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Master of Science in
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Investment project in a Brazilian eucalyptus farm

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ABSTRACT

This report involves the financial evaluation of an investment in a Brazilian eucalyptus farm by a group of entrepreneurs. This is a real case work conducted in a city in the State of Minas Gerais in Brazil. The work consists of a market analysis of four products that can be produced in the farm followed by an economic analysis in order to choose the best investment alternative. The report finalizes with a sensitivity analysis in order to evaluate the conditions in which the alternative chosen continues to be the best choice.

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List of Acronyms

ABRAF – Associação brasileira de produtores de florestas plantadas (Brazilian association of planted forests producers)

AMS – Associação mineira de silvicultura (Silviculture association of MG)

APP – Área de preservação permantente (Permanent preservation areas)

BPDH – Bulk pellets district heating

BPPP – Bulk pellets for Power production

BPRH – Bulk pellets for residential heating

CAPM – Capital asset pricing model

CAGR – Compounded annual growth rate

CAPES – Capital expenditure

CONAMA – Conselho nacional do meio ambiente (National environmental council)

IBGE – Instituto brasileiro de geografia e estatística (Brazilian institute of statistics and geography)

IMA – Incremento médio anual (Average annual increment)

IRR – Internal rate of return

LPRH – Loose pellets for residential heating

MDIC - Ministério do desenvolvimento e comércio exterior

MG – State of Minas Gerais

MMA – Ministério do meio ambiente (Environment ministery)

MST - Metro estereo (stereo meter)

NPV - Net present value

NWC – Net working capital

RL – Reserva legal (Legal reserve)

WACC – Weighted average cost of capital

WTI – West Texas intermediate

1. Executive summary

This work has the main objective of analyzing a farm in a Brazilian city in the North Minas Gerais' state. This farm is now planting eucalyptuses that are growing now and being harvested in 2017.

The four products that can be produced from the eucalyptuses and are being analyzed in this paper are the following: eucalyptus tree, lumber, charcoal and wood pellets. The three first products can't be produced at the same time; however it is possible to produce charcoal and wood pellets at the same time, as it is better explained in the other chapters.

In order to do the analysis, the prices of the products were forecasted like the costs of the alternatives. It is believed that the wood products prices are higher now than it should be in the future years. More than that, the cost of the workforce is increasing, which decreases the margin of this farm's products.

Economic results concluded however that the production of the four products is economically feasible. The economic results for each of the alternatives are the following:

Activity	WACC	NPV (Million)	IRR
Eucalyptus tree	8,52%	R$ 3.306	10,47%
Lumber	8,52%	R$ 3.677	10,68%
Charcoal	8,86%	R$ 2.424	10,32%
Wood pellets	8,86%	R$ 1.413	18,20%
Charcoal + wood pellets	8,86%	R$ 3.837	10,94%

In order to choose the best investment scenario, the alternative which presents the highest net present value (NPV) was taken. By doing so, the best alternative is to invest in the production of charcoal and wood pellets.

2. Introduction

The investment in forests of worldwide pension funds, mainly American, is becoming more and more common in Brazil. The good return when compared to the low risks of the business is attracting this kind of investors, which invest the money in a safe but profitable way.

According to the Brazilian newspaper Valor economico, investment funds plan to invest R$ 4.5 billion only in the Brazilian wood sector[1]. Motivated by this, a group of investors decided to verify the feasibility of an investment in a farm that produces eucalyptus in the North of Minas Gerais (MG).

Eucalyptus tree is part of both the paper and the charcoal production chains. This use flexibility is very good because it makes the product not dependent on only one sector. Because of the proximity of the farm to pig iron producers, the charcoal production chain will be the focus of the analysis[2].

Brazilian technology for the eucalyptus tree production is among the best of the world, what makes the product competitive in global terms. This advantage is function not only of the climate and soil conditions but also of an investment in technology that produced clones of trees that grew better than others. The use of these clones increased the Brazilian production capacity.

The management of the eucalyptus tree forest consists of planting and cultivating the eucalyptus until the age of being harvested (this age is variable from farm to farm[3]. in this study case the cycle of the eucalyptus tree will be of seven years).

The classical energetic wood chain often analyzed by the studies takes into consideration the following products: eucalyptus tree; lumber and charcoal, which is the charcoal's supply chain, a product that is used in order to produce pig iron and that has as its main substitute the coal. The following paragraphs contain a short

[1] GÓES, F. Fundos que investem em florestas têm 4.5 bi para novos projetos.Jornal valor econômico, São Paulo , p.C1, June 25 th
[2] The charcoal is a product that is used in order to produce pig iron
[3] The farmer can decide the age in which the tree is harvested. In this case, the period of seven years was chosen based on the decision of the farm's forestry engineer

description of each of these three products of the supply chain, the eucalyptus tree, lumber and charcoal.

The eucalyptus tree market consists only of cultivating the tree, the work of harvesting is responsibility of the buyer, who goes to the farm and pays the workers to harvest the forest.

The lumber market is very similar to the first one. The costs to the producer are the same of the first market (common costs[4]) but there are additional costs, which are harvesting and internal logistics. Harvesting costs, which in the first market was responsibility of the buyer, is now a liability to the producer; therefore, there is the need to hire the workers to harvest the forest.

Since the products are sold in the entrance of the farm, there also is an internal logistics cost in this case to transport the lumber from the forest to the place where it will be sold. There are no external logistics in this case because the product is sold in the farm.

The charcoal is the last product of the supply chain and, how it is likely to happen, the one with the most aggregated value. However, production costs of this product are higher than the previous ones; important costs and investments like in the ovens to produce charcoal take place in this market.

The production of charcoal in this work will be done in the so called rectangular ovens, which cost R$ 1 million[5] in order to produce 60,000 mdc[6]. In addition to the costs of the first two markets, there are the charcoal production costs, which are the depreciation, labour and maintenance. There is also an important investment in the beginning of the period.

In addition to this classical chain of the charcoal, this analysis will contain another product, which is becoming more and more important in Europe[7] and that already has an important role in the Italian market[8], the wood pellet.

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[4] According to Rezende, J.L.P. et al, common costs are the costs that are incurred when cultivating the eucalyptus. They are called by this name because they're costs that exist in all the three markets: eucalyptus tree, lumber and charcoal.

[5] NETO, R.M.G. Avaliação técnica de um forno container em escala industrial. 64 pages. Thesis. Universidade federal de Viçosa, Viçosa, Minas Gerais. 2005

[6] Mdc is the measure unit that corresponds to one cubic meter of charcoal

[7] According to the pellet@las projections, the consumption of the product in Europe should grow 225% from 2008 to 2020.

According to the Alabama forestry commission, the pellet fuel "is already an accepted and efficient method of home heating, wood pellets are poised to take on commercial applications with unparalleled economy, versatility and practicality[9]".

This commission also highlights that there are two types of wood pellets fuels, the home heating and commercial pellets, this last one has a "higher percentage of agricultural and forest by products than those made for home use".

It is important to take into consideration that the wood pellet can either be the main product of the supply chain or just a secondary one, produced with the residues that result from the charcoal production. The figure 1 that is shown below presents all the alternatives that are being analyzed in this thesis.

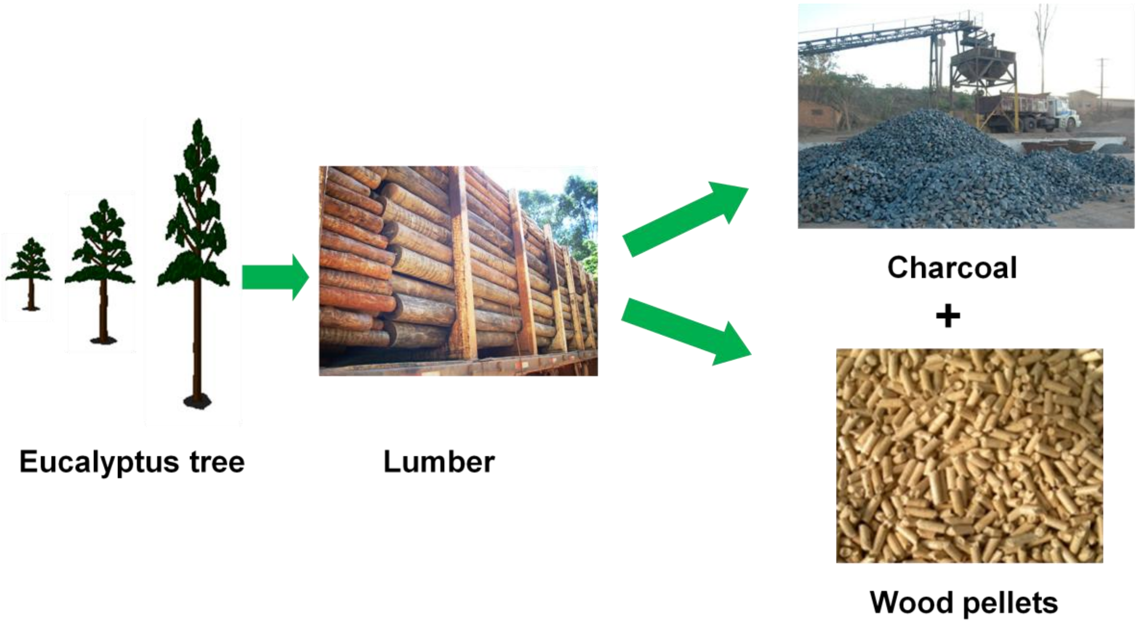

Figure 1 Eucalyptus chain

The following pages of the thesis are dedicated to the analysis of each of these markets in details. This analysis is made in four main parts that are detailed in the following bullets.

- Chapter Three: Markets - Analyzes the supply, the destination and prices of the products

[8] According to pellet@las, the Italian market consumption of wood pellets in 2008 was of 850,000 t, which gives to the country, the fifth position among the European markets.
[9] http://www.forestry.state.al.us/Biomass/Pellets%20Commercia%20lBrochure3.pdf

- Chapter Four: Investments and costs - Shows the investments and costs that are necessary in order to produce each of the products
- Chapter Five: Revenues - Shows the revenues that arise from the sales of each of the products.
- Chapter six: Economic analysis - Analyzes the economic results from each of the investment alternatives

These six chapters are ended with a conclusion in chapter seven followed by the references that were used in the work and the appendix.

3. Markets

The eucalyptus tree, lumber, Brazilian charcoal European wood pellet markets are being analyzed in this part of the work. Before starting with the market analysis, three auxiliary analyses are done.

The first one shows a study of the cost of the work force over the years in the state of Minas Gerais, followed by an analysis of the Brazilian exchange rate against the U.S. dollar and the EURO and the legislation of the Brazilian forestry sector.

3.1. Cost of the workforce in MG

The results of this work are strongly dependent on future costs and prices, therefore it is very important to make some projections in order to try to foresee these variables in the future.

Since the labor cost is a variable which is very important in this market, there is the need of foreseeing the trend of this variable in the North of Minas Gerais. In order to do so, the average nominal income of the main job of the worker in the city of Belo Horizonte, capital of the state of Minas Gerais will be used.

This variable represents the average income of the worker, older than 10 years, in its main job in Belo Horizonte. The name of this variable shows how the work conditions can be very sad in Brazil; the variable takes into consideration the main employment of the worker, this is because in Brazil, many people need more than one work to survive; more complicated than this, the statistic shows peolple that are older than 10 years, because the child labor, mainly in rural areas, can be a problem in some parts of Brazil.

The time series of this variable is published in the IBGE[10] in its web site (http://www.sidra.ibge.gov.br/), the number of the series is 2189. The monthly wage of the worker in Belo Horizonte in R$ / month is presented in the next page.

[10] IBGE Instituto brasileiro de geografia e estatística, is a Brazilian institute that is responsible for the publication of some Brazilian macroeconomic statistics.

Table 1 Average wage of the worker in Belo Horizinte (R$/month)

	2003	2004	2005	2006	2007	2008	2009	2010
Jan	708	749	821	873	999	1049	1188	1315
Feb	696	748	826	892	988	1071	1219	1277
Mar	725	760	842	903	959	1110	1197	1316
Apr	712	757	856	921	994	1090	1181	1296
May	733	755	859	944	1001	1112	1237	1290
Jun	749	764	859	938	1008	1100	1259	
Jul	714	778	876	949	1018	1132	1240	
Aug	710	800	856	956	1033	1140	1261	
Sep	719	807	864	944	1013	1179	1229	
Oct	743	791	846	946	1042	1191	1248	
Nov	732	792	848	944	1075	1176	1249	
Dec	725	788	854	955	1046	1237	1230	
Average	722	774	851	930	1015	1132	1228	1299
Growth	-	7%	10%	9%	9%	12%	8%	6%
Index	100	107	118	129	141	157	170	180

According to this series, the annualy average growth of the wage is equal to 8.75%. This annual increase will be used in order to forecast the labor costs in all the activities that involve the use of labor.

The indexes, considering an yearly growth of 8,75% until 2020, that are going to be used in this projections are presented in table 2.

Table 2 Work force index

2003	2004	2005	2006	2007	2008	2009	2010	2011
100	107	118	129	141	157	170	180	196
2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
213	231	252	274	298	324	352	383	416

With this indexes and the equation 1, it is possible to calculate the value of the labor in the desired year.

$$Cost_i = Cost_r * \frac{Index_i}{Index_r}$$

Equation 1

$Cost_i$ is the value that is being calculated, the $Cost_r$ is the previous known cost in the reference year and $Index_i$ and $Index_r$ are the indexes of the years i and r, respectively.

It is being considered that there are no learning curves in the process. This consideration is being made because the publications that are being used as benchmarks presents the productivity of the workers in the long run. Besides that, all the labor is being outsourced[11] in order to avoid legal problems.[12]

[11] Since the labor is being outsourced to a company that is in the business for a long time, the productivity of the workers is considered stable in this case

[12] In Brazil, the labor justice has rules that are difficult to be understood and it is common to see companies being sued by its workers. The enterpreneurs of this project do not want to have these problmes.

3.2. Brazilian exchange rate

The exchange rate is a very important variable in this context because some of the prices practiced such as the charcoal are function of the steel international prices[13], which are measured in dollars.

The historical series of the exchange rate can be obtained at the Brazilian central bank's (Banco central) web site[14]. The figure 2 shows the variation of the Brazilina real against the U.S. dollar. The average from January 2008 to July 2010, that will be used in the thesis such as equilibrium exchange rate is also shown in the graphic.

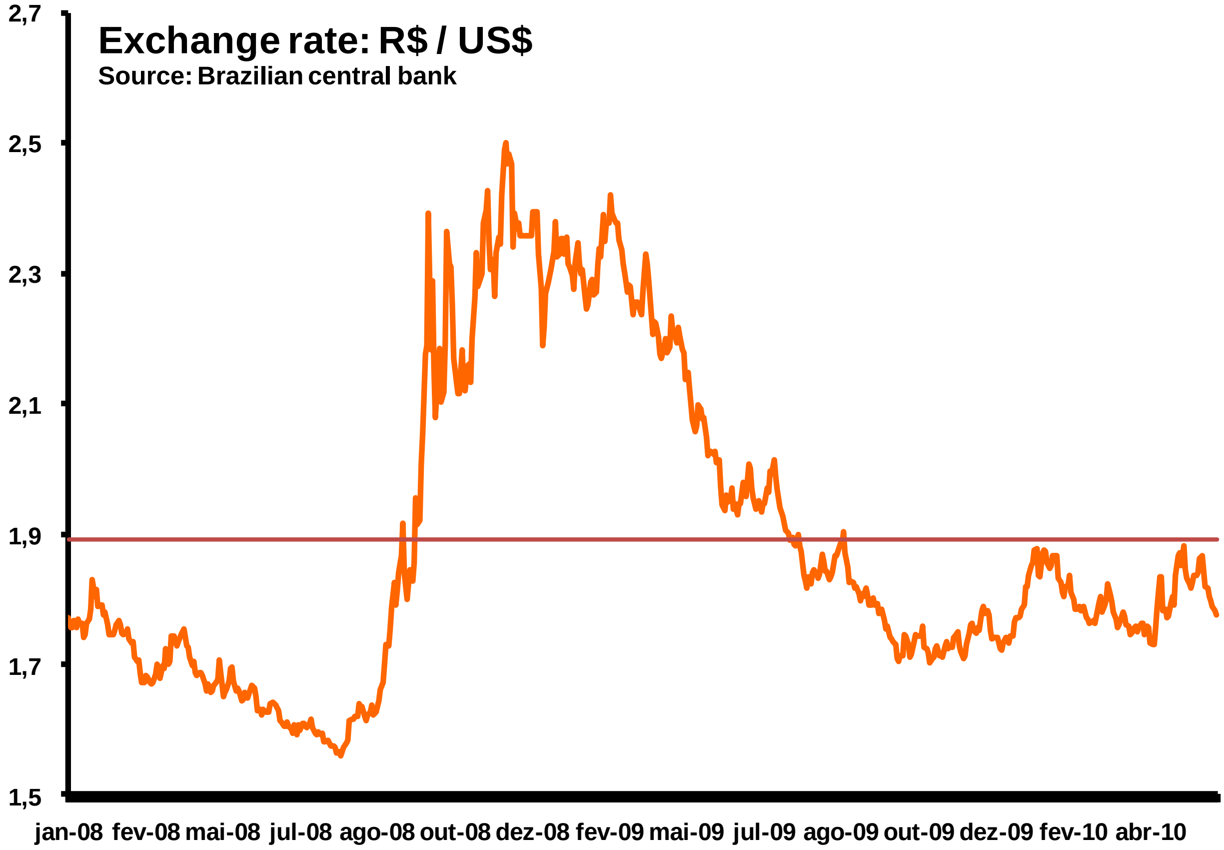

Figure 2 Brazilian exchange rate against the U.S. dollar

The exchange rate theat is being used in this work is equal to R$ 1.89/US$, which is the average value of this variable between January 2008 and July2010.

