STRUCTURING AND CHARACTERIZATION OF THE *Acacia meanrsii* DE WILD CHARCOAL PRODUCTION CHAIN IN THE VALLEYS OF CAÍ AND TAQUARI, RS

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ABSTRACT – Due to globalization, market evolution, and technological implementations, the production chains have been improving, becoming essential for the consolidation of several products in the market, including charcoal, used as a renewable energy source. Thus, the objective of this work was to characterize the structure of this chain, from the qualitative and quantitative perspective, in the municipalities of the Valleys of Caí and Taquari and the interaction between the actors involved. The methodology was based on the division of the chain into macrosegments, with socioeconomic units of production characterized by the application of questionnaires. As a result, it was verified the presence of the production macrosegment (nursery and reforestation sectors), industrialization (charcoal production and packaging sectors), and commercialization (packaging sector), formed by family units. The packaging segment has outsourced manpower and more technology than the others. It was evidenced that a single socioeconomic unit of production can be part of more than one macrosegment or segment and, allied to this, in general, it is possible to perceive the characterization of a long chain of production. It appears that only 3.8% of charcoal producers also pack and sell their products, the remainder (96.2%) sell their production to packers who standardize the product, making the sale to the final consumer directly or indirectly.

Keywords: Black wattle, Forestry sector, Regional development.

ESTRUTURAÇÃO E CARACTERIZAÇÃO DA CADEIA PRODUTIVA DO CARVÃO VEGETAL DE Acacia meanrsii DE WILD NO VALE DO TAQUARI E CAÍ, RS

RESUMO – Em virtude da globalização, evolução dos mercados e implementações tecnológicas, as cadeias produtivas vem se aprimorando, tornando-se fundamentais para a consolidação de diversos produtos no mercado, inclusive do carvão vegetal, utilizado como fonte de energia renovável. Dessa forma, o objetivo do trabalho foi caracterizar a estrutura, sob a ótica qualitativa e quantitativa dessa cadeia nos municípios do Vale do Caí e Taquari e a interação entre os atores envolvidos. A metodologia foi baseada na divisão da cadeia em macrossegmentos, sendo caracterizada as unidades socioeconômicas de produção, por meio da aplicação de questionários. Como resultado, foi possível verificar a presença do macrossegmento de produção (setor dos viveiros e reflorestadores), industrialização (setor de produção de carvão e embalagem) e comercialização (setor de embalagem), sendo formados por unidades familiares. O segmento de embalagem possui mão-de-obra terceirizada e mais tecnologia do que os demais. Ficou evidenciado que uma única unidade socioeconômica de produção pode fazer parte de mais de um macrossegmento ou segmento e aliado a isso e de maneira geral, percebe-se a caracterização de uma cadeia longa de produção. Verifica-se que apenas 3,8% dos produtores de carvão também embalam e vendem seus produtos, o restante (96,2%) vendem a produção para embaladores que padronizam o produto, realizando a venda para o consumidor final de forma direta ou indireta.

Palavras-Chave: Acácia-negra, Setor florestal, Desenvolvimento regional.

1.INTRODUCTION

Black Wattle (*Acacia mearnsii*) is an exotic forest species, originally from Australia and exploited for various purposes (Calegari et al., 2016), such as extracting tannins and biomass for energy. In Rio Grande do Sul, especially in the Valleys of Caí and Taquari, German immigrants introduced this species to their rural properties, motivated by the demand of the leather industry for extracts. However, subsequently, wood began to be used as a source of biomass to produce charcoal (Silva, 2014).

According to data from the United Nations Food and Agriculture Organization (FAO, 2020), the production of charcoal in the world reached 53 million tons in 2018, of which, according to data from the Brazilian Tree Industry (IBA, 2019), 11% was produced in Brazil. In Rio Grande do Sul, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 2019), approximately 30% of the charcoal produced in 2019 came from Pinus and Eucalyptus wood, with the remaining 70% being categorized as other species, where Black Wattle is present.

Souza et al. (2014) highlights the socio-economic importance of charcoal production, which is not only concentrated in large industries, but is also part of the income-generating activities of family farmers, where production is carried out in conjunction with other activities. Added to this is the important role of forest plantations in the preservation of native forests, since the sustainable production of charcoal from planted forests supports the reduction of deforestation (FAO, 2017).

