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Value Creation In Sustainable Production Chains: A Study Of Yerba Mate In Brazil

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Abstract: The tea market is growing worldwide because consumers consider products to be natural and healthy. In Brazil, the main tea consumed is yerba mate and the largest producing state is Paraná. The product is gaining market share in the United States and Europe because of its pharmacological properties. The general objective of the present study was to characterize the productive chain of yerba mate in the main producing state, Paraná, and to estimate the generation of value and participation of the various economic agents. The results showed that the yerba mate production chain generated around 1.3 billion reais in income and 23,000 jobs in the state of Paraná in 2018, which contributed significantly to the preservation of the forest and income for rural producers. The increase in the processing margin of yerba mate producers would be possible with the mastery of part of the processing, mainly heating in the fire (*sapeco*) and crushing (*cancheamento).*

Keywords*: Yerba mate; Sustainability; Marketing margin; Income generation.*

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I. Introduction

The tea market is growing in the world especially because they are considered natural and healthy products. In Brazil, the main product consumed is mate tea, which is produced from yerba mate (Ilex paraguariensis) (Godoy et al., 2013). The product has several pharmacological properties, including antioxidant, anti-inflammatory, antimutagenic, anti-obesity and cardioprotective functions (Gómez-Juaristi et al., 2018). These benefits are related to a unique chemical composition, including alkaloids, polyphenols, terpenes and essential oils, among other substances beneficial to health (Mateos et al., 2018; Riachi et al., 2018).

Mate tea is being increasingly consumed in other parts of the world, especially in the United States and European countries that have immigrants from South America. The diversity of products based on this product makes possible the expansion of consumption, such as iced and energy drinks (Heck & Mejia, 2007). In addition to traditional yerba mate drinks, concentrated extracts are used in the pharmaceutical, cosmetic and food industries (Gawron-Gzella et al., 2021).

The biggest producers of yerba mate are Brazil, Argentina and Paraguay. In Brazil, the world's largest producer, the production of yerba mate occurs predominantly in the South Region, comprising the states of Paraná, Santa Catarina and Rio Grande do Sul, with Paraná having more than 80% of national production in 2021 (Croge et al, 2021). In the southern region of Brazil is the Rainforest, or Araucaria Forest, which is predominantly composed of pine trees where perennial yerba mate plants naturally grow in the shade. Thus, the traditional type of cultivation is extractivism, where producers use native mate plants. The second type of cultivation is the one where the number of plants in the remaining forest is densified through planting. The third type of cultivation is called full sun, in which yerba mate is a monoculture or can be produced in association with other plants or even animals. However, yerba mate grown in full sun usually has lower quality leaves than that grown in the shade of the forest (Marques et al., 2014; Pires et al., 2016, Croge et al., 2021).

Extractive or dense production systems are considered organic, as producers cannot use chemical products such as fertilizers and pesticides. Pest control is carried out exclusively through biological control and the industrialization process does not use chemical substances. Most of the product is marketed in the country with exports mainly to Argentina, the United States, Uruguay and Europe.

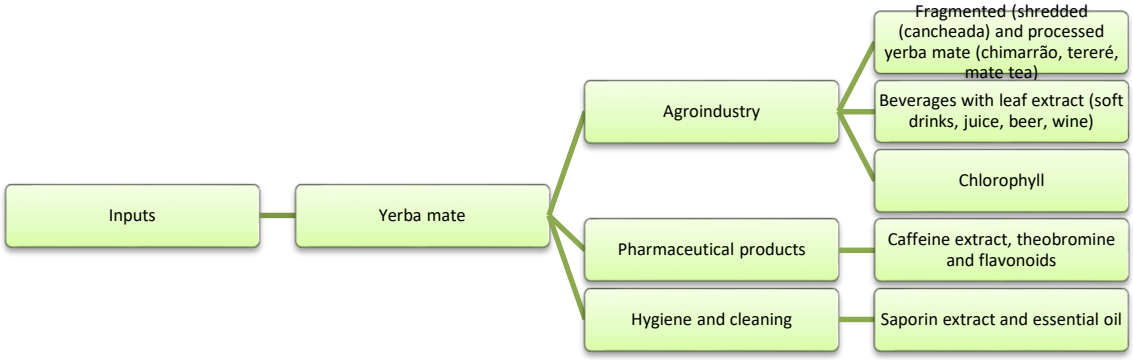
The general objective of the present study was to characterize the yerba mate production chain in the world's main producing state, Paraná, and estimate the generation of added value and the participation of the various economic agents. Specifically, it is intended to: (a) Describe the yerba mate production chain in the state of Paraná, its economic agents, by-products and marketing channels and (b) Estimate the generation of added value and participation of each link in the production chain to analyze the possibilities of new marketing channels and benefits for society from sustainable production.