[13] This relation is better detailed in the chapter 3
[14] http://www.bcb.gov.br/

Besides the U.S. dollar international prices, it is also important to take into consideration the average of the Brazilian real over the euro. This importance exists due to the wood pellet market, which in this case is being sold to Europe.

Since the prices in the Rotterdam harbor are commercialized in euros, the variation of this currency against the real is important to be known. The historical values of this exchange rates are presented in the figure 3. The average value for the euro in terms of Brazilian real from January 2008 to July 2010 is equal to 2.66 R$ / EUR.

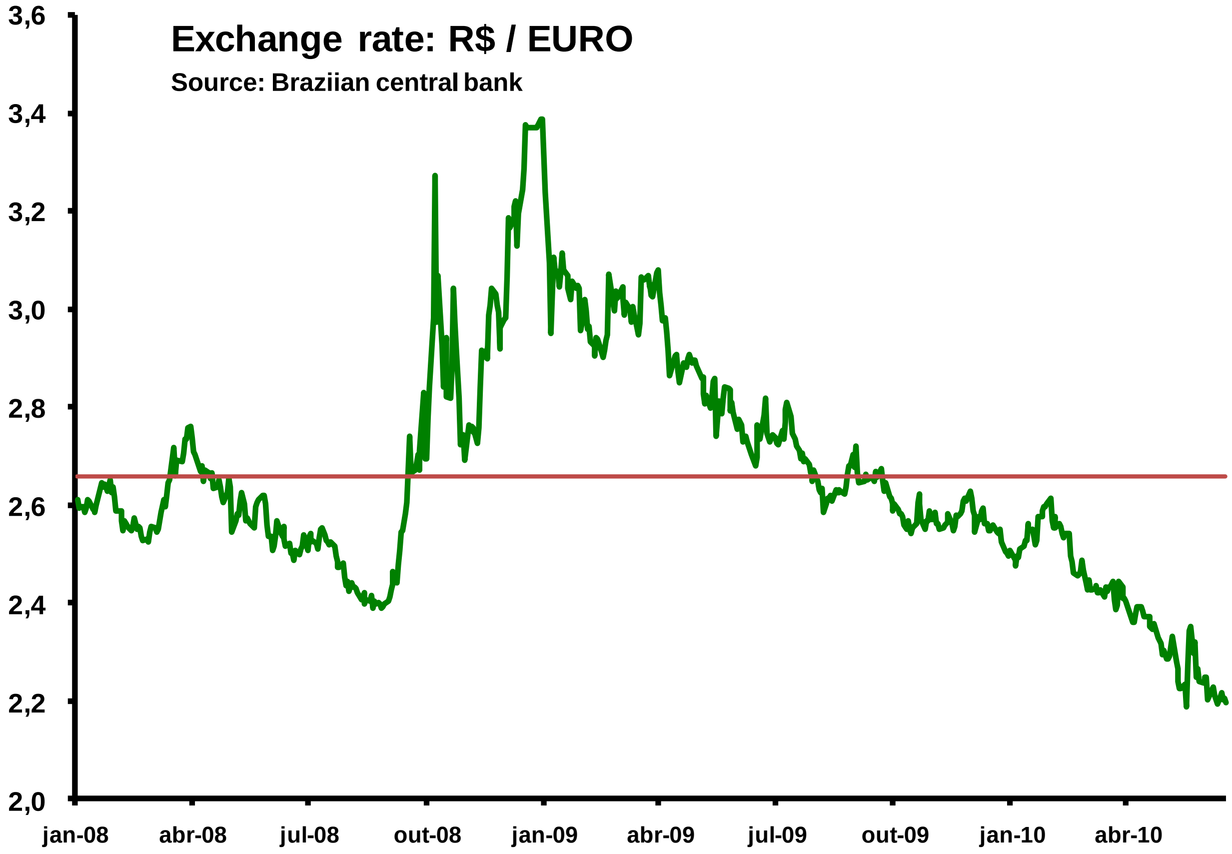

Figure 3 Brazilian exchange rate against the euro

3.3. Forestry legislation in Brazil

The forestry legislation in Brazil is ruled by the forestry code, that was approved in 1965 and was reformulated many times[15]. Nowadays, the code is being reformulated again[16] and this new legislation can have a direct impact in the economy of the whole forestry activity in Brazil[17].

There are many points of the code that are being discussed[18].In this analysis, just the items that have a direct impact in the business of the eucalyptus farm will be analized. The direct impact is being considered such as items that if approved can change the total planted area of the forest.

In order to better represent the situation of the farm nowadays, the software AUTOCAD was used in order to represent the area's map. The items will be better explained in the following topics, but what needs to be taken into consideration is that nothing can be planted in the river, in the legal reserve and in the permanent preservation areas. This situation is shown in the figure 4.

[15] http://www.mudancasclimaticas.andi.org.br/node/955
[16] According to the news published in June 30th in the Valor econômico (a Brazilian newspaper),Aldo Rebelo, who is being held responsible for the changes in the forestry code, was criticised in the first version of the change that was published in June 2010.
[17] There is a paper, produced by CORDEIRO et. al (2009) that analyses the economic impact of two of these changes in the charcoal production. The items that will also have the impact analyzed in the thesis are the changes in the permanent preservation areas and in the legal reserves.
[18] The magazine boletim informativo number 1104, from the agricultural federation from the state of the Paraná (FAEP), points out fourteen points of the forestry code that are being changed.

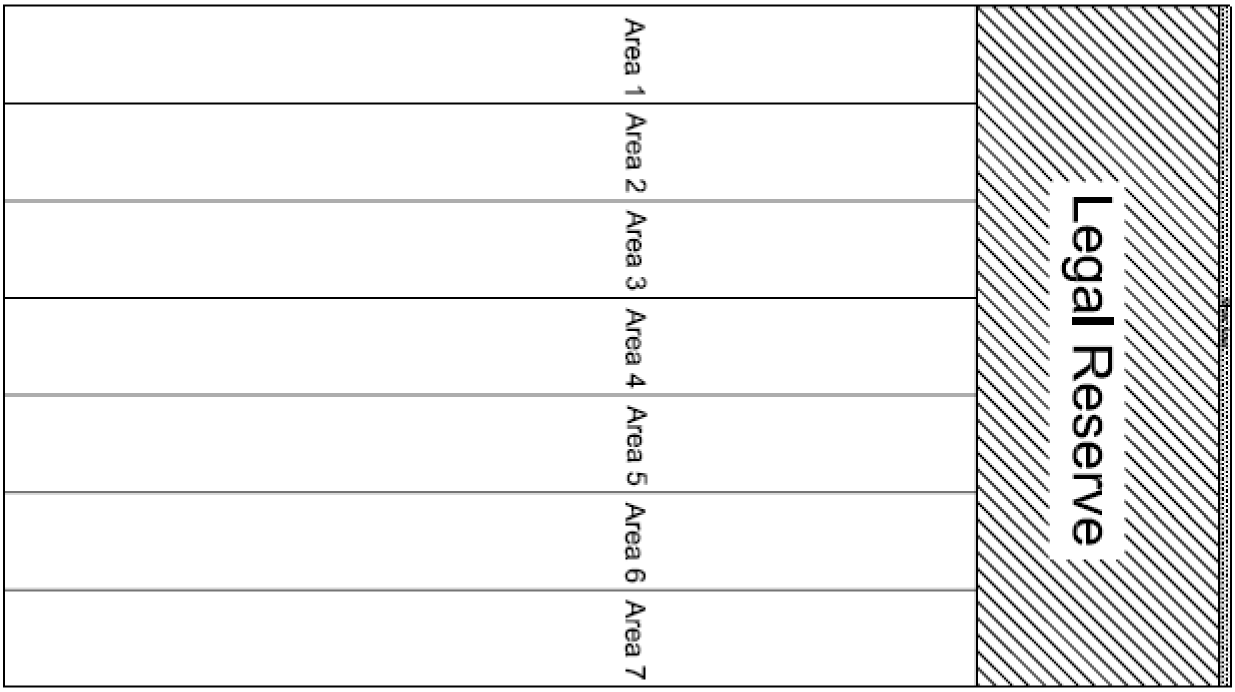

Figure 4 Simplified map of the forest

It is possible to observe in the figure 4, the seven areas that can be used for the plantation plus the river areaa and the legal reserve area that cannot be used for economic purposes.

Although the total area of the farm has 6,315 hectares, the area that can be used for plantation is equal to 3,500 hectares, which is divided in seven areas of 500 hectares each.

Permanent preservation areas

The permanent preservation areas (PPA), or APP, like they are defined in Portuguese, are “places, public or private, that legally limits the right of property, taking always into consideration, the environmental function of the property. (Art. 170, VI from CR/88). However it is not necessary the expropriation of the permanent preservation area because it does not makes unfeasible the right of property”[19].

In other words, PPA are areas that cannot be used for cultivation, actually, cannot be changed by the farmer even though they are his property.

Besides the river, river banks are considered such as permanent preservation areas but the size of the size of the margin that is considered such as PPA is being discussed. According to the forestry code, the river banks that cannot be used by the farmers are equal to 30 meters of width for each side of a river until 10 meters width[20].

According to this same magazine, the new proposal suggests this PPA to be equal to 15 meters for rivers with no more than 5 meters width. If this change happens, the PPA will be reduced from 42 to 21 hectares. It represents an addition of 0.6% in the total planted area that was equal to 3,500 hectares and can grow to 3,521 hectares.

Legal reserve areas

Legal reserve areas (LR) are “protected areas (…). In order to assure the right to the environment well balanced, in all units of the federation, as a common good for all the people and essential to the quality of life”[21]

Such as the PPA, the legal reserve is an area in which nothing can be cultivated for economical purposes. The magazine also defines the percentage of legal reserve as 20% of the total area of the farm (for the state of Minas Gerais) excluding the PPA. Therefore, the area that can be used for cultivation is equal to the following equation:

$$Planted_{area} = (1 - \%LR)Tt_{area} - PPA$$

The changes that are being proposed in this new forestry code that takes into consideration the legal reserve is to consider the PPA such part of the legal reserve. If it does happen, the PPA will be part of the 20% that the legal reserve. However, the

[19] CONAMA. The text was took on http://www.jurisambiente.com.br/ambiente/areadepreservacaol.shtm
[20] FAEP – Boletim informativo number 1104, Page 6
[21] FAEP – Boletmi infromativo number 1104 page 6

PPA can never be used.If the PPA is equal to 35% of the area, the area that won't be used will be equal to 35%.

In other words, the calculation of the potential planted area would be equal to the minimum between the total area minus PPA and one less the percentage of the legal reserve multiplied by the total area. The calculation for the area that can be cultivated if the new code is approved is described in the equation below.

$$Planted_{area} = MIN((1 - \%LR)Tt_{area} \, ; \, Tt_{area} - PPA)$$

If this change is put in practice in Brazil, there will be an increase of 1.04% in the area of the farm that can be cultivated.

3.4. Eucalyptus tree

The eucalyptus tree market is the one that involves the commercialization of eucalyptus tree. In this section of the work aspects such as the supply, the main destinations and the prices of the products are being analyzed.

Supply

The eucalyptus trees come from two main sources, the so called planted forests, farms that replant the trees every time they are harvested and the native forests, which are areas in which there are natural forests that are harvested and the trees are not planted again.

This project analyses the feasibility of using a farm in order to plant eucalyptus, which means that this is a planted forest. The laws in Brazil are restricting more and more the use of products that comes from native forests: "Among the many points in the law, the main one focuses on the reduction of the wood products' consumption from native sources"[22].

It is possible to estimate the percentage of eucalyptus coming from native and planted forests by taking into consideration the quantity of charcoal that is produced from each of these sources. The figure 5 shows this distribution since 2004.

[22] ABRAF Yearly statistical book 2010

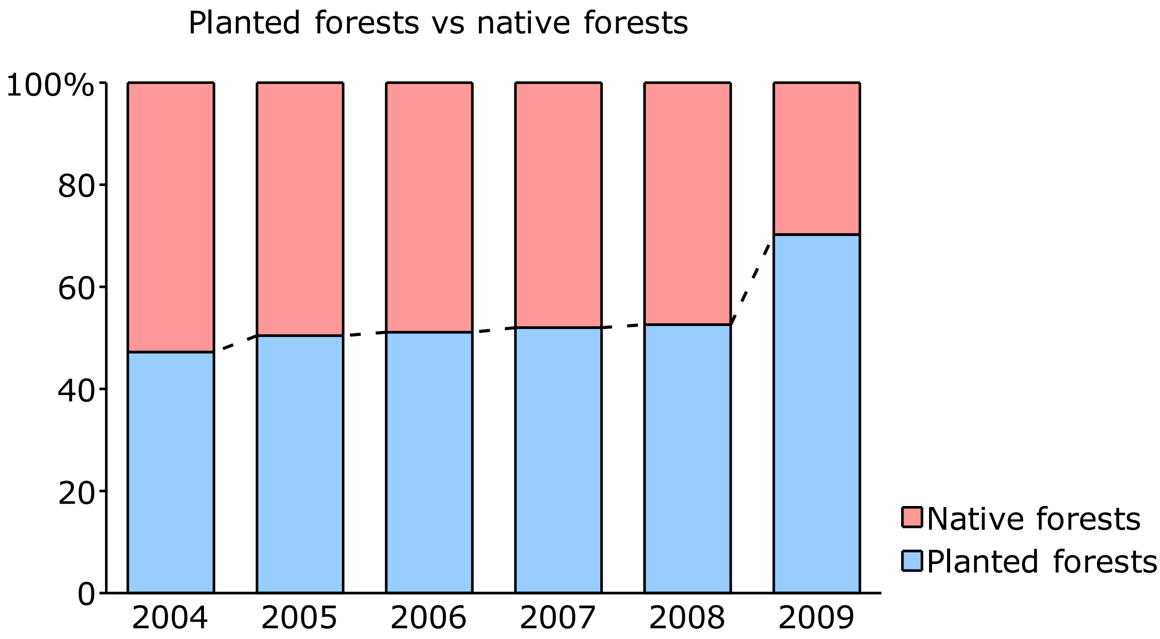

Figure 5 Charcoal consumption from planted and native forests[23]

In this graphic it is possible to see that in the year of 2009 the participation of the planted forests grew a lot, going from 50% to 70% in just one year. This trend should be better analyzed in order to conclude if this really is a trend that the planted forests are gaining importance or just a possible turbulence caused by some effects of the economic crisis.

One way or another, the laws are encouraging more and more the planted against the native forests, which is a very good indicator for this project's entrepreneurs.

Considering the native forests such as the future in this business, now the focus is on the evolution of the planted areas of eucalyptus and pinus, the main sources for the production of cellulose and charcoal in Brazil.

In order to verify the trend of the planted forests business, it is important to analyze the growth of the area that is being used in order to plant eucalyptus and pinus. The figure 6 shows the evolution of these two cultures that are planted in Brazil. It is important to take into consideration that these areas correspond only for the planted areas in Brazil.