According to Fantini et al. (2010), it is possible to notice that there are no consistent data published on the production of charcoal, since most rural producers carry out the activity in an unregulated manner. Without available data that portray the reality of the sector, the more difficult it becomes to structure an efficient production chain.

The lack of official data means that the existence and the importance of the charcoal activity remain unrecognized and, consequently, public policies and legislation aimed at this reality are not considered (Souza et al., 2014). Thus, knowledge of the production chain is an important planning and decision-making tool, as stated by Simioni et al. (2018), to assist in the identification of bottlenecks and in the development of future scenarios with different critical factors of the production process.

Thus, based on the basic principle of the need to know and identify the charcoal production chain in Rio Grande do Sul, the study aimed to characterize the structure, from the qualitative and quantitative perspective of this chain in the municipalities of the Valleys of Caí and Taquari and the interaction between the actors involved.

2.MATERIAL AND METHODS

2.1 Study Area Characterization

The study region covered the municipalities of Brochier (29º32'43 "S and 51º35'10" W), Maratá (29º32'56" S and 51º33'14" W), Paverama (29º33'06" S and 51º43'49" W) and Poço das Antas (29°27'00" S and 51°40'15" W), belonging to the Regional Development Council (COREDE) of the Valleys of Caí and Taquari, respectively. The Gross Domestic Product (GDP) per capita in the regions varies from R $ 25,442.00 (US $ 4,510.993), in the Caí Valley and R $ 28,669 (US $ 5,083,156) in the Taquari Valley. The municipalities have an economy focused on the footwear and agriculture sectors (such as poultry and pigs) and an important share of forestry and charcoal production is also perceived, mainly in Brochier (Secretaria do Planejamento, Mobilidade e Desenvolvimento Regional, 2015).

2.2 Data Collect

The methodology was characterized as a case study, with the purpose of gathering detailed and systematic information on the structuring of the charcoal production chain. According to Yin (2001), this strategy is considered adequate to understand the phenomena of economic organizations (markets, companies, and institutions) and its complexity, being useful to characterize the case study with the regional context.

The research had a qualitative approach, but it was also based on quantitative data. Quantitative data come from the database provided by the State Secretariat for the Environment (SEMA) and the Technical Assistance and Rural Extension Company (EMATER). In addition, information obtained through

structured questionnaires applied in 2014 was used, following sampling criteria in each macrosegment and its links identified in the charcoal production chain. Qualitative data were obtained through semi-structured interviews and direct observation, specific to the research. The interviews and questionnaires applied served as a basis to validate the information made available by public agencies, as well as to understand and verify the reality of the sectors in loco. The bibliographic review in articles and magazines were fundamental for the discussion of the work.

The structuring of the production chain was based on the methodology of Batalha and Silva (2007). The authors pointed out that a production chain can be characterized through its Socioeconomic Production Units - USEPs. These units ensure the functioning of the system in which they are inserted and can influence and be influenced by that system. A Socioeconomic Production Unit is understood as each property or facility responsible for one or more processes in a production chain. These units were then distributed within the production chain in four different macro-segments, namely: supplier of seedlings, production of raw materials, industrialization, and commercialization.

2.3Survey of Information

1087 rural properties producing Black Wattle were quantified in the municipalities, of which 869 are also charcoal producers. Thus, 123 rural properties producing firewood and charcoal were randomly selected for the application of the questionnaires, representing 11.31% of the sample.

The number of charcoal packers surveyed was 33, of which 9 (nine) were sampled, representing 27.27%, these values being defined by determining the constant variation coefficient. For the application of the questionnaires in the nurseries, a census was carried out in the seven nurseries established in the region, identified in the survey of the database.

3.RESULTS

The main macrosegments found in the charcoal production chain in the region are highlighted in Figure 1.