II. The Production Chain of Yerba Mate

Agribusiness can provide raw material for industry, food for the population, savings for investment, expansion of markets for its products and export revenue (Delgado et al., 1998). It can be defined as the set of food and fiber production, processing and distribution activities, and divided into four aggregates: agricultural inputs, agriculture, processing and distribution (Davis & Goldberg, 1957). The agribusiness production chain is a process of adding value, in which the raw product from agriculture and livestock is industrialized and originates several by-products with greater added value, which includes the addition of transport services, advertising, cold chain for its conservation and other customer service services (Leones et al., 1994; Reardon & Barret, 2000; Pingali, 2007).

Figure 1 illustrates the yerba mate agribusiness's production chain. Agricultural inputs, whether for the extractive system, densification (increase the density of the number of plants in the forest) or planting in full sun, correspond to all the inputs necessary for production, which correspond to intermediate goods and services necessary for the production process in the field. Agricultural production encompasses agricultural and extractive production, with extractive or thickened yerba mate being considered of higher quality due to its development in the shade, with a softer and less bitter drink and earning a higher price than the value of yerba mate planted (Teixeira, 2006 and Croge et al., 2021).

Figure 1: Yerba mate productive chain.



Source: based on Teixeira (2006).

The main industrial link in the production chain refers to the production of preparations for making *chimarrão (hot water infusion)*, *tereré* (cold water infusion) and tea (ground and toasted leaf). The so-called *ervateiras* (processing industries) are industries whose process consists of drying and grinding yerba mate to obtain the basis for preparing drinks. To produce the shredded *(cancheada)* herb, the green leaves from the field undergo a process of heating in the fire (*sapeco*) and then crushing and drying. The shredded herb *(cancheada)* can be ground (benefited herb) and used for *chimarrão* (hot water infusion) or later roasted (toasted mate tea). Yerba mate can be used to produce an extract that will serve as the basis for various beverages, the main one being iced mate tea, or chlorophyll extraction used in the agro-food industry (pigment and preservative). The pharmaceutical industry uses by-products such as caffeine extract, theobromine and flavonoids with different effects on the organism (nervous system stimulant, compound for treating hypertension, bronchitis and pneumonia). Other by-products are saporin and essential oil, the former is used as an emulsifier and the latter as a bactericide and sterilizer (Teixeira, 2006, Croge et al., 2021 and Gawron-Gzella et al., 2021). The existence of many by-products that can be obtained from yerba mate shows the versatility of its use. However, its main use is the production of beverages.

IV. Material and Methods

Margin of trade

According to Marques and Aguiar (1993), the commercialization margin is the difference in prices practiced between different links in the production chain. As an example, you can define the price paid (Pp) and the sale price (Pv) within one of the links in the production chain. The margins to be calculated can be defined as:

Absolute Margin (MA):

$$MA = Pv - Pp \quad (1)$$

Relative margin (MR):

$$MR = \left(\frac{Pv-Pp}{Pv}\right) \times 100 \quad (2)$$

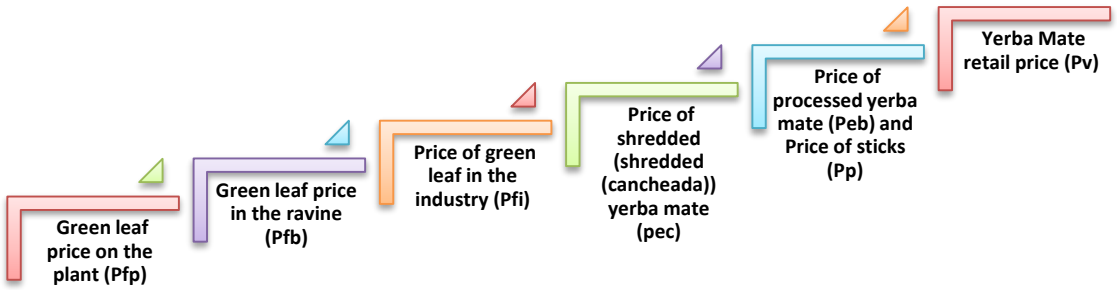
Markup (MK):

