers from different countries can identify different symbolic-identity relations and relate them to broader cultural dimensions.

Ceretta *et al.* (2022) observed a region in the state of Rio Grande do Sul and found an average consumption of craft beers once a week, especially on weekends, averaging one liter per person, higher prevalence of consumption at home, in moments accompanied by friends, boyfriends or spouses. The most assiduous consumers are men, with medium high remuneration and who normally produce their beer and consider the product something functional, interesting, exciting and fun.

4 CONCLUSION

The cultivars analyzed are in their first year of production, and have not yet expressed their full potential. Proper management was carried out at the different stages of growth, after harvesting and processing of the crop, and ending the production of craft beers with sensory tests. In addition, more seedlings were organized for the next planting. Therefore, this project



is still under development and intends to bring several relevant information to this production chain.

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