Based on the determination of Batalha and Silva (2007), and considering the data collected, it was found that the supplier macro-segment consists of a single link: forest nurseries. The production of raw material brings together the link responsible to produce firewood. The industrialization macrosegment, on the other hand, brings together two distinct links comprised by the charcoal and selection and packaging USEPs. Finally, commercialization deals with the sale and transport of the generated product, identified in this analysis to the selection and packaging USEPs, since this link ends up selling the final product, directly or indirectly.

Source – by the authors.
Fonte - Elaborado pelos autores.

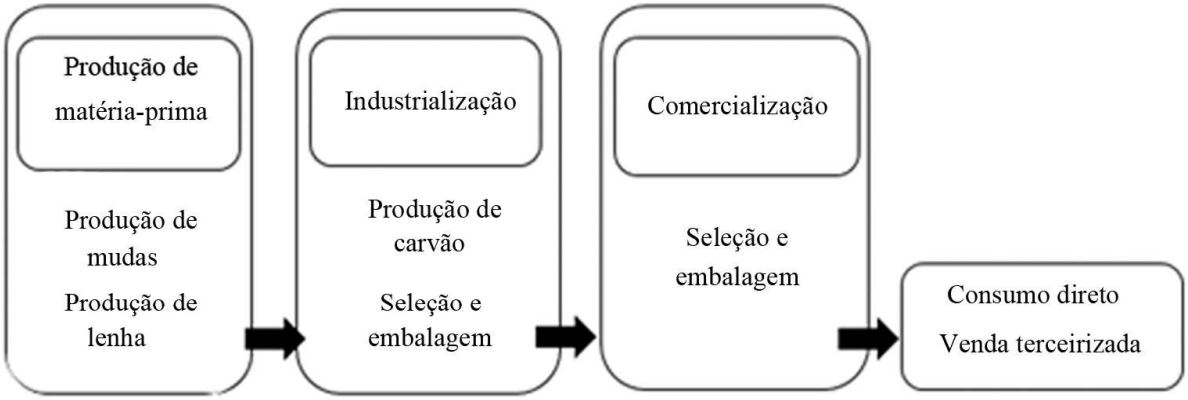

Figure 1 – Flowchart of the structure of the charcoal production chain in the Vallyes of Caí and Taquari.
Figura 1 *– Fluxograma da estruturação da cadeia produtiva do carvão no vale do Caí e Taquari.*

3.1 Production of Raw Materials – Production of Seedlings

Seven (7) nurseries producing Black Wattle seedlings were identified in the region, with the largest number of enterprises in the municipality of Paverama, totaling 43% of the total. The municipality of Brochier owns 29% and Poço das Antas and Maratá own 14% each, it being observed that in 29% of the nurseries the production of Black Wattle has already been extinguished.

In relation to the manpower, it was found that family work predominates, and the hiring of personnel was restricted to companies with an annual production of more than 300,000 seedlings, since it works on a larger scale and the family workforce is not enough. However, this situation refers to only 14.3% of the total analysis.

The establishments use seeds, with genetic material of good origin, which is supplied or marketed by companies in 71.4% of the cases, resulting in better quality seedlings and more productive forests. The container used predominantly is the laminate (57.1%), however there was a trend of gradual replacement by a tube. The owners are aware that the seedlings produced in tubes are of better quality and that the operational part also benefits, but the replacement is being gradual due to the costs involved.

In 85.7% of the nurseries the fertilizer used is organic, while in 14.3% the chemical fertilizer with slow release is used. The use of herbicide, fungicide, and insecticide to control weeds, pathogens and pests is made in 64.3% of the nurseries. The predominant irrigation system is sprinkler (57.1%), followed by manual irrigation (28.6%), which was restricted to smaller nurseries. Sprinkler irrigation with timer (14.6%) was found in places with the highest annual seedling production.

3.2Production of Raw Materials - Firewood

Regarding the properties surveyed, 38% were concentrated in the city of Brochier, 22% in the city of Maratá, 22% in Paverma and 18% in Poço das Antas. The plantation area predominantly found was 5 to 10 hectares per rural property, totaling 19%. Only 9% of the properties have plantations between 0-5 hectares and 16% with more than 10 hectares. It is clear the fact that in 56% of the properties visited there was no more planting of Black Wattle, since these were already cut and sold, and there was no replanting at the time the information was collected.