$$MK = \left(\frac{Pv-Pp}{Pp}\right) \times 100 \quad (3)$$

The calculation of the commercialization margin must consider the equivalent quantities in the different market levels, that is, the losses and transformations along the commercialization chain. In addition, the existence of several by-products must take into account the apportionment of the acquisition cost of the raw material, normally by weight participation in the total of by-products. The commercialization margins reflect the risk of losses, handling, added value by processing, technological level and transportation costs. Therefore, the commercialization margin should not be understood as the profit of the economic agent, but a process of adding value between the different links of the production chain.

Figure 2 illustrates the different links in the yerba mate production chain. It is possible to calculate the margins of the processes and marketing of yerba mate along this chain with the data in Figure 3. Note that the processing of an arroba (15 kg) of green leaves of yerba mate (15kg) will transform (after sapeamento, drying and *cancheamento*) in 7.1kg of stuffed yerba mate (4.6kg of leaves and 2.5kg of sticks). Part of the sticks is mixed with the product (leaves) resulting in 5.8kg of processed yerba mate and 1.3kg of sticks remaining. The sticks are mixed with the final good because they serve as a pump filter in the *chimarrão* (hot water infusion) or *tereré (infusion in cold water)* (Matieski, 2015).

Figure 2: Prices formed in the yerba mate production chain.



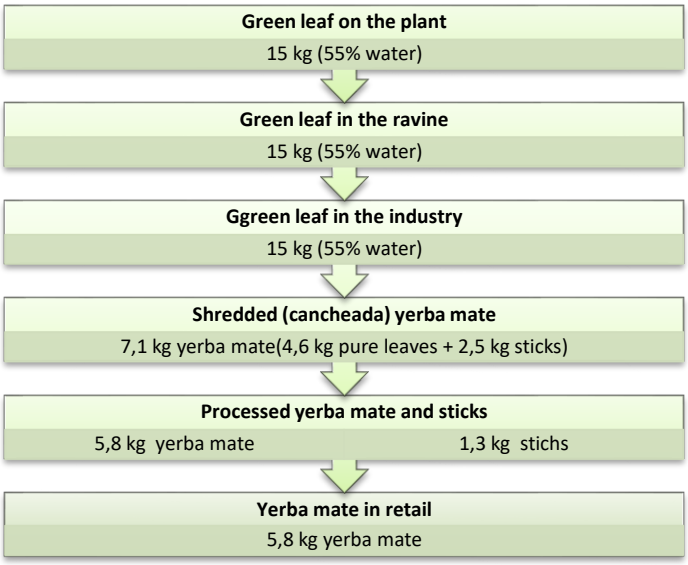
Rural producers may have part of the machinery for the initial industrial process (*cancheamento*) on their property, therefore, they carry out the *sapecamento*, drying and grinding of the raw material and sell yerba mate to the industry. The herbal industries can be of three types:

A. *Cancheamento* industries (drying and crushing): they acquire yerba mate from their own or third-party plantations and produce *shredded (cancheada)* yerba mate that they sell to processing companies,

B. Processing industries: purchase *shredded (cancheada)* yerba mate and produce processed yerba mate and sticks,

C.Full-cycle industries: they acquire yerba mate from their own or third-party herbs and produce processed yerba mate and sticks,

Figure 3: Quantitative transformations in the yerba mate production chain.



Sizing of agribusiness

Brazil's Paraná-Remainder input-output matrix for the year 2018 was prepared based on the methodologies described in Guilhoto and Sesso Filho (2005), Guilhoto and Sesso Filho (2010) and Guilhoto et al. (2010). The inter-regional input-output model, also called the Isard (1951) model based on Leontief (1951), requires a large amount of data on regional and inter-regional intersectoral flows. Data referring to the yerba mate production chain and the state of Paraná were obtained from IPARDES (2023). Carbon emission data were obtained from the OECD (2023).

The methodology used in the present study for dimensioning the yerba mate agribusiness was adapted from Furtuoso et al. (1998) and Bajan & Mrówczynska-Kaminska (2020), who use the input-output matrix. The method is based on the division proposed by Davis and Goldberg (1957) into four parts or aggregates. Thus, the aggregate (I) represents the inputs, the aggregate (II), the production of yerba mate (cultivated and extractive), the aggregate (III) represents the agroindustry and the aggregate (IV), the services.