[23] Source: AMS web site: numbers of the sector

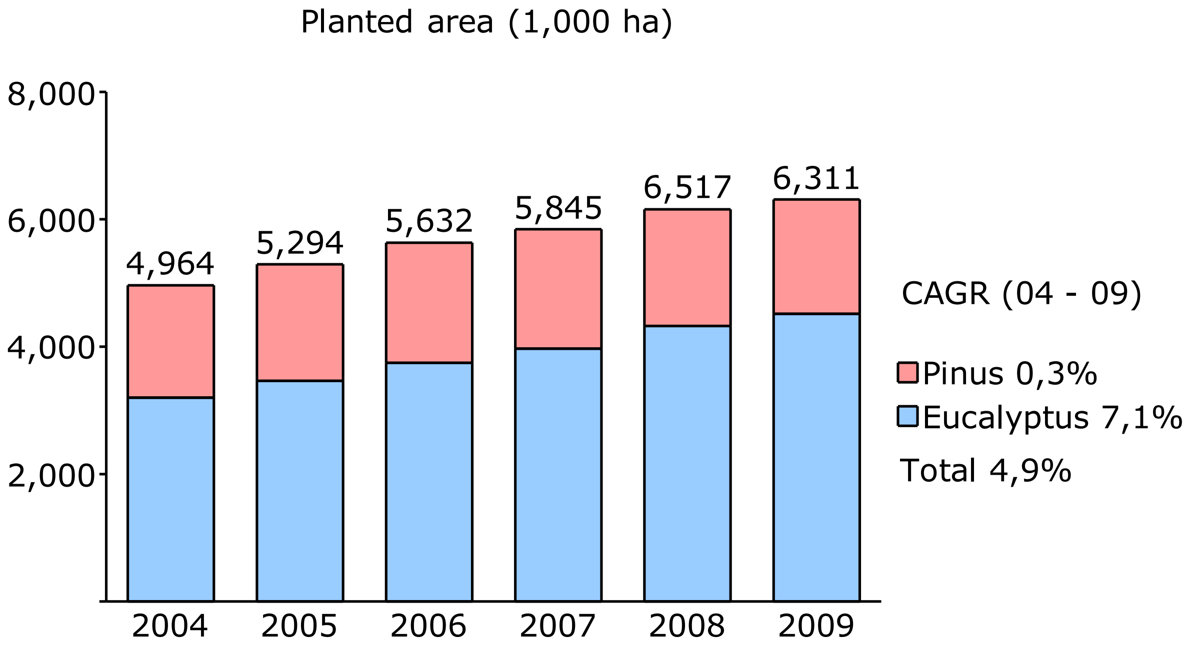

Figure 6 Planted forests' growth[24]

The total growth in area planted was equal to 27% in 5 years, which corresponds to a CAGR of 4.9%. This growth however happened mainly due to the eucalyptus, which increased its planted area by 41.1% in this same period (CAGR of 7.1%). Although the pinus planted area also grew, it happened at a CAGR of 0.3% in the period and therefore the pinus lost importance in relative terms.

These numbers show that from 2004 to 2009 the growth in planted forests was supported mainly by the eucalyptus tree that gained importance not only in relative but also in absolute terms.

The last phase of the analysis is to verify how these forests are distributed in Brazil, in order to do so, the following chart was prepared in order to better visualize this distribution, which is presented in the figure 7.

[24] Source: ABRAF yearly statistical book 2010. The numbers correspond only to the participation of the companies associated to the ABRAF

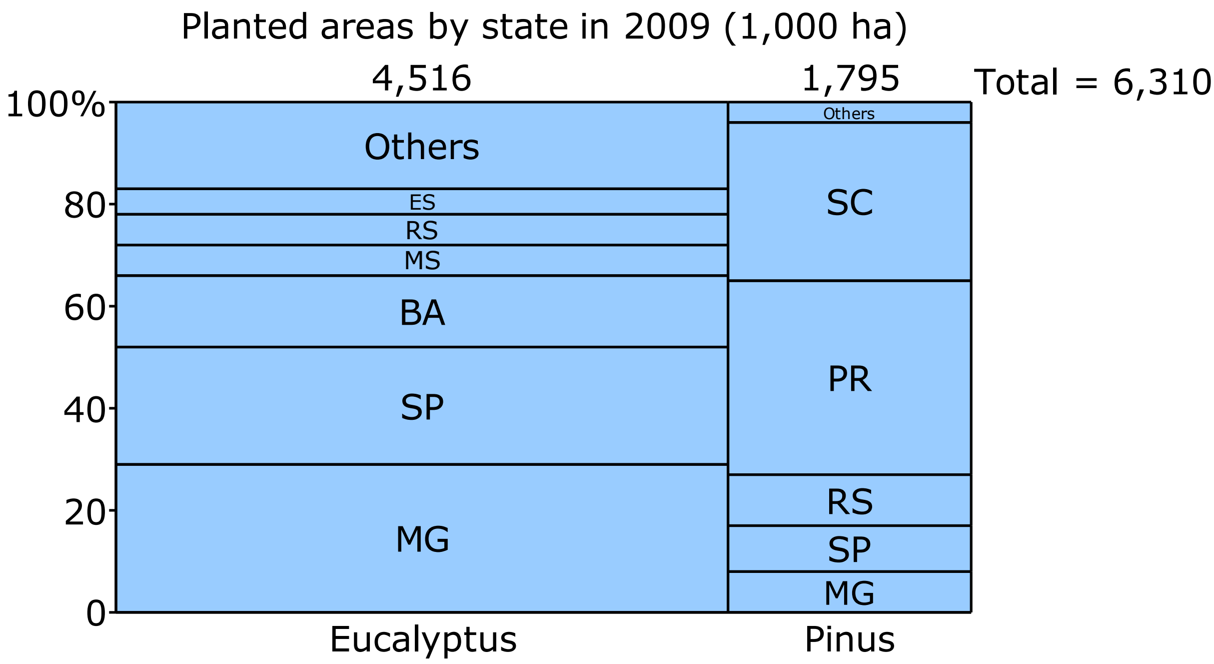

Figure 7 Distribution of the planted forests in Brazil[25]

Figure 7 shows that the eucalyptus is more important than the Pinus in absolute terms, especially in states that are more to the North of Brazil.

this higher number of eucalyptus in Brazil happens because of the climate. This theory is possible because the states from the South of Brazil (RS, SC and PR) are the main producers of pinus while states that are in the middle or in the North of the country (SP, MS, BA and ES) are specialized in the production of eucalyptus. Since this is not the scope of the work, this will be considered just a theory to the fact that most of the pinus come from the South of the country.

The importance of the state of Minas Gerais in the planted forests, especialy in the culture of eucalyptus is hihglighted in the graphic. This can be either good or bad to the enterpreneurs; it is good because this is an indicator that the plantation of eucalyptus is an important activity in the state, the bad part however takes place because the big supply means big regional competition.

[25] Source: ABRAF yearly statistical book 2010. The numbers correspond Just to the planted forests that are associated to the ABRAF

This third graphic finishes the supply of eucalyptus tree in Brazil. The sectors that uses eucalyptus trees are analyzed in the following pages.

Despite the high number of forests growth in the last years, there are not big companies that control the market. The influences of imports and exports are very low and the internal competition is made only by small entrepreneurs.

Destination

This part of the work is dedicated to the analysis of the main eucalyptus trees' destinations. The knowledge of the main destinations of the eucalyptus trees is important due to the fact of analyzing for instance if the sector is dependent from one activity, which can reflect sector risks and therefore a possibility of not selling the products or a high probability of bargaining power of the customers.

The destination of the products will be analyzed by using the data provided by ABRAF.

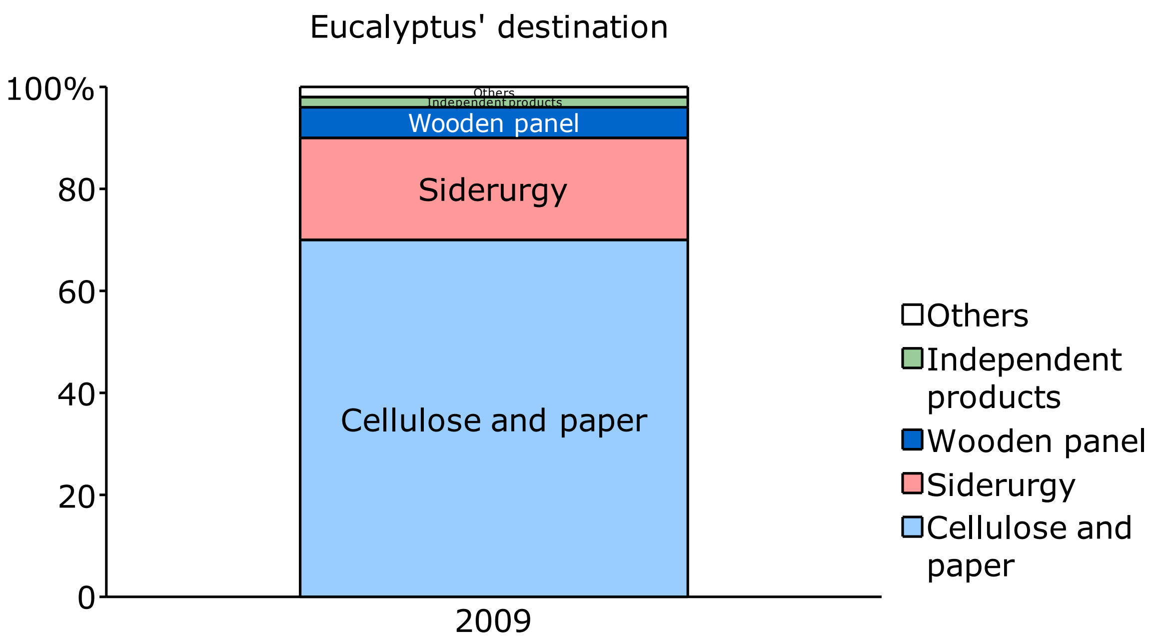

Figure 8 Destination of the eucalyptus tree

Figure 8 shows that the eucalyptus products go to two main sectors; cellulose and paper and siderurgy. These two sectors correspond for 90% of the eucalyptus products, showing a very high concentration of the industry and therefore a sector risk for the eucalyptus' plantation.

This concentration can be explained, the biggest area in the graphic corresponds to the area of cellulose and paper, this situation is explained by two main reasons, the first one is that the "cellulose and paper activity needs plantation in areas that are bigger when compared to other industrial segments"[26], the second one is that the certification of the products is more present in this sector[27].

Since the eucalyptus' supply and the main destinations of the prodcut have already been analyzed, a study of the prices is necessary in order to complete the macro analysis of the sector.

Prices

The eucalyptus tree prices are the main indicator for the future revenues. Unfortunately, the historical price series available for the product is very short and available only from January 2009. This series is presented in the table below.

Table 3 Eucalyptus tree prices[28]

Eucalyptus tree (R$/st)	
JAN / 09	30
FEB / 09	30
MAR / 09	30
APR / 09	30
MAY / 09	30
JUN / 09	30
JUL / 09	30
AUG / 09	30
SEP / 09	30
OCT / 09	30
NOV / 09	30
DEC / 09	30
JAN / 10	30
FEB / 10	30
MAR / 10	30

[26] ABRAF Yearly statistical book 2010 page 34
[27] Certifications such as the FSC demands that the trees must be harvested from planted forests
[28] Source: AMS. http://www.ams.com.br

The eucalyptus tree prices are presented in stereo meter (st), which is a measure of volume that corresponds to the volume of timber contained in a theoretical regular box of 1 m³[29]. The figure 9 helps us to understand more exactly what a stereo meter is.

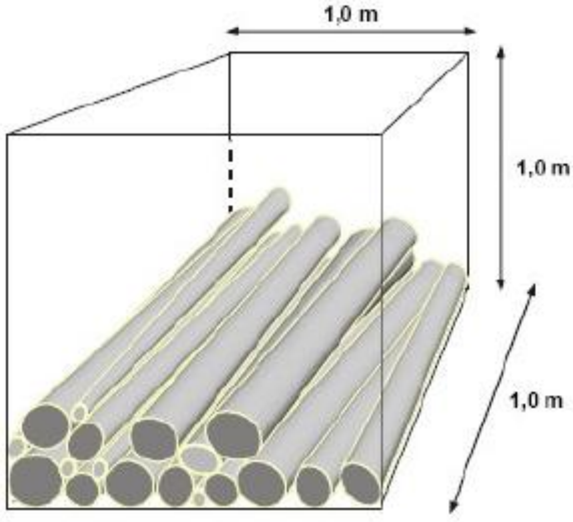

Figure 9 Explanation of stereo meter (mst)[30]

In order to transform st to m³, we can use the so called cubic factor, that is equal to 0.7[31]. In other words, it is needed to multiply the stereo meter by 0.7 in order to calculate the volume in m³. Therefore, if we want to know the eucalyptus prices in cubic meters (m³), we need to divide the prices in st by 0.7, obtaining by doing so the hystorical prices equal to R$ 42,85/m³.

Although the number of planted forests is growing at a high level, the prices for this market remain stable, which means that the competition is not influencing the price levels, at least for now.

29 A square Box with 1 meter each side
30 Image taken from JASPER, A. Atividades para saídas de campo envolvendo Biologia e Matemática. Um exemplo em uma disciplicna de botânica.
31 JASPER, A. Atividades para saídas de campo envolvendo Biologia e Matemática. Um exemplo em uma disciplicna de botânica.

3.5. Lumber

The lumber market is similar to the eucalyptus tree market. Since all the eucalyptus must become lumber in order to be used in its final purpose, the macro analysis (supply and destination) for these two markets are being considered the same. Therefore, only a price analysis of this market is needed.

Just like the eucalyptus tree market, there are no big players in the lumber market or competition from outside of the country (lumber imports and exports are not relevant considering the overall market). The competition is made only by small entrepreneurs and the prices for this product are stable, as we see in the next session.

Price

The analysis of the lumber prices is needed because since there are two additional activities in order to transform eucalyptus trees in lumber, the prices are a little bit different. The table presented below shows the historical lumber prices.

Table 4 Lumber historical prices[32]

Lumber (R$ / st)	
JAN / 09	40
FEB / 09	40
MAR / 09	40
APR / 09	40
MAY / 09	40
JUN / 09	40
JUL / 09	40
AUG / 09	40
SEP / 09	40
OCT / 09	40
NOV / 09	40
DEC / 09	40
JAN / 10	40
FEB / 10	40
MAR / 10	40

Like in the eucalyptus tree where the prices were stable, the lumber prices were equal to R$ 40/st from January 2009 to March 2010 and, 33% higher than the prices paid for the tree.

[32] Source: AMS

3.6. Charcoal

The charcoal market is being described in more details in this section of the work. This is a more complex market and, therefore a better analysis of the supply and denad mus t be done.

Supply

The supply of the charcoal can happen in two ways, the first, the production in Brazil and the second, the imports. Since there is no data about the production of charcoal, in order to calculate these numbers, the equation below will be used.

$$Production = Consumption + Exports - Imports$$

According to the equation, the charcoal production in Brazil is equal to its consumption plus the exports less the imports of the good. The following chapters of the work describe the consumption, the imports, the exports and the production respectively.

Consumption

The charcoal consumption can be obtained from two main sources, the planted forests and from natural forests. The graphic containing the quantity obtained from each of these two sources is shown below.