Furthermore, in addition to rural producers having their own Black Wattle plantations (42.7%), the partnership situation was also evidenced. In this case, another producer performs the planting, maintenance and harvesting of Black Wattle and pays the lease with his own production (39%). In the rest of the cases, raw material available on the market for charcoal production is purchased.

The preparation of the soil, cleaning of the area, planting of seedlings and activities of maintenance of forest plantations are performed manually and with family labor (90.8%). Most of the plantations come from seedlings acquired in nurseries in the region (84.1%), and there are also areas where the burning of forest residues is carried out and later management of the natural regeneration of Black Wattle (15.9%).

The control of ants before and after planting is carried out by 51% of the producers, while the control of the bush-competition by only 38%. The twig girdler beetle *(Oncideres impluviata*), the main Black Wattle pest, caused damage in 11% of the plantations, and its control was carried out by burning infected branches.

The wood and bark are sold standing on 3.3% of rural properties, mainly motivated by the scarcity and high price paid for outsourced labor for cutting. When this form of sale occurs, in the production macrosegment one more link is added: the intermediaries. They buy the forest standing up, cut it and resell it to charcoal producers. Intermediaries may also be present when the producer resells Black Wattle firewood to a buyer who is not a charcoal producer, however, it is difficult to measure this link, as it is a traditionally informal event.

In the properties where the cut is made, 81.9% use family labor and in 14.8% third parties are hired. In addition to paying cash for labor, the harvest can also be remunerated in other ways, such as: percentage of production (the worker receives a part of the raw material harvested) and by bark (the cutter peels the wood and receives the bark for sale to tannin producing companies).

In addition to the traditional planting of Black Wattle, in 57.5% of the forest plantations a consortium

Table 1 – Characterization of black wattle plantations in the study region.
Tabela 1 *– Caracterização dos plantios de acácia-negra na região de estudo.*

	Rating Criteria	Nº of producers	%
Manpower	Family	1001	90,8
	Family and Contractors	86	9,2
Proprietary	Own	471	42,7
	Partnership	196	18,3
	Own and Partnership	420	39,0
Origin	Seedlings	915	84,1
	Conducting of the natural regeneration	172	15,9
Planting	Manual	1087	100
	Semi-mechanized	00	0,0
	Mechanized	00	0,0
Maintenance	Ant control	556	51,0
	Bush-competition Control	408	38,0
	Twig girdler control	123	11,0
Harvest	Own	890	81,9
	Contracting third parties	161	14,8
	Raw material buyer	36	3,3
Composition	Pure	461	42,5
	Consortium	625	57,5

Source: Emater (2014)
Fonte: Emater (2014)

is carried out with agricultural crops (corn, beans, manioc, watermelon) and animals (dairy cattle and sheep). In the first year after planting, agricultural crops are explored between the lines and later the animals are introduced for grazing. Other information obtained can be identified in the Table 1.

3.3Industrialization – Charcoal Production

Of the 123 rural properties visited, it was found that 26% do not produce charcoal. Charcoal producers were found in greater numbers in the municipality of Brochier, corresponding to 47% of the 869 belonging to the study region, as surveyed by EMATER (2014). In the municipality of Maratá there are 22%, in Poço das Antas 19% and in Paverma 12% of all producers. Therefore, the municipality of Brochier also presented the largest number of ovens, corresponding to 52.2% of the 3,531 existing ovens found in the quantitative survey.

The number of furnaces normally found per property sampled was 2 units, consistent with the survey by EMATER (2014), normally employing family labor (96.9%). Other information can be found in Table 2.

Table 2 – Characterization of charcoal production in the study region.
Tabela 2 *– Caracterização da produção de carvão vegetal na região de estudo.*

Rating Criteria			Nº of producers	%
Manpower		Family	842	96,9
		Hired	27	3,1
Number of ovens	Hot-tail	With chimney	1669	46,3
		Without chimney	1843	52,2
	Brochier		19	1,5
Use of the "moinha"		Use in the property	493	56,7
		Sell	376	43,3

Source: Emater (2014)
Fonte: Emater (2014)

The types of ovens found were the "hot tail" and the Brochier oven. The "hot tail" type oven (98.5%) is a low-cost, semi-spherical structure, made of bricks and clay, with a door at ground level, which serves to supply firewood and to remove charcoal, in addition to a cavity in the upper part that serves to ignite the fire. The process is monitored through an orifice called "baiana" which is closed to reduce the entry of air after the carbonization front reaches the site. As the firing does not occur uniformly inside the oven, the openings at the same height of the wall (baianas) will be closed at different times.