The agribusiness GDP measurement method considers that the first aggregate is the inputs for the Cultivated Yerba Mate and Yerba Mate Extractive and Densification sectors, which were disaggregated from the Agriculture and Forestry sectors, respectively. Aggregate II are the sectors that produce yerba mate. The sectors of cluster III (yerba mate processing), which was disaggregated from the Other food products sector. Aggregate IV refers to sectors related to trade and services.

The calculations presented in this section refer to the size of the yerba mate agribusiness in terms of GDP, and the estimates for other variables (employment, production) follow the same procedure. The measurement of aggregate I is carried out by Eq. 4, which begins by multiplying the values of the columns of inputs used by the Yerba Mate sector (aggregation of cultivated and extracted Yerba Mate) by the respective added value coefficients (CVAi), where i = number of sectors of the economy. The GDP of aggregate I is calculated by:

$$\mathrm{PIB_I} = \sum_{i=1}^{n} z_i \times \mathrm{CVA_i} \quad (4)$$

$\mathrm{PIB_I}$ is the GDP of aggregate I (inputs),

z_i is the total input value of sector i to produce yerba mate (cultivated or native) and

$\mathrm{CVA_i}$ is the added value coefficient of sector i.

Value Added Coefficients ($\mathrm{CVA_i}$) are obtained by dividing the Value Added at Market Prices for each sector ($\mathrm{VA_{PM_i}}$) by the respective production (X_i), according to Eq. 5:

$$\mathrm{CVA_i} = \frac{\mathrm{VA_{PM_i}}}{X_i} \quad (5)$$

Value Added at market prices ($\mathrm{VA_{PM}}$) is obtained by adding value added at basic prices ($\mathrm{VA_{PB}}$) to net indirect taxes (IIL). Therefore, we have $\mathrm{VA_{PM}} = \mathrm{VA_{PB}} + \mathrm{IIL}$.

The measurement of Aggregate II is carried out in Eq. 6, which considers the Added Value of the Yerba Mate Production sector in the calculation and subtracts the added value of agricultural inputs used by the sector itself. It then follows that:

$$\mathrm{PIB_{II}} = \mathrm{VAA_{PM}} - z_1 \times \mathrm{CVA_1} \quad (6)$$

Where:

$\mathrm{PIB_{II}}$ is the GDP of aggregate II (cultivated Yerba Mate and extracted Yerba Mate),

VAA_{PM} is the Added Value of the Yerba Mate sectors (cultivated and extracted) and the other variables are as previously defined and

z_1 x CVA_1 is the value of the yerba mate production input used in the field.

Aggregate (III) covers agro-industry (yerba mate processing). The measurement of Aggregate (III) is carried out in Eq. 7 by the sum of the added value of the Yerba Mate Processing sector subtracted from the added value of the sector used as an input of the Aggregate (II). It then follows that:

$$PIB_{III} = \left(VA_{PM_i} - z_i \times CVA_i\right) \quad (7)$$

Where:

PIB_{III} is the GDP of the aggregate (III) of the industry.

The measurement of the Aggregate (IV) performed by Eq. 8 takes into account the Added Value of the sectors related to Transport, Commerce and Services. The portion related to the yerba mate agribusiness of the total Added Value of these sectors is calculated by the share of agricultural and agroindustrial products in the final demand for products. The process of calculating the Value Added of the IV Aggregate starts with the definition of the Final Domestic Demand (DFD):

$$DFD = DFG - IIL_{DF} - PI_{DF} \quad (8)$$

DFD is the domestic final demand,
DFG is the global final demand,
IIL_{DF} are the net indirect taxes paid by final demand and
PI_{DF} are the products imported by final demand.

The trade margin of the transport, commerce and services (MC) sectors is calculated by Eq. 9:

$$MC = VAT_{PM} + VAC_{PM} + VAS_{PM} \quad (9)$$

MC is the marketing margin,
VAT_{PM} is the added value of the transport sector at market prices,
VAC_{PM} is the added value of the trade sector at market prices and
VAS_{PM} is the added value of the services sector at market prices.