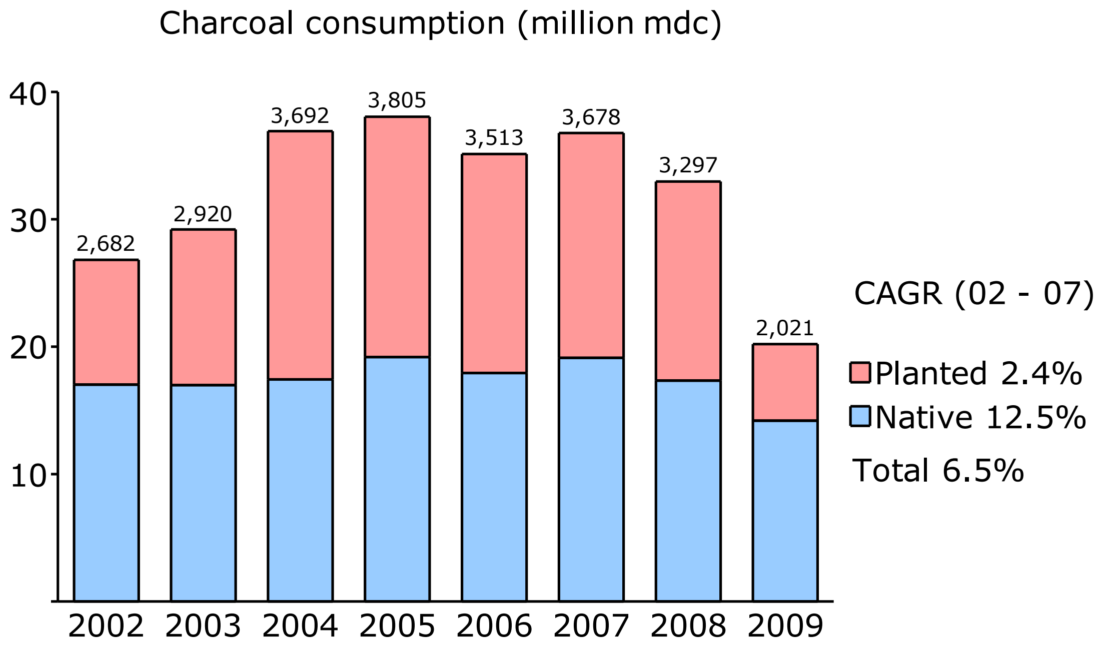

Figure 10 Charcoal consumption[33]

The numbers in the figure 10, show the evolution of the charcoal consumption from 2002 to 2009. It is possible to identify in the graphic the effects of the economic crisis that began in 2008 and had effects in this year and in 2009. The reduction in the consumption was of 10% from 2007 to 2008 and of 39% from 2008 to 2009.

Since it is clear that these are effects of the economic crisis, the year of 2007 was used such as basis in order to calculate the CAGR (compounded average growth rate).

According to the numbers given by the AMS, the charcoal consumption from planted forests is grew by 2.4%, while the consumption from native forests grew by 12.5% from 2002 to 2007. Therefore, the charcoal consumption grew at a CAGR of 6.5%. What can be concluded from these numbers is that the charcoal growth is resulting mainly from the growth its production in native forests.

However, if we take into consideration opinion from other sources, such as the INEE[34] or the MMA[35], these numbers are different. According to the INEE, in 2006,

[33] Source: AMS
[34] INEE Instituto nacional eficiência energética, or National institute of efficient energy

66% of the charcoal produced came from native forests, which according to the MMA is even worse and “85% of the Brazilian charcoal come from native forests”[36].

These differences can be explained because these numbers that are coming from sources such as the IBGE[37] “takes into consideration just the extraction from native forests that are legally indexed”[38]. Since a big slice of the extraction in native forests is illegal, it is not indexed and therefore, it is not presented in the numbers coming from the IBGE or from the AMS.

Although the numbers about the native forests obtained from the AMS are not very accurate, the data about the planted forests is trustable and the CAGR in quantity produced in this sector was equal to 2.4% from 2002 to 2007.

Imports

Imports can be an important share of the consumption of a good if this is a product that is more easily found abroad than inside the country. Besides that, this is a part of the equation that is needed in order to forecast the charcoal production in Brazil. The figure below shows the evolution of the imports from 2006 to 2009.

---

[35] Ministério do meio ambiente, or Environmental ministry
[36] VITAL, MARCOH. F. and PINTO MARCO A. C. Condições para a sustentabilidade da produção de carvão vegetal para a fabricação de ferro-gusa no Brasil.
[37] IBGE Instituto brasileiro de geografia e estatística or Statistics and geography Brazilian institute
[38] VITAL, MARCOH. F. and PINTO MARCO A. C. Condições para a sustentabilidade da produção de carvão vegetal para a fabricação de ferro-gusa no Brasil.

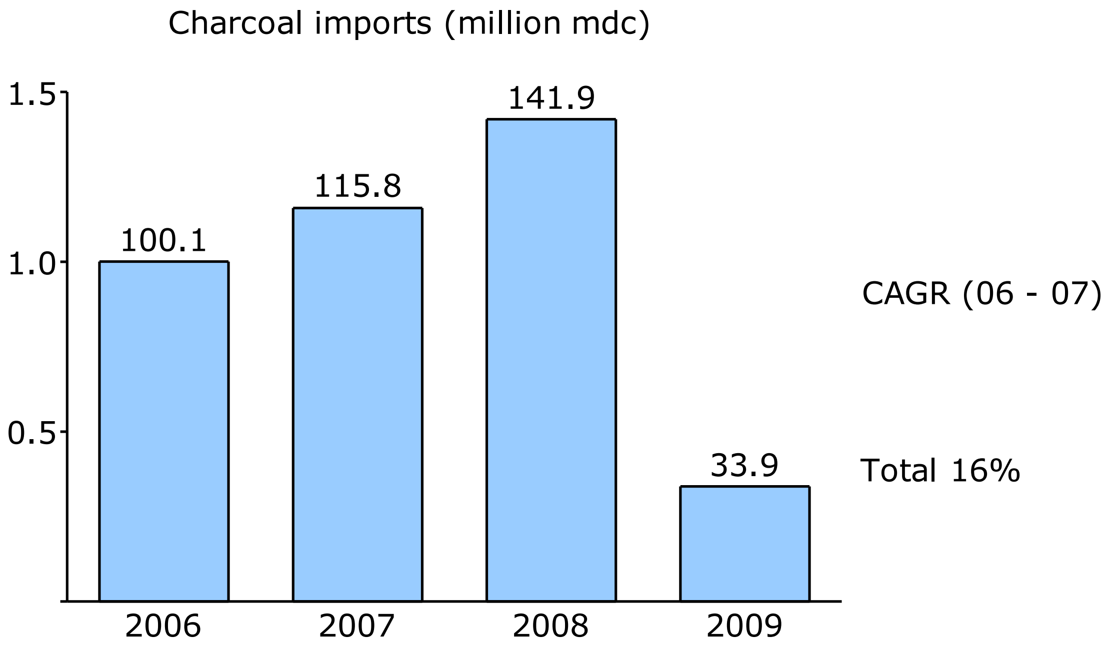

Figure 11 Charcoal imports[39]

It is interesting to take a look at this figure and see that even with the economic crisis, in 2008 the charcoal imports didn't suffer the effects of the economic crisis. However, in 2009 the numbers showed a very big reduction in the quantity imported.

In order to see the importance of the imports over the charcoal consumption, the figure 12 was prepared.

[39] Source: MDIC Ministério do desenvolvimento e comércio exterior or Development and external trade ministry

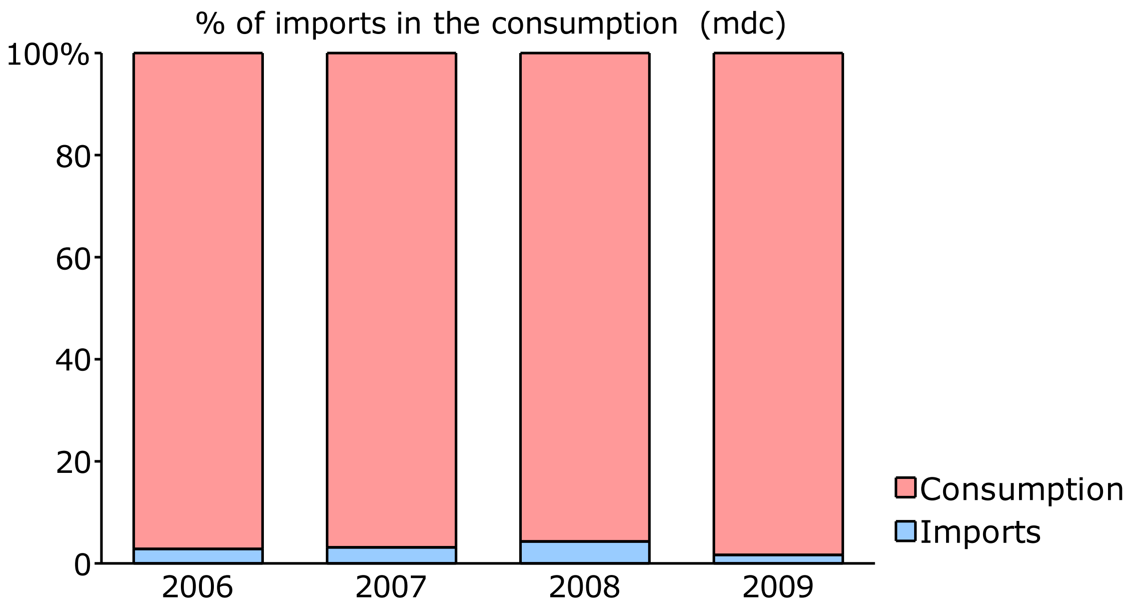

Figure 12 Charcoal imports importance

This figure helps us to see that although the imports presented a very high growth in 2007 and 2008, they have never been important for the sector since not even in 2008, when the imports grew despite of the economic crisis. It can be concluded from this figure that the imports are not relevant in this market.

Exports

The analysis of the exports is necessary in order to conclude the dependancy of the sector from abroad. The logic of the analysis is the same as the one that was made for the imports, there will be an analysis of the evolution of the numbers over the years followed by an analysis of the relative importance of the exports over the total production.

Figure 13 shows the evolution of the numbers from 2002 to 2009.

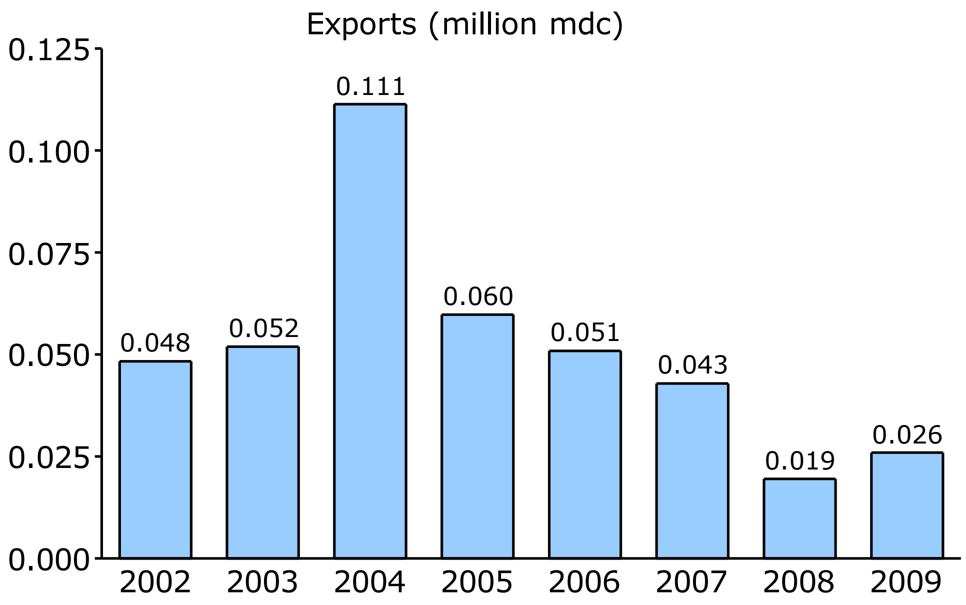

Figure 13 Charcoal exports[40]

The charcoal exports do not seem to have a regular trend over the years. Despite of the increase in the exports in 2004, this number decreased a lot since this data and increased a little bit in 2009, a year in which many sectors were suffering effects of the economic crisis.

The relevance of the exports for the charcoal will be analyzed in terms of total production of the commodity in Brazil. The production will be calculated in the next section, but the numbers about it are used in this part of the work. The figure below shows the historical relation between the charcoal production and the exports.

[40] Source: MDIC, AMS

Figure 14 Charcoal exports importance

Since the importance of the exports is very low (lower than 1% over the total production since 2006), there is no need of a more detailed analysis in this sector.

Production

Once we have the data about consumption, imports and exports, it is possible to prepare an analysis about the charcoal production. It is possible to prepare a balance of supply of the charcoal. This balance of supply is shown below.

Table 5 Charcoal balance of supply

	2006	2007	2008	2009
Exports	0,05	0,04	0,02	0,03
Imports	1,00	1,16	1,42	0,34
Consumption	35,13	36,78	32,97	20,21
Production	34,18	35,66	31,57	19,89

It is possible to see that in 2009, there was a decrease in the charcoal production. This can be an effect of the economic crisis in 2008. In order to better analyze the evolution of the charcoal production, the figure 16 was prepared.

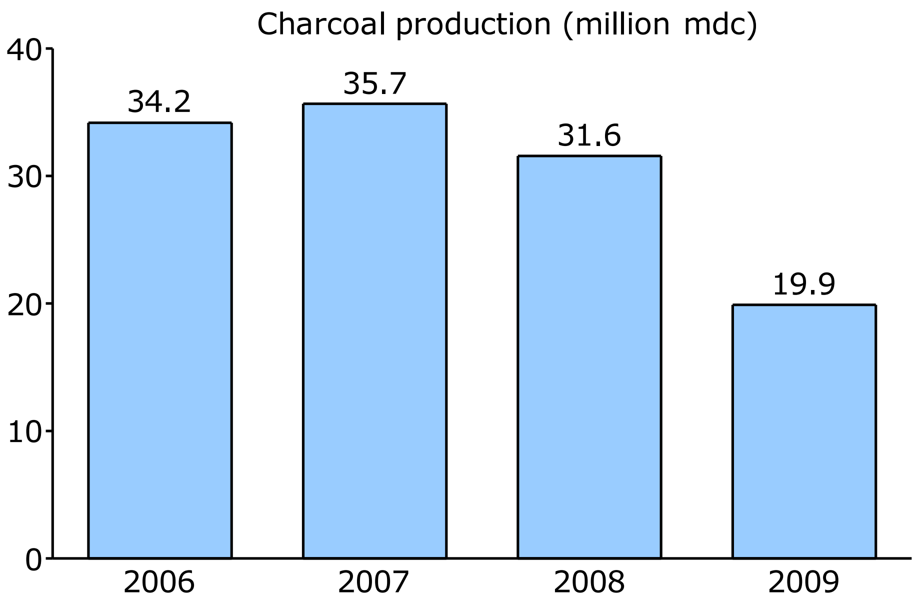

Figure 15 Charcoal production

The charcoal production does not show a regular trend over the years and therefore, based in the historical data, it is difficult to forecast an increase or decrease in the market. The destination of the product will be analyzed in order to try to forecast these market trends.

There aren't big players that are working on the charcoal production in Brazil. As it will be seen in the next pages, the charcoal prices and its consumption are actually determined by the pig iron industry.

Destination

The destination of the charcoal is being analyzed in order to verify if the product is dependent or not of some sector. The figure 16 shows the evolution of the destination of charcoal products since 2004 in percentage.

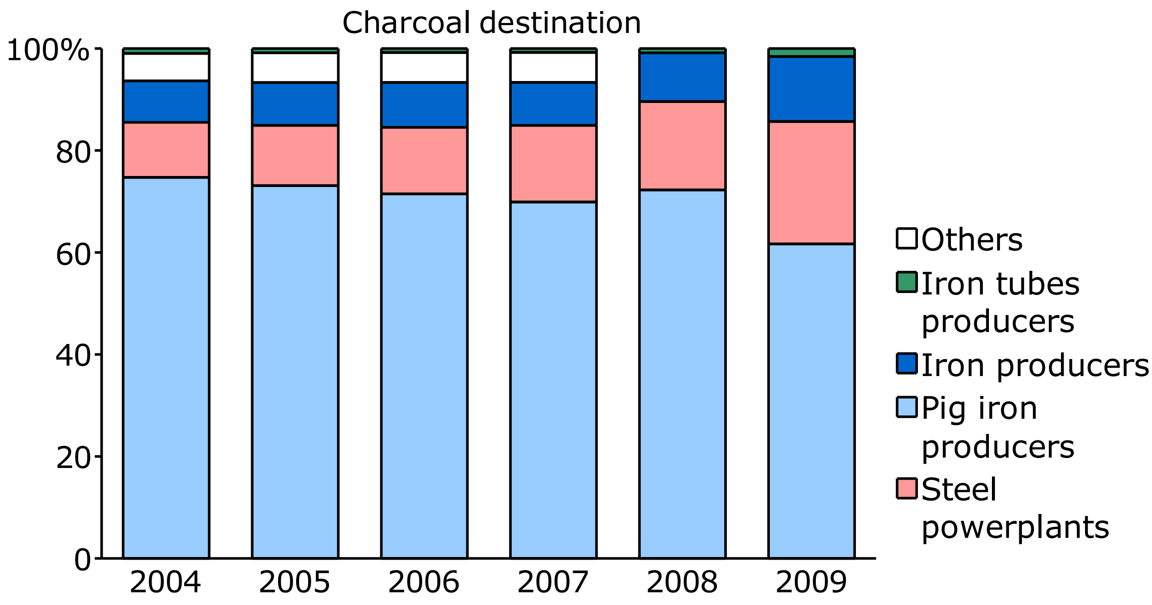

Figure 16 Charcoal destination

This figure shows the imortance and dependence that the charcoal has on the iron sector, especially on the pig iron, which corresponds to more than 70% of the charcoal destination in almost all the years of the period.