The time of each cycle and the productivity in this type of oven are variable and dependent on the conditions of the raw material (size, humidity), and the quality of the oven. However, most enterprises (52.2%) have these same ovens with a chimney attached (Figure 2A) which, in addition to facilitating the work with the reduction of the released smoke, increases productivity (1,100 kg/cycle) due to greater concentration of heat inside the oven and, consequently, greater efficiency (33%). A production cycle lasts an average of three to five days and productivity has an average value of 900 Kg/cycle.

The "Brochier" ovens (Figure 2B), which correspond to 1.5% of the total ovens, are named after the municipality where it was invented and implanted. It is an oven similar to the "hot tail", but it has a system of tubes and cooling chambers that condense the smoke produced from the burning of the wood.

3.4Industrialization and Commercialization – Selection and Packaging of Charcoal

The charcoal packers totaled 33 units, of which nine projects were interviewed. In this study, packers

Source - Silva (2014).
Fonte - Silva (2014).

Figure 2 – A) Hot-tail oven with chimney. B) Brochier oven
***Figura 2** – A) Forno rabo-quente com chaminé. B) Forno Brochier*

were considered as industry and commerce since this sector has both functions within the production chain. When industrialization is considered, this link differs somewhat from production due to having a higher level of mechanization and the hiring of third parties (33%), in many cases necessary to carry out the production process. The highest monthly quantity packed per enterprise observed was 10 to 20 tons.

The packaging process is basically divided into three phases: a) the charcoal is discharged through a sieve, mostly automated (79%), so that the finer particles (charcoal fines, as known as "moinhas" in Brazil) are removed and only the material with the desired size for commercialization remains; b) it is then poured into paper packages of varying sizes (3 to 10 kg), weighing with the aid of a scale, usually digital (90%); c) finally, the packaging is filled, ending with the closing through an appropriate sewing machine.

When considering the commercialization macrosegment, it is possible to consider charcoal packers, since after this phase they also sell what was produced directly to the final consumer. The commercialization chain, which refers to outsourcing the sale of the product, has not been surveyed, since the last phase analyzed was the packaging with possibilities to trade the product. After this phase, packers also sell the production to third parties, who resell it to different businesses, such as supermarkets, meat shops, etc.

It was possible to notice that the number of packers, around 33 USEPs, is much smaller than the number of charcoal producers, that is, the producers do not participate in the complete industrialization process, as they are not part of the packaging sector of the product. According to data from EMATER (2014), proving by the survey in loco, this relationship of duplicity of activities (production and packaging) is restricted to 5 of the 33 USEPs, whose purpose is to carry out the packaging, of which only 2 can supply the charcoal monthly demand with their own production.

Most packers are characterized by only buying the product, some of which even have 300 enterprises supplying charcoal. This structuring characterizes a long chain, where it is not possible to know the origin of the product.

4.DISCUSSION

Regarding the follow-up of raw material production (supply of seedlings and production of firewood), it is possible to highlight the participation of small producers and family labor, which contributes to the generation of income and permanence of these families in the rural environment. This fact is

corroborated by the Gaúcha Association of Forestry Companies (Ageflor, 2017), which highlights the significant social aspect of Black Wattle culture in Rio Grande do Sul, since most of these forests are owned by small and medium farmers.

The results about the industrialization segment - charcoal production - are in line with Carvalho et al. (2005) who highlight the existence of few large industries and a significant percentage of small and medium-sized charcoal production units, which are inserted in rural areas of small owners. Still, it was evidenced in this work that in relation to the sampling carried out, 56% of the 123 rural properties visited no longer have Black Wattle plantations, ceasing to belong to the second link of the productive chain, however, only 26% stopped producing charcoal. Thus, the producer is less and less inserted in the whole charcoal chain, reducing his chances of adding value to the product, since in at least 30% of the enterprises that produce charcoal, inside rural properties, must be carried out the purchase of firewood for the production.