The commercialization margin (MC) and the Final Domestic Demand (DFD) are used in the calculation of the aggregate of Commerce and Services (Distribution of agribusiness products) and the added values of the commerce and services sectors that were used as inputs of the Aggregate (II), according to Eq. 10:

$$PIB_{IV} = MC \times \frac{DF_A + \sum_{i=1}^{k} DF_k}{DFD} - \sum_{i=1}^{q}(z_i \times CVA_i) \quad (10)$$

PIB_{IV} is the GDP of aggregate IV,
DFD is the domestic final demand,
DF_A is the final demand of agriculture,
DF_K is the final demand of the processing sector (k≥1, depending on the number of agro-industrial sectors),
q = number of trade and services sectors.

The total GDP of Agribusiness is given by the sum of its aggregates in Eq. 11:

$$PIB_{AGRO} = PIB_I + PIB_{II} + PIB_{III} + PIB_{IV} \quad (11)$$

PIB_{AGRO} is the Agribusiness GDP.

IV. Results and Discussion

Marketing margins

Table 1 has the average prices in the state of Paraná in the different links of the yerba mate production chain, from the data it is possible to calculate the absolute, relative and markup sales revenues and margins, which are in Tables 2 to 5. Recipes (Table 2) were obtained from processing one arroba (15kg) of yerba mate from the field and the transformations in Figure 3 were considered.

Table 3 shows the absolute marketing margins, the price differences between yerba mate in the foot and in the ravine reflect the cost of harvesting, while the margin between yerba mate in the ravine and in the industry should reflect the cost of transport. The highest values of absolute margins refer to filling and retail sales. The *cancheamento* process involves *sapeco (heated in the fire)*, drying and crushing; these initial processing steps are very important for the quality of the final good, as *sapeco (heated in the fire)* (leaf exposure to fire) must be carried out as soon as possible to dry, clean and paralyze the enzymatic activity that can deteriorate the raw material. Drying and grinding are also important to have a product with a softer and less bitter taste.

Table 4 shows the relative margins for processing and marketing yerba mate in Paraná. The yerba mate leaf presents greater volatility of the relative margin, either in the foot, in the ravine or in the industry. This shows

that the producer price varies more over time than in other links in the production chain. The highest values of relative margin and with the lowest volatility refer to the trimming process, values approaching 50%. This means that half of the sale price of the yerba mate that has been *shredded (cancheada)* is a marketing margin. The relative margins of processed yerba mate over the last four years are close to 25-30% and retail between 28% and 32%.

Table 5 shows the markup values for the processing and commercialization of yerba mate in Paraná. The markup for *shredded (cancheada)* yerba mate is the highest, close to 100%, which means that the value of yerba mate doubles after this step in the marketing chain. In retail, the markup is 30-40%, in processing 30-45%, yerba mate in the ravine 13-17% and the leaf in the industry has a markup between 27-35%.

The results show that the *cancheamento* process presents the highest commercialization margins. Producer prices show greater volatility, which contributes to income instability (Conto & Hoeflich, 1997). Furthermore, price formation shows that downward price variations impact the industry less than the producer (Balcewicz & Hoeflich, 2000). In the case of industry, it is interesting to cover the processes of curing and processing, in order to obtain the total industrial margin. Backwards verticalization with the herbs themselves is a strategy to guarantee raw material in quantity and quality, considering the perishability of mate leaves. In the case of the producer, mastering the initial processing can increase their margins and guarantee the quality of their product to be delivered to the processing industry.

The shares of yerba mate leaf in industry, *cancheamento (crushing)*, processing and retail in the consumer price in 2020 are illustrated in Figure 4. It can be said that the value added along the production chain is relatively equitable compared to other industrialized agricultural products, such as coffee, for which most of the value generation belongs to the trade and services sectors (Sesso et al., 2021). The conclusions obtained from the average values for Paraná are the same when the commercialization margins are calculated for the different cities in the data of the Secretary of Agriculture, such as Guarapuava, Laranjeiras and Ponta Grossa.

Table 1: Average prices of yerba mate and by-products in the state of Paraná, database of the Secretary of Agriculture of the state of Paraná. One arroba equals 15 kg.