Prove of this importance is the influence that the steel have on charcoal prices. Because of this importance, the pig iron market is being analyzed in details in the next topic.

Pig iron

The pig iron is a very important market for the charcoal, or even for the eucalyptus market in general, this importance figure is highlighted in the figure below.

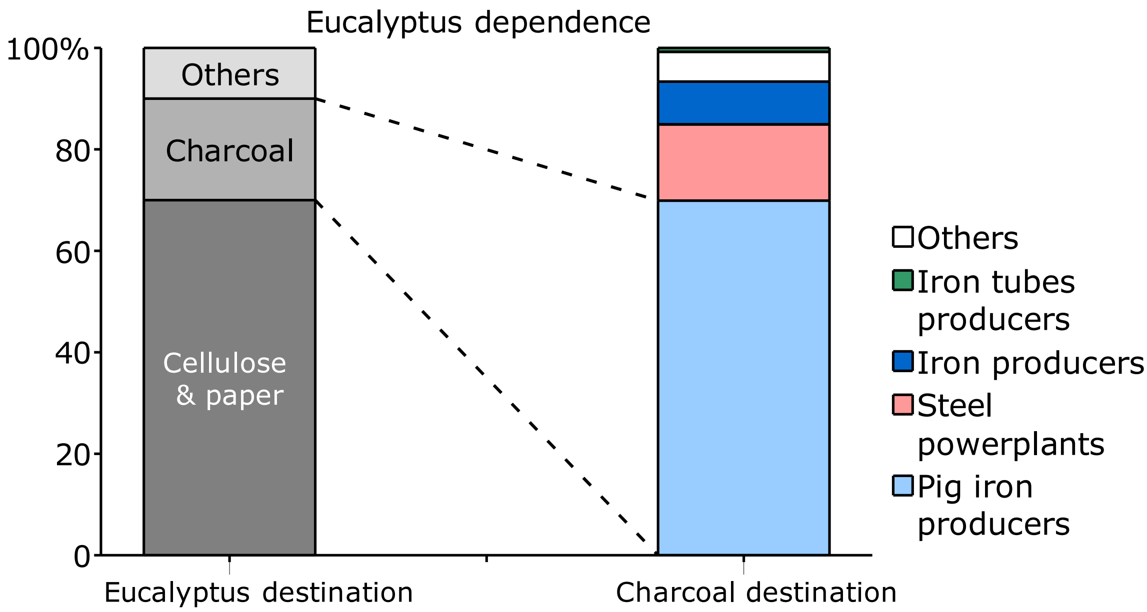

Figure 17 Eucalytus and charcoal destination[41]

The pig iron market will be analyzed in three main parts, the pig iron supply, the main players in the market and the destination of the goods in a general way (external or internal market).

Supply chain

The main raw materials used in the pig iron production are the iron ore and the reducer, that can be either the coal and the charcoal. The iron ore comes from the minings, that are located inside Brazil like the majority of the charcoal, while the coal is mainly imported from other countries. The figure 18 shows the pig iron's supply chain.

[41] The year used as basis for the analysis of the charcoal destination is 2007

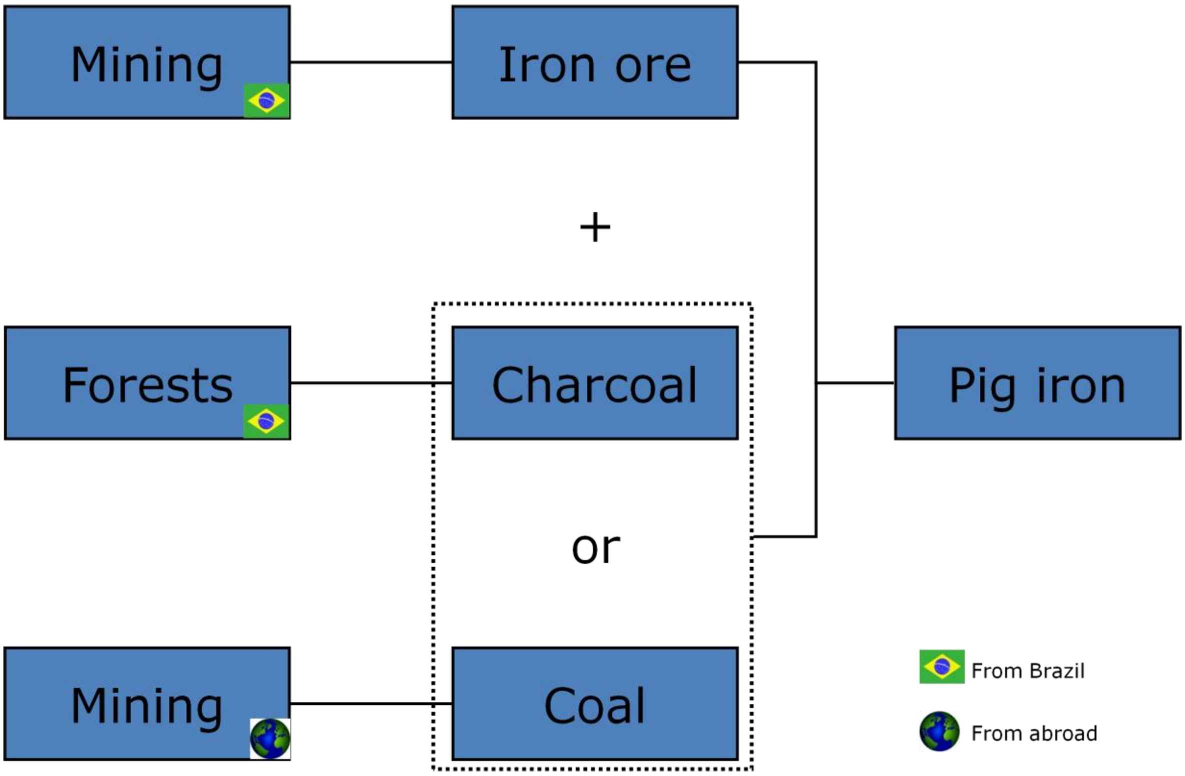

Figure 18 Pig iron supply chain

By analyzing the supply chain, it is possible to verify that there are two main raw materials that have influence on the charcoal, the iron ore, that can be understood such as a complementary product the coal that can be seen such as a substitute to the charcoal. Hence, the higher the iron ore prices, the lower there will be the charcoal prices.

On the other hand, if the coal prices suffer an increase, the charcoal ones will do the same. Since the coal is a good that is mainly imported, it suffers effects from the exchange rate. Therefore, the devaluation of the real (Brazilian exchange rate) could have a positive effect for the charcoal, since it increases the prices of its main substitute product.

The use of these two raw materials, the charcoal and the coal, is better analyzed in the next topic since they are segmented by the players that use them.

Players

There are three main pig iron producers, that are segmented either by the raw material that is used (charcoal or coal) and by the vertical integration with the steel production (integrated producers are the ones that produces the steel from the pig iron and the independent ones are the players that produce the pig iron but do not produce the steel).

The importance of these main players is being analyzed in terms of production. The figure below shows the evolution of these numbers in Brazil since 2004.

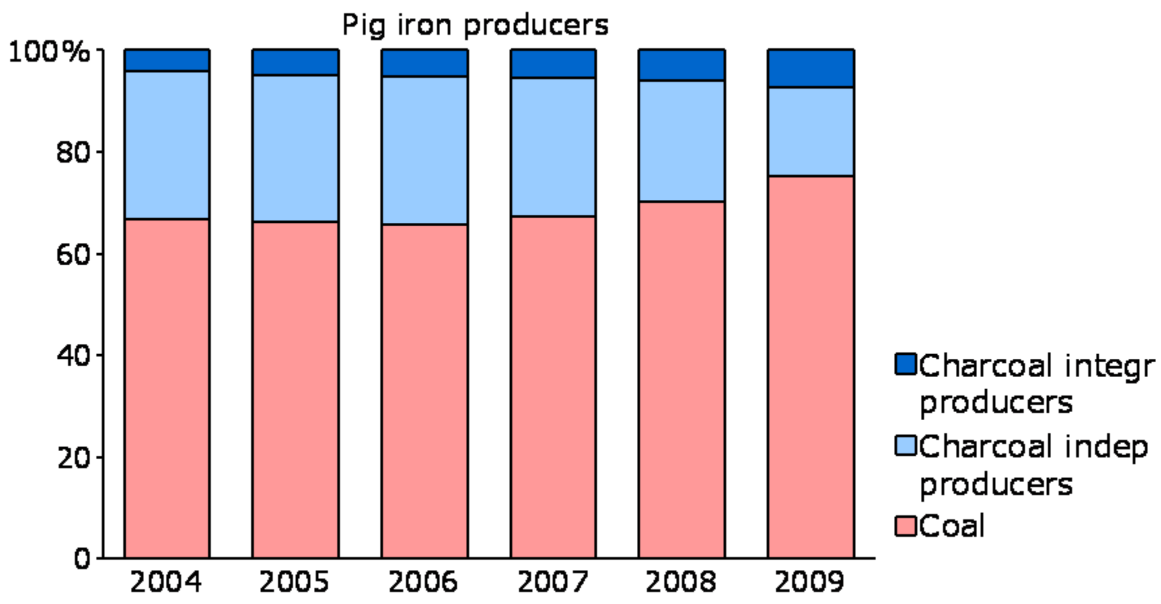

Figure 19 Pig iron producers

Three players can be observed in the graphic above. The players that use coal as its reducer and two charcoal players: the integrated and independent players. The meaning of integrated and independent players is the relation that the pig iron producers have in relation to its steel production.

Integrated pig iron producers are the ones that produce not only the pig iron but also the steel while the independent players only produce the pig iron, selling the product to other industries.

The figure 19 shows that the coal is much more used than the charcoal, which is very bad for our product. When the analysis of why this is happening is made, we can observe some of the root causes for this situation, these reasons are described below:

a) Pig iron power plants that are prepared to use coal as reducer cannot use the charcoal. However the power plants that are prepared to use charcoal can use the coal without losing yield. Therefore, the coal is a perfect substitute for the charcoal but the charcoal cannot be used to substitute the coal.
b) Pig iron power plants that operate with big economies of scale are prepared to use coal. Since these industries cannot use the charcoal and they are the main producers of pig iron, the charcoal loses a big slice of market share from these power plants
c) The coal is more efficient than the charcoal. It is needed less coal than charcoal, in kilograms, to produce the same amount of pig iron. Besides that, the price per kilogram of the coal is cheaper than the charcoal's prices. Therefore, the efficiency in terms of pig iron produced divided by the reducer expenses is higher for the coal.

This last point that justifies the reasons why the coal is more used than the charcoal also explains why the charcoal producers tend to be near the pig iron industries. It happens because the charcoal producers by doing so, reduce the logistics costs and therefore reduce the total cost of the product.

Since most of the coal used by the industries is imported, this raw material will necessarily have logistics costs, what can be used as a competitive advantage by charcoal producers in terms of total cost for the industry.

Destination

The last point of the analysis of the pig iron market is the destination of the pig iron to other markets. In the state of Minas Gerais that is the most important region for our analysis, since the consumer market for the farm is located only in the state.

The independent producers are the most important consumers of the charcoal, since they produce more pig iron than the integrated ones. The figure 20 analyses the historical values for pig iron destination, in terms of internal and external markets.

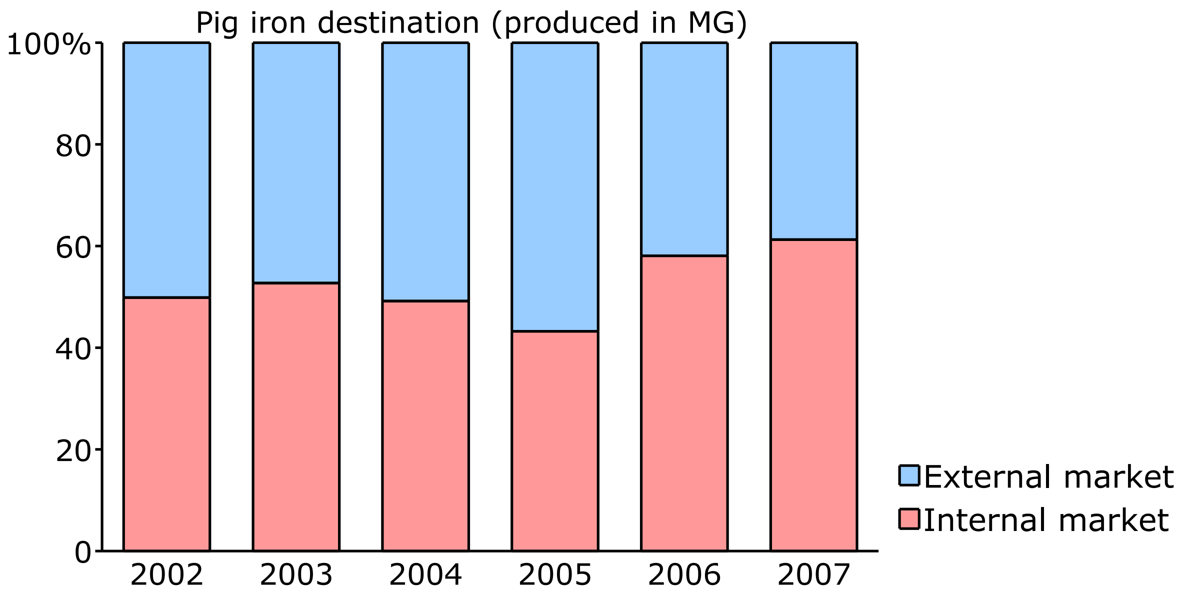

Figure 20 Pig iron destination

Figure 20 shows that the Brazilian pig iron producers have a big dependence on the external market and therefore are exposed to some risks of the world economy, such as the exchange rate and the global economic situation.

What can be concluded from this analysis once again is that the more devaluated the Brazilian exchange rate, the better for the charcoal market, since the prices of pig iron will be lower in the international market and the coal prices will be higher for the steel manufacturers[42]. Therefore, charcoal's main substitute product will be more expensive, while the pig iron, one of the main destinations of the charcoal will have an increase in the volume sold.

[42] When these prices are measured in reais

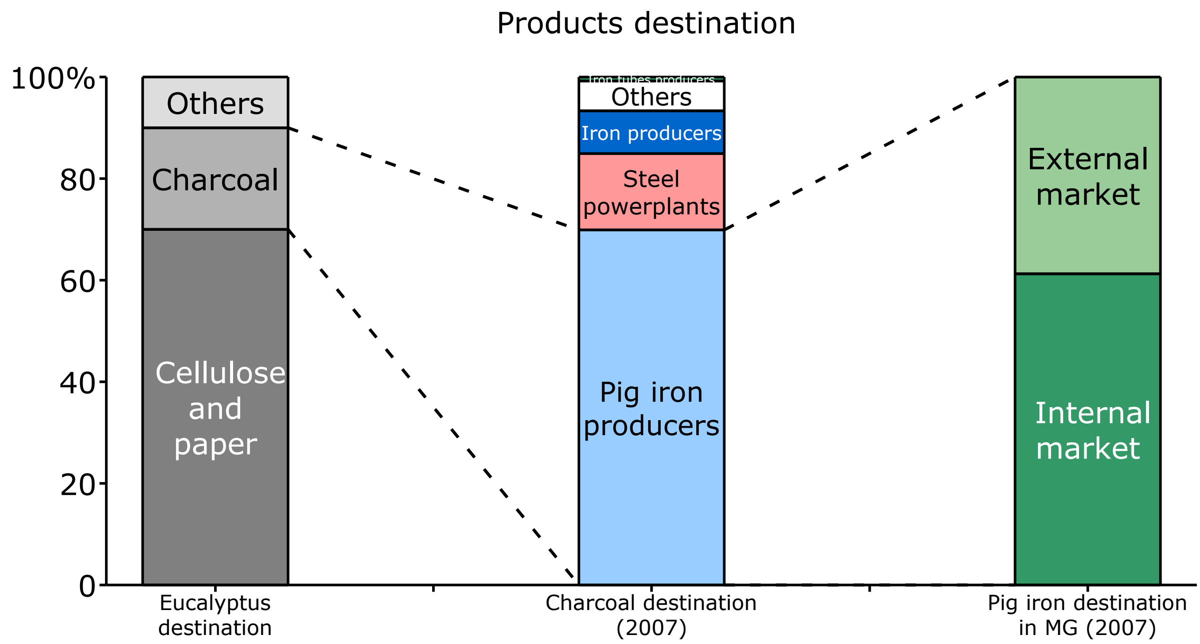

Figure 21 Products' destination

This last figure that shows the destination of the charcoal pig iron, helps to observe the products destination in a broad way.