However, it is still worth noting that the production of charcoal is lacking in new technologies to optimize production, resulting in loss of efficiency in the process and yield. Considering that an oven has an average capacity of 5.5 m³, and the basic density of Black Wattle is 600 kg / m³ (Schneider et al., 2005), the yield is 27%, a result that corresponds to that proposed by Oliveira et al. (2013) for the "hot-tail" oven, which behaves similarly to the Brochier.

Brochier ovens release a reduced amount of smoke that is basically composed of water vapor. However, due to dangerous condensable components, such as tar, being present in the collected net fraction, this technology ends up generating an environmental liability.

Brazilian charcoal production is still largely carried out in rudimentary masonry furnaces, with empirical control of carbonization, resulting in low gravimetric yield and social, economic, and environmental impacts (Oliveira et al., 2017). However, the authors note that more modern production systems, such as the oven-furnace system, have been adopted, obtaining, in addition to the technological contribution, the environmental gain, due to the system having low emission of pollutants during carbonization, since they emit only heat, water vapor and carbon dioxide (CO_2).

It is relevant to highlight and characterize the charcoal production chain, also, in relation to the origin of the raw material. Packers buy charcoal from several producers' enterprises directly or through intermediaries, carry out the uniform packaging process and send it to retail establishments and/or sell directly to the final consumer.

For Sproesser (2001), the relationship between producers and intermediaries can be negative or positive, which can contribute to reducing costs, regularizing, and standardizing the flow of products with the consumer and increasing productivity in the system. However, due to a high bargaining power, intermediaries can obtain a profit margin that is not related to adding value.

Still, in general, there are two classifications for these chains: long chain and short chain. In a long chain, according to Souza et al. (2014), the products are standardized to facilitate large-scale distribution, so the raw material and charcoal from several different producers and entrepreneurs are packaged in a standardized manner, making it impossible to distinguish the product's origin, that is, the consumer does not know if the charcoal activity is regularized. In short chains, consumers are aware of the origin and identity of the product consumed. According to Marsden et al. (2000), the key feature of short production chains is their ability to bring consumers and producers together.

Souza et al. (2014) report that the greater the participation of the producer in the various stages of charcoal production (supplier, production, industrialization, and commercialization) the greater the gain per unit sold. In a study carried out in Santa Catarina, the authors identified that the prices paid for the product were higher in the municipalities where farmers producing raw materials and charcoal were able to enter the stages of product selection, packaging, and distribution. Thus, in the short production chains, the insertion of farmers is possible and, consequently, allows them to leave the situation of price takers and start operating in the chain with higher yields, thus seeking better prices for the marketing of their product.

5.CONCLUSIONS

The charcoal production chain in the Valleys of Caí and Taquari is classified into four macrosegments:

supplier (nurseries); production (reforestation agents); industrialization (charcoal producers and packers) and finally the commercialization sector that includes packers.

The production of Black Wattle seedlings is concentrated in the municipality of Paverma, and the largest production of forests and charcoal producers is concentrated in Brochier.

It is evident the presence of partnerships between producer and owner in planting and harvesting, where the remuneration is carried out with the production of Black Wattle itself, a conduct only pointed, so far, in this sector.

The results of this research identified, characterized, and structured each macro-segment of the charcoal production chain in the region, making it possible to use this information to gradually promote the forest-based chain, obtaining greater visibility in the market with support to the nurseries, to Black Wattle and charcoal producers. Still, it is mentioned that it is important to encourage suppliers of inputs, support services (transport, storage) and that there is an institutional environment (laws, regulations) for their respective activities.

Finally, it is evident that this work may serve as subsidies for new research aimed at identifying new links in the productive chain linked directly or indirectly to the process.

6. AUTHOR CONTRIBUTIONS

F.C.L.S and J.A.F elaborated the idea of the research and applied methodology. D.L.P and M.C.X participated in the data analysis and contributed to the writing together with the other authors.

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