Product	Unit	2013	2014	2015	2016	2017	2018	2019	2020
Yerba mate leaf in the tree	R$/arroba (15kg)	7.76	15.93	11.74	10.22	9.32	9.93	11.65	11.93
Yerba mate leaf in the ravine	R$/arroba	10.92	19.31	14.97	13.06	12.54	13.63	15.06	15.17
Yerba mate leaf in the industry	R$/arroba	12.45	21.15	17.35	14.97	14.48	15.44	17.63	17.15
Shredded (cancheada) yerba mate	R$/kg	3.06	5.67	4.97	4.29	4.23	4.38	4.56	4.72
Processed yerba mate	R$/kg	4.39	7.52	7.46	7.40	7.32	7.19	7.44	7.46
Yerba mate sticks	R$/kg	0.62	1.19	1.19	0.90	0.91	1.08	0.99	0.64
Yerba mate in the retail market	R$/kg	5.39	10.39	10.74	10.53	10.54	10.64	10.71	10.39

Table 2: Recipes from the processing and commercialization of yerba mate in the state of Paraná.

Product	Quantity (kg)	2013	2014	2015	2016	2017	2018	2019	2020
Yerba mate leaf in the tree	15	7.76	15.93	11.74	10.22	9.32	9.93	11.65	11.93
Yerba mate leaf in the ravine	15	10.92	19.31	14.97	13.06	12.54	13.63	15.06	15.17
Yerba mate leaf in the industry	15	12.45	21.15	17.35	14.97	14.48	15.44	17.63	17.15
Shredded (cancheada) yerba mate	7.1	21.74	40.27	35.29	30.46	30.03	31.06	32.36	33.51
Processed yerba mate	5.8	25.48	43.64	43.27	42.94	42.46	41.70	43.12	43.27
Yerba mate sticks	1.3	0.81	1.54	1.55	1.17	1.18	1.40	1.28	0.83
Processed yerba mate plus sticks	7.1	26.29	45.19	44.82	44.11	43.64	43.10	44.41	44.10
Yerba mate in the retail market	5.8	31.24	60.27	62.29	61.07	61.13	61.72	62.14	60.26

Table 3: Absolute margins of yerba mate processing and commercialization in the state of Paraná.

Product	2013	2014	2015	2016	2017	2018	2019	2020
Yerba mate leaf in the tree	-	-	-	-	-	-	-	-
Yerba mate leaf in the ravine	3.16	3.39	3.23	2.84	3.22	3.70	3.41	3.24
Yerba mate leaf in the industry	1.53	1.84	2.38	1.91	1.94	1.81	2.57	1.98
Shredded (cancheada) yerba mate	9.29	19.12	17.94	15.49	15.55	15.63	14.73	16.36
Processed yerba mate plus sticks	4.55	4.92	9.53	13.65	13.61	12.03	12.05	10.59
Yerba mate in the retail market	5.76	16.63	19.02	18.14	18.68	20.02	19.02	16.99

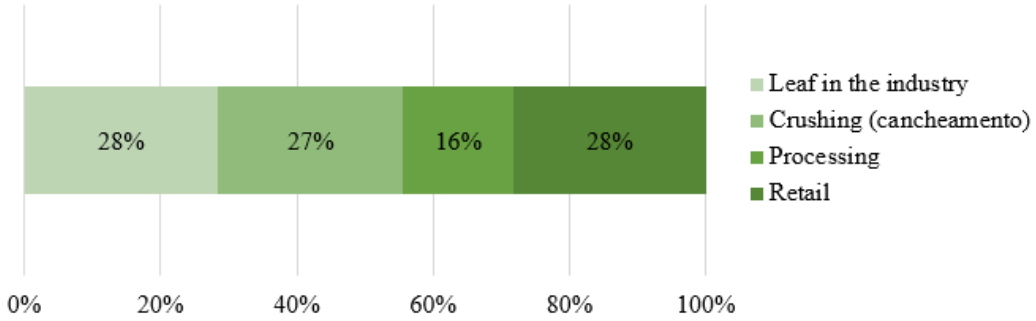
Table 4: Relative margins of yerba mate processing and commercialization in the state of Paraná.

Product	2013	2014	2015	2016	2017	2018	2019	2020
Yerba mate leaf in the tree	-	-	-	-	-	-	-	-
Yerba mate leaf in the ravine	29%	18%	22%	22%	26%	27%	23%	21%
Yerba mate leaf in the industry	12%	9%	14%	13%	13%	12%	15%	12%
Shredded (cancheada) yerba mate	43%	47%	51%	51%	52%	50%	46%	49%
Processed yerba mate plus sticks	17%	11%	21%	31%	31%	28%	27%	24%
Yerba mate in the retail market	18%	28%	31%	30%	31%	32%	31%	28%

Table 5: Markup of the processing and commercialization of yerba mate in the state of Paraná.