Prices

The analysis of the markets suggests that the charcoal depends a lot on the pig iron, a market that according to some analysts is very dependent on the steel and the global economy. According to these, the graphic comparing the steel international prices and the charcoal prices both measured in US dollars was prepared.

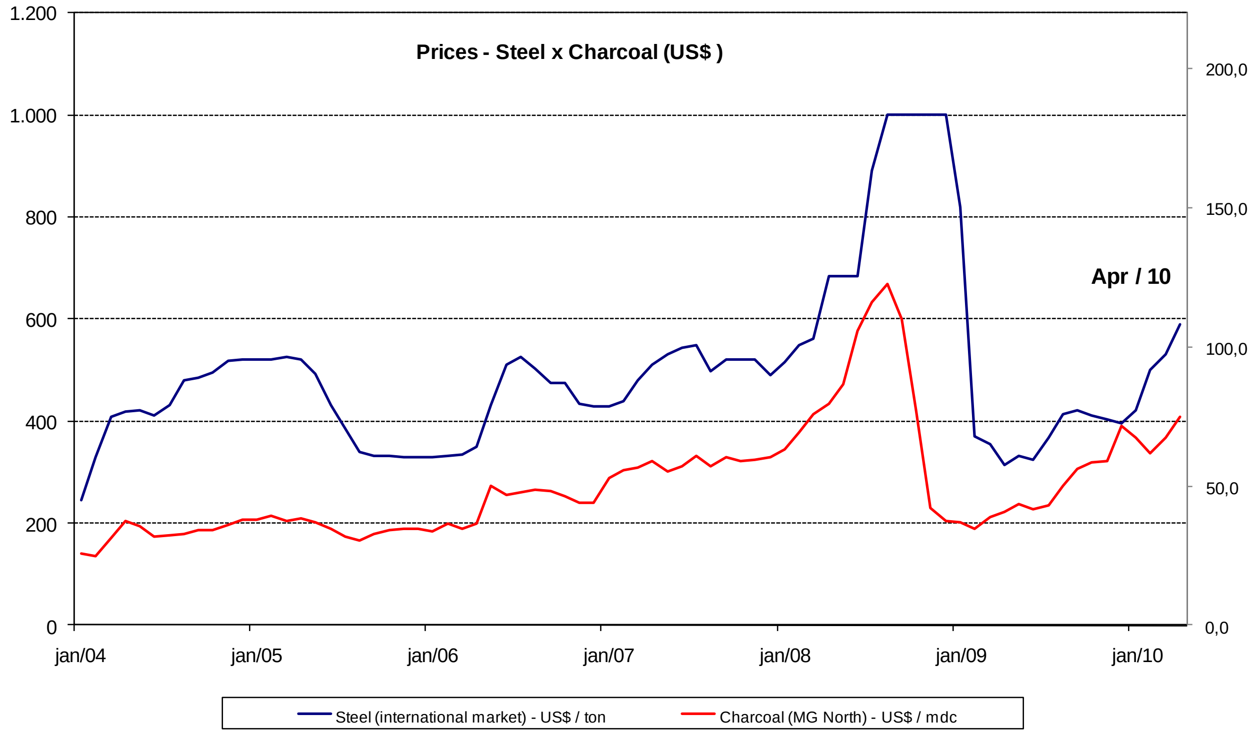

Figure 22 Charcoal and steel prices'

The adherence of these two curves (charcoal and steel prices) is almost perfect for all the period. It can be concluded from this, that the charcoal is very dependent on the international steel market. Since this dependence is clear, the prices for this market are being considered as a function of the steel prices.

3.7. Pellets

"Wood pellets are the most advanced biomass, a cylindrical organic fuel produced with dense biomass made out of *serrim,* wood residues and other biomass".[43] The characteristics of a wood pellet are described below:

a) Length: 10 to 30 mm
b) Diameter: 6 to 8mm
c) Calorific power: 4,600 kcal/kg
d) Unitary density: 1 to 1.4 kg/dm³
e) Density (to transport): 650kg/dm³
f) Humidity: 10%[44]

The analysis of the wood pellet market is being done for the European market, which seems to be the main market for this commodity. The study is made in four main parts, which are described below:

a) Wood pellets production: Shows the way the pellets are being produced in the farm
b) Types of wood pellet: Describes the types of wood pellets, its applications and the European countries that consume each kind of pellet
c) Wood pellets market: Describes the European market in details, the main producers, consumers, exporters and importers
d) Prices: The prices of the wood pellets that are being used in the economic analysis

Wood pellets production

In the farm, the wood pellets are being produced only with the residues that are left from the charcoal production. In other words, since when the eucalyptus tree is sold the buyer takes with him all the eucalyptus tree (trunk plus residues), it is not possible to produce wood pellets when the eucalyptus tree or lumber is sold.

The quantity of residues from an eucalyptus tree can be obtained by calculating all the parts that are not used in order to produce lumber. The biomass of the eucalyptus tree, divided by its forms is described in the table below.

---

[43] http://energiabiomassa.com/energias-renovaveis/o-que-sao-pellets/
[44] http://energiabiomassa.com/energias-renovaveis/o-que-sao-pellets/

Table 6 Residues distribution[45]

Part	Quantity
Trunk	67%
Root	15%
Bark	10%
Others (leaves and branches)	8%
Total	100%

This is the description of the total eucalyptus tree's biomass, out of this only the trunk is used in order to produce the charcoal, meaning that there is 33% of residues that are not being used. In this work however, the root is not being used in the pellet production[46].

The quantity of residues available per hectare can be calculated by using the equation below.

$$RPH = \frac{AAI}{\%\, trunk} * (\%\, residues)$$

The percentage of trunk and the percentage of residues is the quantity of each one out of the total biomass. This equation happens because the AAI refers only to the quantity of biomass that is present in the trunk.

In the farm, the AAI is equal to 40 m^3 / ha year, the RPH (residues per hectare) is equal to 10.75 m^3 / ha year (since the root is not being used).

Types of wood pellet

The wood pellets are divided in four main types that varies according to its applications and size. These types of fuels are bulk pellets for power production (BPPP), bulk pellets for disctrictal (BPDH) heating, loose pellets for residential heating (LPRH) and bagged pellets for residential heating (BPRH).

The differences between the LPRH and the BPRH are the size of the bag. The loose pellets are pellets that contain more than 25 kg per bag while the bag pellets contain until 25 kg per bag.

45 Source: http://www.eucalyptus.com.br/capitulos/capitulo_minerais.pdf
46 The farmers consider that it is difficult to extract the root and they believe that it can cause damage in the soil

There are differencies between countries according to the use of the wood pellets, these are highlighted in the figure 23 presented below.

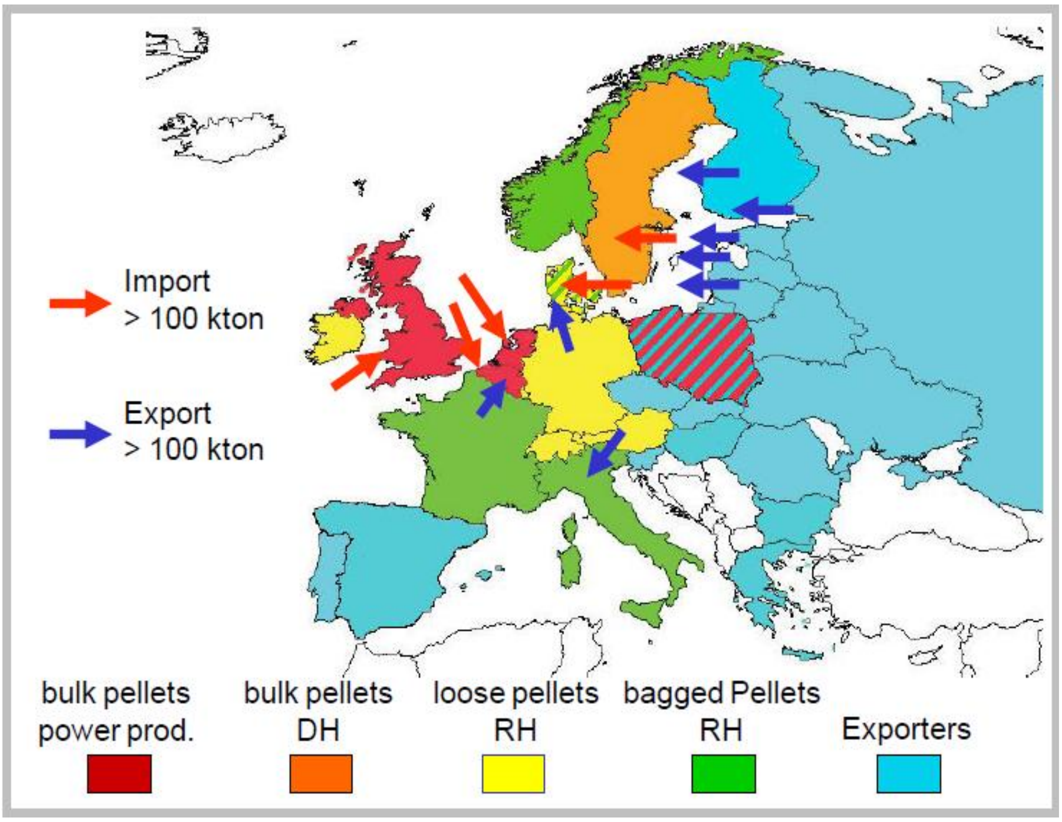

Figure 23 Use of wood pellets[47]

According to the figure it is possible to observe the main consumers for each type of pellet. These countries are described below according to its pellet use.

a) BPPP – United Kingdom, Belgium and Netherlands
b) BPDH - Sweden
c) LPRH – Germany, Austria and others
d) BPRH - Italy, France and Norway
e) Exporters – Portugal, Spain and most of Eastern Europe

Besides these, there are countries such as Denmark that consumes more than one type of wood pellet.

The prices for each type of wood pellet varies according to its use and country in which the product is sold. The prices for each type of application are presented in the annexes.

[47] This figure was taken from Pellets@las. *Final report on producers, traders and consumers of wood pellets.* Vienna, Austria, p.9 December 2009.

Wood pellets market

The European market consumed 8,074 thousands of tonnes of wood pellets in 2008. In the same year the production in the European union was of 7,429,000 tonnes which corresponded to 56% of the total production capacity used.

The production, consumption, imports/exports, total production capacity and the number of pellet producers by European country is presented below.

Table 7 European countries - wood pellets production, consumption and production capacity

European market ('000 tons)					
Country	Consumption	Production	Imports / Exports	Production capacity	Used capacity
Germany	900	1460	-560	2400	61%
Sweden	1850	1405	445	2200	64%
Italy	850	650	200	750	87%
Austria	509	626	-117	1006	62%
Latvia	39	379	-340	744	51%
Finland	149	373	-224	680	55%
Poland	120	340	-220	674	50%
Estonia	0	338	-338	485	70%
Belgium	920	325	595	450	72%
France	200	240	-40	1392	17%
Slovenia	112	154	-42	185	83%
Denmark	1060	134	926	313	43%
United Kingdom	176	125	51	218	57%
Netherlands	914	120	794	130	92%
Lithuania	20	120	-100	153	78%
Slovakia	18	117	-99	142	82%
Romania	25	114	-89	260	44%
Portugal	10	100	-90	397	25%
Spain	10	100	-90	150	67%
Others	192	209	-17	645	32%
Total	8074	7429	645	13374	56%

The European wood pellet total production used capacity was below 60% in 2008. This information can be tricky however since the main reason for this low usage was not the lack of interest in producing the product but the scarcity of raw materials.

According to pellet@las, “a shortage of raw materials for pellet production is reported from most of the European pellet markets and the broadening of the feedstock bas, i.e. the use of residual wood, SRC (short rotation coppice) or agricultural biomass for pellet production, is becoming necessary."[48]

Main consumers

According to table 7, the main wood pellets consumers are Sweden, Denmark, Belgium, Netherlands, Germany and Italy. These six markets, when summed correspond to more than 80% of the consumption in Europe.

The figure below shows all the European countries in order of consumption.

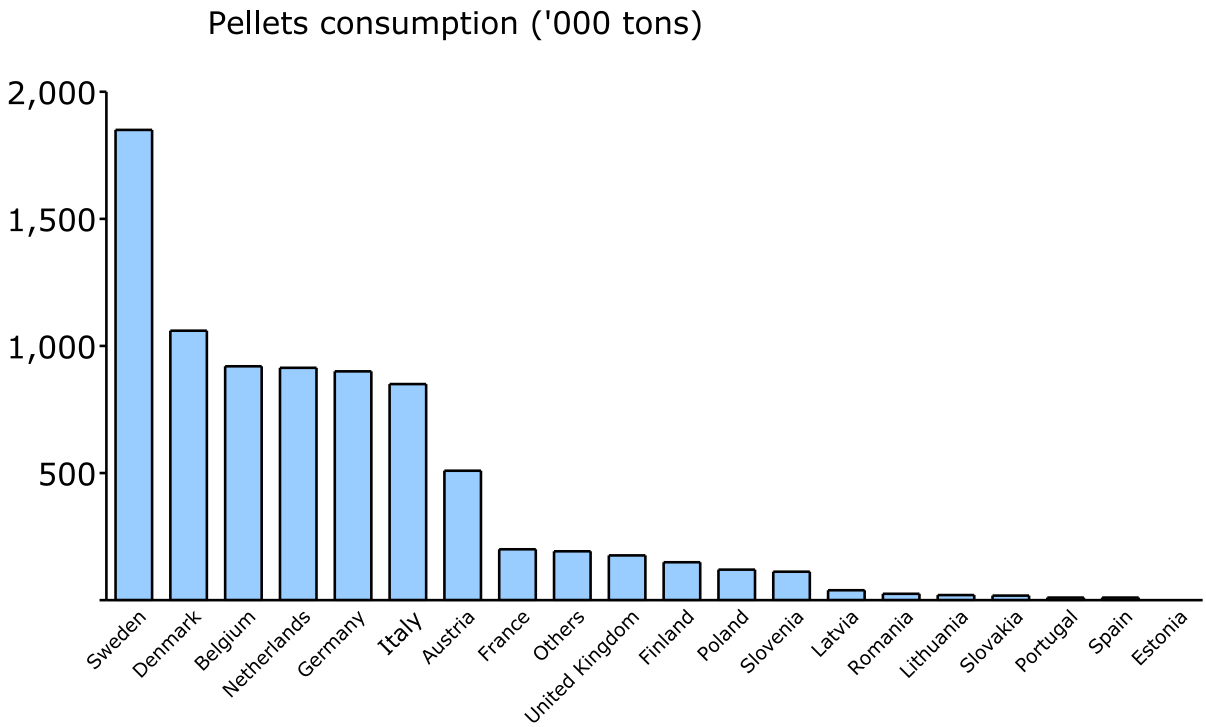

Figure 24 European wood pellets consumption

Main producers

The main wood pellet producers in order of importance are the following: Germany, Sweden, Italy, Austria, Latvia and Finland, that together corresponds to more than 65% of all European production.

The first three more important countries in terms of production are between the most important ones also in terms of consumption. The most important European producers are shown in the figure below.