Product	2013	2014	2015	2016	2017	2018	2019	2020
Yerba mate leaf in the tree	-	-	-	-	-	-	-	-
Yerba mate leaf in the ravine	41%	21%	28%	28%	35%	37%	29%	27%
Yerba mate leaf in the industry	14%	10%	16%	15%	15%	13%	17%	13%
Shredded (cancheada) yerba mate	75%	90%	103%	103%	107%	101%	84%	95%
Processed yerba mate plus sticks	21%	12%	27%	45%	45%	39%	37%	32%
Yerba mate in the retail market	23%	38%	44%	42%	44%	48%	44%	39%

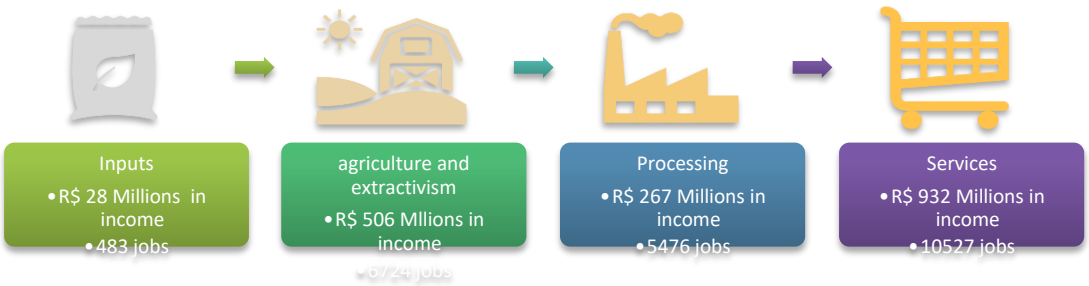
Figure 4: Participation of yerba mate leaf in the industry, crushing (cancheamento), processing and retail in the final consumer price in the state of Paraná, 2020.



Generation of production, income, employment and CO2 emissions in the yerba mate production chain

Figure 5 illustrates the main results for dimensioning the yerba mate production chain in the state of Paraná. Inputs intended for agricultural and extractive production generated R$ 28 million in income and 483 jobs in 2018. The link in the chain responsible for producing the raw material (yerba mate leaves) generated R$ 506 million in income and 6,724 jobs. The processing of yerba mate, which includes *cancheamento* and improvement, generated around R$ 267 million in income and 5476 jobs. The final link in the production chain, commerce and services, added R$932 million in income and 10,527 jobs.

Figure 5: Dimensioning of the yerba mate agribusiness in the state of Paraná.



The detailed results of the dimensioning of the yerba mate agribusiness are in Tables 6 and 7. The total values of the productive chain are R$ 2.8 billion of production generation, R$ 1.3 billion of income generation and 23 thousand jobs. In production generation, processing stands out with around 47% of the total followed by

services with 33%. Regarding income generation, Services (Aggregate IV) account for 47% and 30% are from Yerba Mate (cultivated and extractive), Aggregate II.

The components of Income are the EOB (Gross Operating Surplus), which approximates the accounting profit concept of the sector. Remunerations are payment for salaried work and gross mixed income is payment for self-employed workers and owners. In addition, one of the components of Income (GDP) is Other taxes on production and Subsidies (government support), for which rural producers are the main beneficiaries with 3.2 million reais. Aggregate IV (Trade and services) accounts for 47% of Income, about half of EOB and 59% of Wages, therefore, it is the link in the chain with the highest value generation. Aggregate II (Yerba Mate) has 67% of Gross Mixed Yield, this shows the importance of family farming in the production of Yerba Mate, whether extractive, dense or cultivated.

The generation of jobs along the production chain totals 23,210 jobs, with emphasis on Commerce and services (Aggregate IV) with 45%, production of yerba mate (cultivated and native) with 29%, Processing with 24% and Inputs with 2%. The generation of CO_2 by burning fossil fuels is low (41,000 tons per year) in the production chain, lower than the average for the economy, and makes an important contribution to environmental preservation, sustainable use of natural resources and increased income for rural producers.