[48] Pellet market overview report

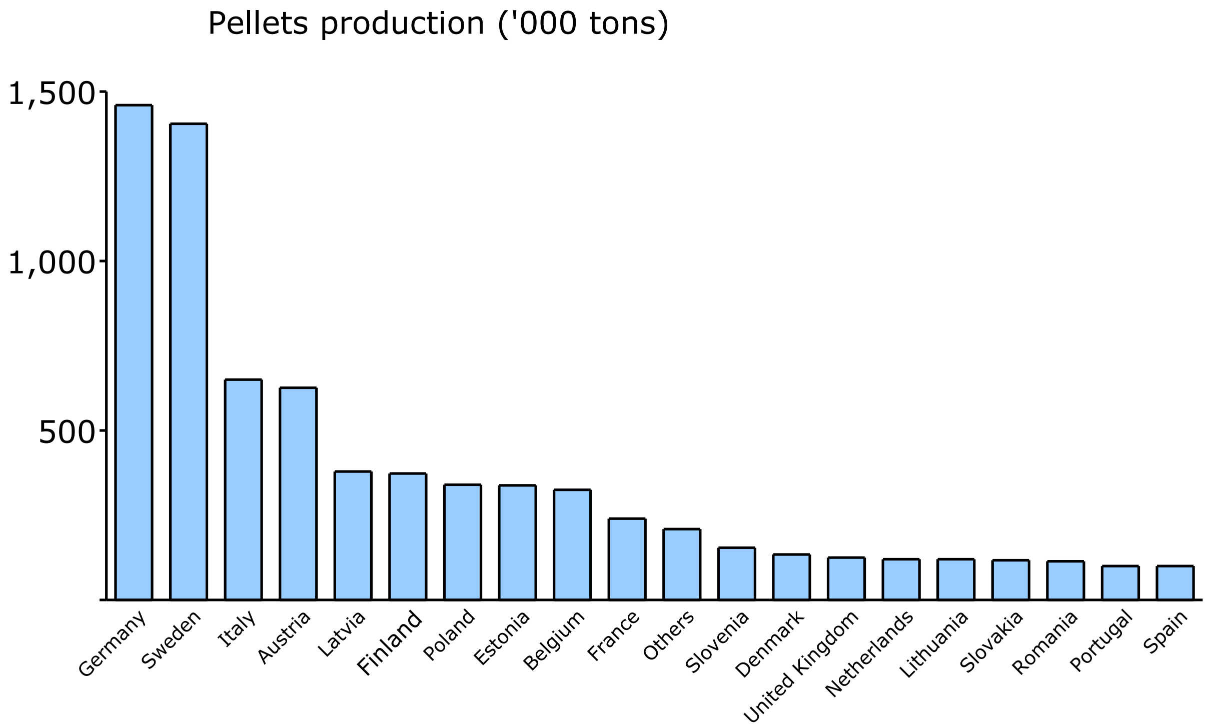

Figure 25 European wood pellets production

It is possible to observe that, differently from consumption, all European countries produce wood pellets.

Importers

The most important importers of this commodity are Denmark, Netherlands, Belgium, Sweden, Italy and the United Kingdom. The balance for all the countries is shown in the figure 26 below.

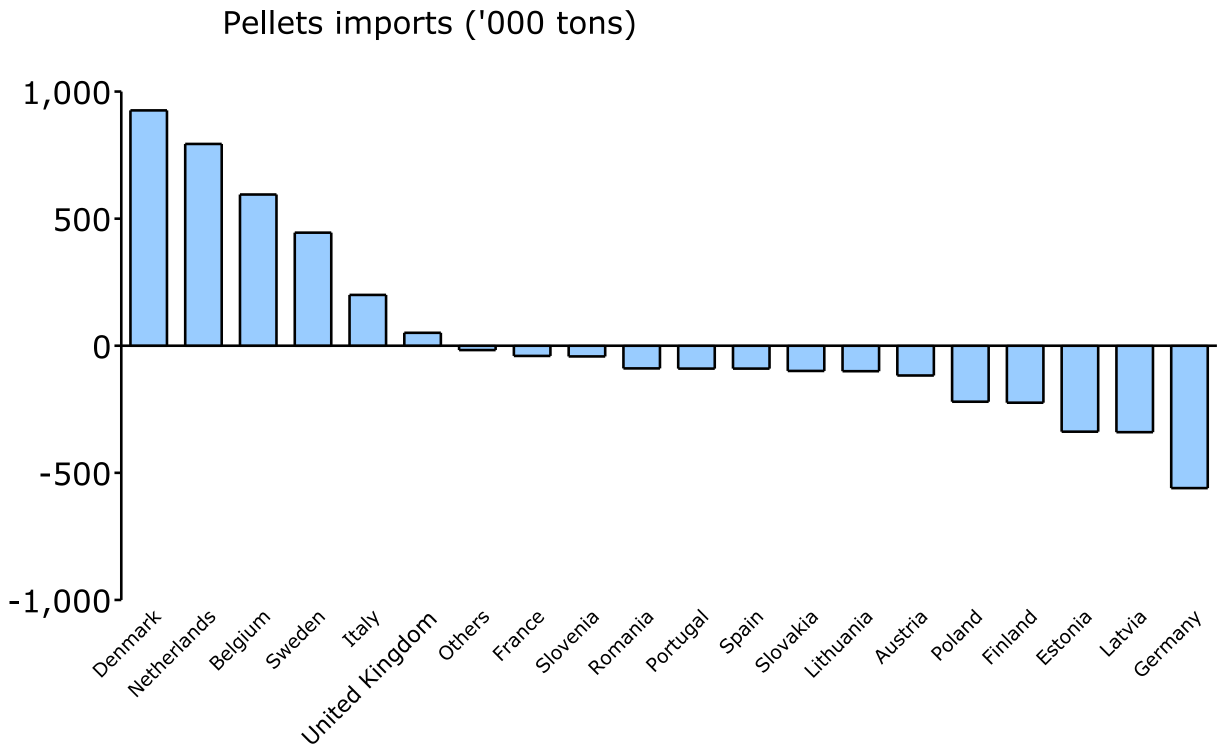

Figure 26 European wood pellets importers

Future of the market

According to the pellet@las in its report about future projections for the market[49], there will be a growth in the demand that will be much stronger than the growth in the supply in the European union.

Consequently, there will be an increase in the imports made by the continent, what represents an opportunity for potential exporters such as Brazil that has a good technology for cultivating its eucalyptus trees. The figure below shows these projections.

[49] Pellets@las Projections on future development of European pellet market and policy recommendation

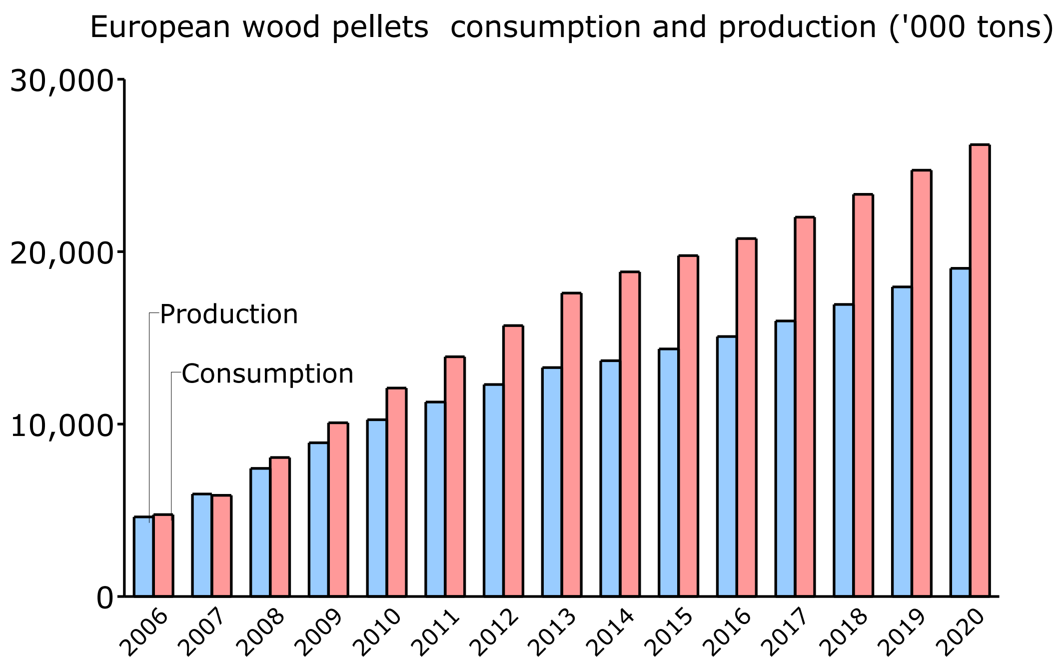

Figure 27 European wood pellets consumption and production

It is possible to verify in the graphic that the pink bar, that corresponds to the wood pellets consumption increases faster than the consumption, what creates a deficit that will be fulfilled by imports.

Main companies

The top ten companies in terms of production capacity all over the world in 2008 are listed in the table 8.

Table 8 Wood pellet companies

Company	Country	Annual production capacity ('000 tons)
VAPO pellets	Sweden	500
Energy E2	Danmark	280
Premim pellts	Canada	200
SCA BioNorr AB	Sweden	160
Pacific Bioenergy Corp	Canada	140
Skelleftea Kraft	Sweden	130
BBG Hansa Grannul	Estonia	120
BG Graujas Granula	Latvia	110
Fulghum Fibres Fuels	USA	110
Labee Group	Netherlands	100

The number of wood pellet producers just in the regions studied in Europe is equal to 537[50]. Since the total production capacity in Europe is equal to 13,374 tons/year and the top seven European producers have an annual production capacity of 1,400.

Since the production capacity of the seven top players in Europe corresponds to a little bit more than 10% of the total European production capacity , it can be concluded that there is not a very big player in the market with a high bargaining power capable of causing market distortions.

Prices

The wood pellet prices that are being considered in this analysis are the ones that correspond to the bulk pellets for power production. This type of pellet was chosen by the farmers in Brazil because the commercialization of the product is easier than the others, since it is only necessary to sell the product in the Roterdam port, without the need of internal distribution.

[50] ETA Florence renewable energy. *Projections on future development of European pellet market and policy recommendation.* Florence, Italy December 2009

The prices for this commodity in that are presented below are prices that correspond to long term contracts. According to the pellet@las, "The difference between long term contracts of one year and longer (relative high prices) and short term contracts of spot markets (generally lower prices) could be about 10 euros/tonne or more."

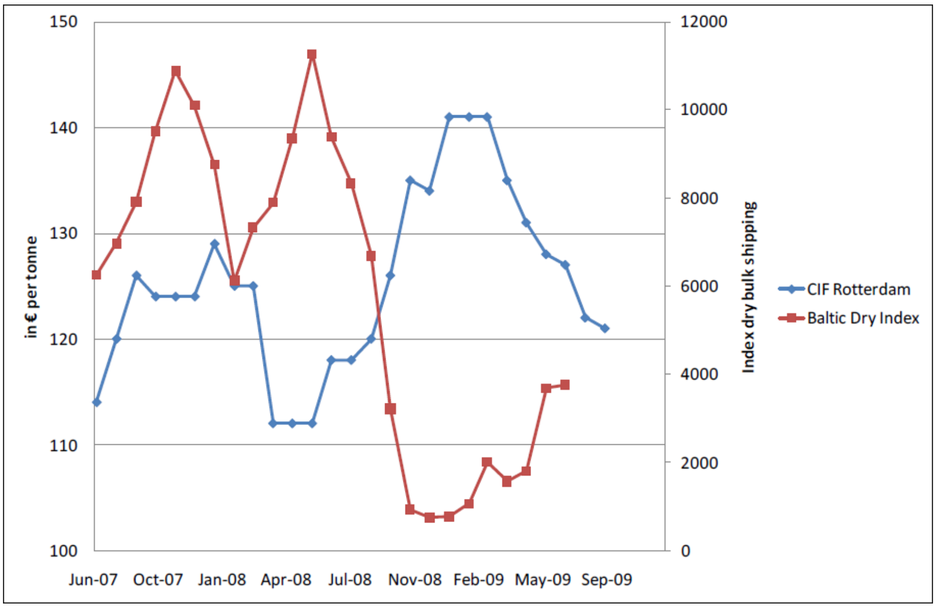

Figure 28 BPPP prices (FOB)[51]

The analysis of thes prices is better done in the chapter about revenues, in which there will be made prices' forecasts in order to try to antecipate the revenues for this product.

[51] This figure was taken from Pellets@las. *Final report on producers, traders and consumers of wood pellets.* Vienna, Austria, p.9 December 2009

4. Investments and costs

In this chapter, the costs of each activity will be described in details. According to REZENDE et al[52], the costs can be separated in common costs and others.

Common costs are incurred to the producer independently of its final production; these are the forest cultivation costs. Besides these, there are the harvesting costs, the activity which transforms the eucalyptus tree in lumber; the charcoal production costs, which transforms the lumber in charcoal; and the wood pellets production costs, which transforms the residues in wood pellets.

4.1. Common costs

The cultivation of the forest is the most important part of the forestry activity because the productivity in this phase has a strong and direct impact in all the following phases of the supply chain.

It is also important to highlight that in the cultivation of the forest, there are no revenues for a period of seven years[53], and therefore, the management of the cash in this period is extremely important. Since the costs are the only cash activity that deals with the cash flow during the first seven years, its administration must be done carefully.

Since the cycle of the eucalyptus is being considered a 14 years period, which means that the forest is harvested two times in the period, each one after a seven years. There are two types of common costs, the plantation common costs that occur from the first to the seventh year and replanting commons costs that occur in the second period, from the seventh until the fourteenth year.

According to the IEF/Asiflor fomentation program, the common costs are divided in four categories, which are mechanization, raw material, labor and maintenance. The table 9 shows the plantation costs for the year of 2006. The table shows respectively in each of the columns: the cost specification; the year in which the

[52] REZENDE, J.L.P. ET AL. *Análise econômica de fomento florestal com eucalipto no estado de Minas Gerais. Cerne,* Lavras, v.12, n.3, p. 224, Jul / Sep 2006

[53] The eucalyptus takes seven years to grow and, during this period it is not possible to obtain revenues from the forest

cost is incurred; the unit in which the cost is measured; the cost for each unit; the quantity needed for each hectare[54]; and the total cost for each hectare.

Table 9- Common costs of the IEF/Asiflor program

Cost specification	Year	Unity	Cost / unity	Quantity / ha	Cost (R$ / ha)
Mechanization	1				**R$ 480**
Plowing	1	th*	R$ 80,00	1,5	R$ 120
Disking	1	th	R$ 80,00	1,5	R$ 120
Herbicide application	1	th	R$ 80,00	2	R$ 160
Fertilization	1	th	R$ 80,00	1	R$ 80
Raw materials	1				**R$ 501**
Ant protection	1	kg	R$ 4,33	6	R$ 26
Seeding	1	unity	R$ 0,15	2000	R$ 300
N-P-K	1	kg/L	R$ 14,00	5	R$ 70
Herbicides	1	kg	R$ 0,70	150	R$ 105
Labor					
Ant protection***	1 and 7	ld**	R$ 30,00	1	R$ 30
Fertilization	1	ld	R$ 30,00	1	R$ 30
Plantation	1	ld	R$ 30,00	3	R$ 90
Sprouting	7	ld	R$ 30,00	1	R$ 30
Assistance	1	unity	R$ 10,43	21	R$ 219
Others	1	ld	R$ 30,00	6	**R$ 180**
Maintenance	***	hectare	R$ 55,00	1	**R$ 55**

*th - truck hour

*ld - labor day

***costs happen from the year 2 to 7 and from the year 8 to 13

In this work, the farm is divided in seven areas, equally distributed. This was made because by doing so, the farm can have revenues during all the years starting from the seventh year[55].

According to the table 9, taking into consideration the years in which the costs actually happen and the type of cost, it is possible to prepare the following cost tables:

[54] 10,000 square meters

[55] The eucalyptus takes seven years to grow, therefore, it is possible to harvest one area each year if the land is divided in seven

Table 10 Common costs from year 1 to 7

Year	1	2	3	4	5	6	7
Mechanization	R$ 480	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0
Raw materials	R$ 501	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0
Labor	R$ 549	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 60
Total	R$ 1.530	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 60

Table 11 Common costs from year 8 to 14

Year	8	9	10	11	12	13	14
Mechanization	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0
Raw materials	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0	R$ 0
Labor	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55
Total	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55	R$ 55

Since this is a work in which the costs are being projected for a long period of time, it is needed to use a factor that corrects the costs in the future. The raw material and mechanization costs are going to be considered stable in the projections, but the labor costs are being considered variable because these are costs that are growing a lot[56].

The labor costs are going to be forecasted by using the table 2, work force index, which forecasts the work force cost in the future. The total costs in R$ thousands, using this correction divided by each cost category are shown in the following tables.

[56] Like it was said in the chapter 2, the costs in the last six years, the wage in MG grew at an average growth of 8.75% yearly.