Table 6: Results of dimensioning the yerba mate agribusiness in the state of Paraná, 2018. Monetary values in millions of reais per year and CO2 emissions in tons.

Variables	Agribusiness Aggregates				Total
	I	II	III	IV	
(A) Production	69.1	505.8	1337.4	931.5	2843.7
(B) Income (Gross Domestic Product)	28.2	383.8	267.0	600.4	1279.5
(B1) Gross Operating Surplus (EOB)	11.9	167.4	80.9	246.4	506.5
(B2) Remuneration	9.2	39.4	152.3	290.0	490.9
(B3) Gross mixed income	6.8	178.3	24.0	57.2	266.3
(B4) Other taxes on production	0.5	2.0	9.9	6.9	19.4
(B5) Subsidies	-0.1	-3.2	-0.1	-0.2	-3.6
(C) Employment	483	6724	5476	10527	23210
(D) CO2 emissions	2750.6	11918.6	13636.2	12491.7	40797.1

I – Inputs, II – Yerba Mate (cultivated and extractive), III – Processing and IV – Trade and services.

Table 7: Participation of households in scaling the yerba mate agribusiness in the state of Paraná, 2018.

Variables	Agribusiness Aggregates				Total
	I	II	III	IV	
(The production	2%	18%	47%	33%	100%
(B) Income (Gross Domestic Product)	2%	30%	21%	47%	100%
(B1) Gross Operating Surplus (EOB)	2%	33%	16%	49%	100%
(B2) Remuneration	2%	8%	31%	59%	100%
(B3) Gross mixed income	3%	67%	9%	21%	100%
(B4) Other taxes on production	2%	11%	51%	36%	100%
(B5) Subsidies	3%	89%	two%	6%	100%
(C) Employment	2o%	29%	24%	45%	100%
(D) CO2 emissions	7%	29%	33%	31%	100%

I – Inputs, II – Yerba Mate, III – Processing and IV – Trade and services.

The results show that the greater market power in retail and added services is due to the large number of industry units and producers. The producers sell a standardized good (commodity), while the industry has many companies (more than one hundred herbalists), but with the important participation of large groups. Therefore, the industrial sector approaches a differentiated oligopoly, where a few companies dominate the market with a large number of small and medium sized companies disputing the other part. Small and medium-sized industries face highly price-sensitive demand and have brands with relatively low market power and low advertising spend. In addition, technological innovations are slow both at producer and industry level, which makes it difficult to obtain greater differentiation of products in the production chain itself, as well as to compete with substitute goods (coffee, juices and other beverages). According to Goulart (2020), increasing the productivity of yerba mate at the producer level with the adoption of new technologies involves access to technical assistance. The predominance of family farming with traditional cultivation methods is a characteristic of mate production. Units with higher productivity are able to acquire new techniques with improved varieties, pest control and new methods.

IV. Conclusion

The yerba mate production chain in the state of Paraná generated around R$1.3 billion in Gross Domestic Product (income) and around 23,000 jobs in 2018. The participation of the commerce and services sectors is close to 50% for both variables. The generation of carbon dioxide from burning fossil fuels is less than the average for the economy. Environmental impacts are minimized by conserving areas of extractive (native) yerba mate and the system for denser yerba mate plants in the remaining forest. The production of yerba mate stands out in the generation of direct and indirect jobs in the region itself, while the processing sector stands out in the generation of production and taxes and services in the generation of income.

The *cancheamento* process, which includes *sapeco (heated in the fire)*, drying and crushing the yerba mate, presents the highest values of relative margin and markup. The industry's strategy is to cover the entire transformation process with verticalization until it has its own herbs, with guaranteed quality and quantity of the raw material. For the producer, the possibility of owning part of the processing, mainly the *cancheamento*, implies increasing its commercialization margin. Producers can jointly, cooperatives or groups of families, obtain and dominate part of the industrial process to guarantee greater income in the activity. The final good can be differentiated with the addition of other herbs, storage time and percentage of sticks, or even marketing the "pure leaf" mate.

The study presents theoretical-methodological contributions with the use of the input-output matrix to estimate income generation, employment and carbon dioxide emissions in the yerba mate production chain. In addition, the research results bring practical contributions indicating strategies to increase the income of rural producers with the identification of processes that have higher values of commercialization margin. New studies can be developed using the described methods to analyze sustainable production chains, notably the sizing of production chains, being a methodological contribution.

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