Table 12 Common costs from 2011 to 2017

Year	2011	2012	2013	2014	2015	2016	2017
Mechanization	R$ 240	R$ 240	R$ 240	R$ 240	R$ 240	R$ 240	R$ 240
Raw Material	R$ 250	R$ 250	R$ 250	R$ 250	R$ 250	R$ 250	R$ 250
Labor	R$ 537	R$ 643	R$ 762	R$ 898	R$ 1.052	R$ 1.226	R$ 1.430
Total	R$ 1.028	R$ 1.133	R$ 1.253	R$ 1.389	R$ 1.543	R$ 1.717	R$ 1.921

Table 13 Common costs from 2018 to 2024

Year	2018	2019	2020	2021	2022	2023	2024
Mechanization	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Raw Material	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Labor	R$ 686	R$ 746	R$ 812	R$ 812	R$ 812	R$ 812	R$ 801
Total	R$ 686	R$ 746	R$ 812	R$ 812	R$ 812	R$ 812	R$ 801

Table 14 Common costs from 2025 to 2030

Year	2025	2026	2027	2028	2029	2030
Mechanization	R$ 240	R$ 240	R$ 240	R$ 240	R$ 240	R$ 240
Raw Material	R$ 250	R$ 250	R$ 250	R$ 250	R$ 250	R$ 250
Labor	R$ 1.829	R$ 1.829	R$ 1.829	R$ 1.829	R$ 1.829	R$ 1.829
Total	R$ 2.320	R$ 2.320	R$ 2.320	R$ 2.320	R$ 2.320	R$ 2.320

Since all the activities are outsourced, there are no specific investments in order to produce eucalyptus tree.

4.2. Lumber production costs

According to REZENDE, J.L.P. et al, there are two other important costs (besides the common costs) which take place in order to produce lumber, the harvesting costs and the internal transportation costs[57].

4.2.1 Harvesting costs

In 2006, the harvesting costs charged was equal to R$ 2, 67 / mst harvested[58]. This is a cost that is totally dependent on the labor; therefore it must be forecasted by using the table 2 like it was done to the labor costs of the eucalyptus tree.

By doing these calculations, it is possible to reach the table below that presents the harvesting costs for each stereo meter.

Table 15 Harvesting costs per estereo meter from 2010 to 2015

Year	2010	2011	2012	2013	2014	2015
R$ / mst	3,73	4,05	4,41	4,79	5,21	5,67

Table 16 Harvesting costs per estereo meter from 2016 to 2020

Year	2016	2017	2018	2019	2020	After 2020
R$ / mst	6,17	6,71	7,29	7,93	8,63	8,63

In order to take a look at the total harvesting costs, the numbers in table 15 must be multiplied by the production in estereo meters. Since the AAI in this work is being considered equal to 40 m³ / ha year, the productivity in terms of stereo meter is equal to 56.3 mst / ha year. The table 17 shows the total harvesting costs in R$ thousands.

Table 17 Total harvesting costs from 2011 to 2020 (R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Harvesting costs	-	-	-	-	-	-	1.322	1.438	1.564	1.701

[57] Although the sale of the lumber is made in the farm, the logistics inside the farm needs to be taken into consideration.
[58] REZENDE, J.L.P. et al. 2006

Table 18 Total harvesting costs from 2021 to 2030 (R$ thousands)

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Harvesting costs	1.701	1.701	1.701	1.531	1.531	1.531	1.531	1.531	1.531	1.531

It is important to notice that in 2024 these costs decrease. It happens because in 2024 the quantity that is harvested is lower due to the loss of 10% in the farm's productivity that happens from 2024 to 2030 since these are years in which there are harvested trees that were replanted.

4.2.2 Logistics costs

The transportation costs that are incurred in order to produce lumber are only the internal transportation costs, since the sale of the lumber is made inside the farm. The average distance that the truck must travel inside the farm is considered equal to 4.3 km, which is equal to half of the farm's highest distance[59].

The average cost for each kilometer in 2006 was of R$2.00 / km[60]. It is believed that this cost is a direct function of the oil prices; therefore, the transportation costs that are being considered in this work must be corrected by the future oil prices' forecast.

The equilibrium of the oil prices that is being considered in the thesis is equal to the average prices of this commodity from July 2004 to June 2010, that is equal to 69.59 US$ / barrel[61]. The figure 29 shows the daily prices for the petroleum in the period considered, such as its average.

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[59] Since in this model the area of the farm that is used for the plantation is equal to a rectangle of 5x7 kiometers, the highest distance that is traveled in it is equal to 8.6 km.
[60] REZENDE, J.L.P. et al. 2006
[61] Source: New York stock exchange

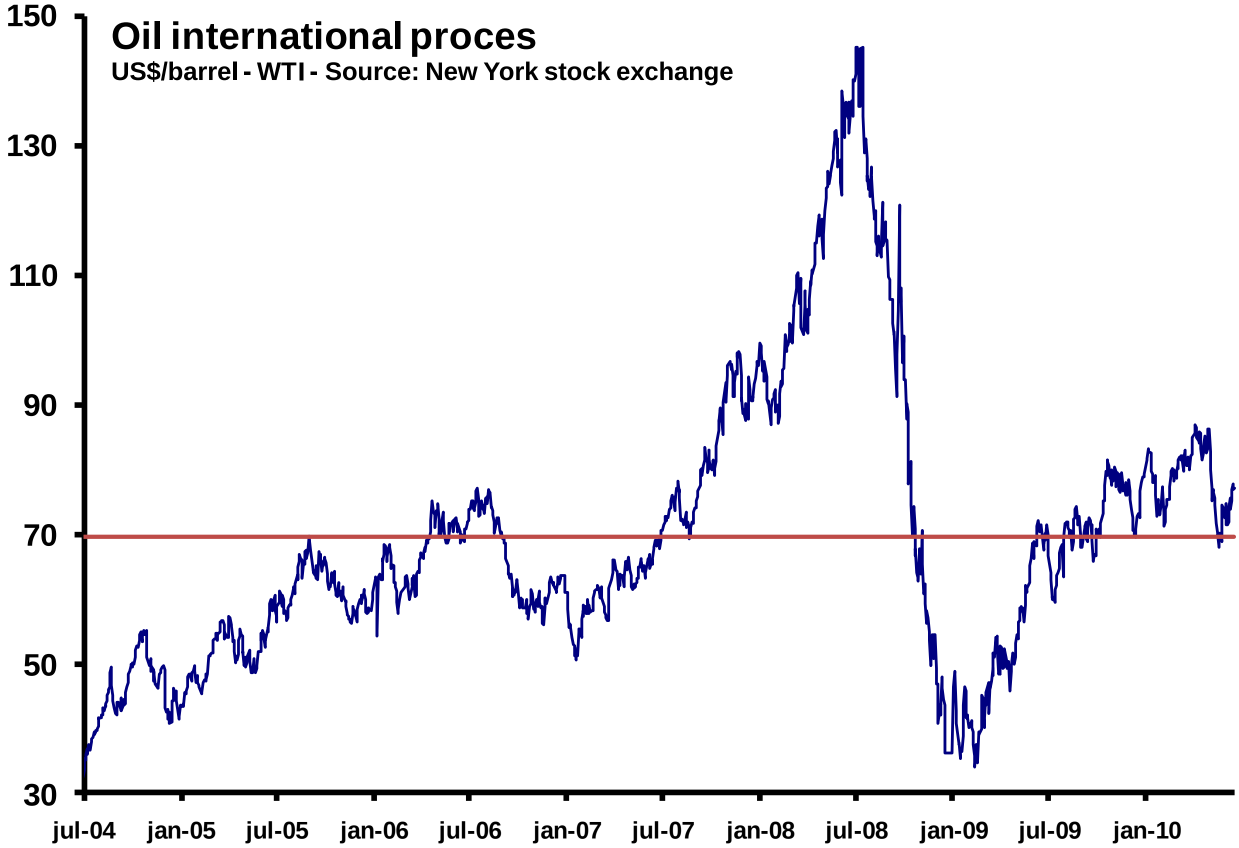

Figure 29 Oil international prices (WTI)

The average prices of this commodity in 2006 was equal to 66.37 US$ / barrel, which suggests that in the long run the oil prices will increase in US$ when compared to 2006's prices. However, it is also supposed that the Brazilian real will gain value against the US dollar when compared to 2006, since the average value of the exchange rate in this year was 2.17 R$ / US$ and the projections forecast this value to be equal to 1.89 R$ / US$.

It is possible to forecast the average oil prices in Brazilian real with these informations. By multiplying the oil prices in US$ in 2006 by its exchange rate, we reach the value of R$ 143.85 / barrel. By doing the same thing for the equilibrium oil prices and the equilibrium exchange rate, the value of R$ 131.59 is found.

Therefore, it is expected that the oil prices will decrease 8.5% in Brazilian reais when compared to 2006's..Hence, the transportation costs are also expected to decrease in to R$ 1.83 / km in the long run.

The capacity of the truck to that transports the lumber is equal to 30 mst[62]. Therefore, the equilibrium cost of each mst transported is equal to R$ 0.26 / mst. This value can be found by multiplying the average distance that is traveled by the truck in order to put the lumber in the entrance of the farm (4.3 km) by the cost for each kilometer (R$ 1.83 / km) and dividing this result by the capacity of the truck (30 mst).

The internal logistics or transportation costs in this case will be equal to the transportation cost per mst multiplied by the number of mst harvested. Like explained in the item 4.2.1, in the year of 2024, there will be a reduction in the costs because there will be a reduction in the productivity.

The internal logistics costs in R$ thousands are presented in the tables 19 and 20 in.

Table 19 Internal logistics costs from 2011 to 2020 (in R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Internal logistics	0	0	0	0	0	0	52	52	52	52

Table 20 Internal logistics costs from 2011 to 2020 (in R$ thousands)

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Internal logistics	52	52	52	47	47	47	47	47	47	47

[62] REZENDE, J.L.P. et al. 2006. This cost comprises the cost both ways, to get and deliver the lumber.

4.3. Charcoal production investments and costs

The charcoal production has its specific costs and investments. Besides these, there are the so called common costs and the lumber production costs that must be taken into consideration, since it is not possible to produce charcoal without the lumber.

The table 21 shows the charcoal production investments and costs to the production of 60,000 mdc, with 144,000 mst of lumber, in the year of 2005.

Table 21 Charcoal production costs in Brazilian real[63]

Investment	1.000.000
Costs	521.100
Fixed	143.000
Depreciation	100.000
Maintenance	43.000
Variable	378.100
Operation	100.000
Labor	185.400
Social benefits	92.700

Since the prices that were forecasted are the prices paid by the buyer in the farm, there are no external logistics costs.

However, the farm has a production 37% higher than 60,000 mdc from 2017 to 2023 and 23% higher from 2024 to 2030[64]. For this reason, the investments necessary are 37% higher like the depreciation and maintenance. The variable costs are 37% higher from 2017 to 2023 and 23% higher from 2024 to 2030.

It is now possible to prepare a table for the forecasted production for this farm.

[63] Costs adapted from NETO, 2005. Neto considers in its work the oportunity cost and the working capital such as costs, which are not being considered such as in this thesis. Besides that, the lumber costs do no exist in this case, since this raw material is being produced in the farm
[64] The years from 2024 to 2030 are a replanting period and the production is 10% lower

Table 22 Actual charcoal investments and costs (2005)

In R$	
Investment	1.369.327
Fixed	195.814
Depreciation	136.933
Maintenance	58.881
Variable A	378.100
Operation	136.933
Labor	253.873
Social benefits	126.937
Variable B	378.100
Operation	123.239
Labor	228.486
Social benefits	114.243

It is possible to observe two types of variable costs, raw material supplies and production. These differences happen because there is a change in the production capacity all over the years because of the amount of raw material available[65].

The investments and the fixed costs do not change however, since they do not depend on the production. It is also important to highlight that the variable costs

[65] There are years in which the productivity of the forest is 10% lower than the regular one. It happens because these are years of replanting

depend on the labor and hence they have an increase from year to year according to the table 2, presented in the second chapter.

The values for the costs that result from this analysis are presented below for the years from 2010 to 2030.

Table 23 Charcoal costs from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Fixed	196	196	196	196	196	196	196
Variable	1422	1547	1682	1829	1829	1829	1829
Total	1618	1743	1878	2025	2025	2025	2025

Table 24 Charcoal costs from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Fixed	196	196	196	196	196	196	196
Variable	1646	1646	1646	1646	1646	1646	1646
Total	1842	1842	1842	1842	1842	1842	1842

The increase of the costs from 2017 to 2020 happens due to the fact that the cost of the work force is likely to increase. In 2024 however, there is a decrease in the variable costs due to the reduction of the total production.

4.4. Pellets production investments and costs

The wood pellets production will be made just from the scraps from the charcoal production. Therefore, the activity will never be the main one, but an auxiliary, that only happens in the case that there is an industrial production[66].

There could be an analysis in which this scrap could be bought from other farms, or even the main destination of the tree could be to the production of would pellets. Although these analyses are not made in this work, it is possible to verify the feasibility of the wood pellet production in the analysis made by Serrano[67].

In order to produce the wood pellets, besides the charcoal production costs, it is necessary to invest in machinery and incur in some additional costs, which are the production costs: depreciation, electricity, maintenance and labor and logistics: transport to the train station by truck, transport to the harbor by train and transport to Europe by vessel.

The analysis is divided in two, 1. Investments and production costs and 2. Logistics

Investments and production costs

The production of wood pellets needs investments and incur in costs that can be either variable or fixed. The first part of the analysis deals with the investments and it is followed by the costs. This analysis was based on the thesis made by Serrano.

Investments

In its work, Serrano considers that it is necessary to invest 7,140,000 Euros plus US$ 1,235,973 in order to produce 100,000 tons of wood pellets. By considering the Brazilian exchange rate against these currencies, this production of wood pellets would need an investment of R$ 21,319,385[68]. Therefore, it is necessary an investment of R$ 214 for each ton of wood pellet produced.

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[66] It is not possible to produce the wood pellets when the eucalyptus tree or the lumber is commercialized. It happens because, in these cases, there are no scraps, meaning that there are no input for the wood pellet production.

[67] SERRANO, D.M.C. *Avaliação de produção e exportação de pellets combustível no pólo florestal da região sul do Brasil*

[68] The equilibrium exchange rates being considered for the Brazilian real against the US dollar and the euro are equal to 1.89 R$ / US$ and 2.66 R$ / EURO.

In this production model, in which only the residues are being used in order to produce the wood pellets, the quantity produced varies according to the raw material available. Since the quantity of raw material varies according to the period, so does the quantity of wood pellets produced.

The amount of wood pellets that will be manufactured in the farm is equal to 16,624 tons from 2017 to 2023 and 14,962 tons from 2024 to 2030. The investments however must be made in order to produce the maximum quantity of goods of the period and therefore, equal to R$ 3,544,236.

Fixed costs

The costs that are considered fixed are the depreciation and the maintenance, since the values of these two variables do not depend on the quantity produced. The machinery has 10 years of useful life and therefore, by considering a linear depreciation, this cost is equal to 10% of the investment value or 354,424 each year.

The values of the maintenance depend on the machine that is taken into consideration. According to Serrano, in this equipment, the overall value of the maintenance is equal to 5.8% of the investment yearly. Therefore, R$ 1,236,618 will be spent in order to produce more than 16,500 tons of wood pellets.

Variable costs

There are two variable costs in the pellets production, the labor and the electricity. It is needed R$ 17 of electricity in order to produce 1 ton of wood pellets and therefore, in years in which the production is equal to 16,624 tons of wood pellets, the electricity costs are equal to R$ 289,241 and in years that the production is equal to 14,962 ton, this cost is equal to R$ 260,317.

The labor costs however are not so simple to be calculated, since it is being considered in the work that these costs increase in a rate of 8.75% each year. It is possible however to calculate these costs in 2009[69].

The labor cost that is incurred in order to produce 1 ton of wood pellet is equal to R$ 1.00[70], showing the high degree of the process' automation[71]. The labor costs,

[69] 2009 is the year in which the thesis that is being used as model was written
[70] Value for the year of 2009
[71] The process is considered automated because the machinery costs are more important than the labor costs

which consider the inflation of 8.75% yearly and the quantity of wood pellets produced is presented below.

Table 25 Wood pellets labor costs from 2017 to 2023 in R$

Year	2017	2018	2019	2020	2021	2022	2023
Labor costs	30.743	33.433	36.358	39.540	39.540	39.540	39.540

Table 26 Wood pellets labor costs from 2024 to 2030 in R$

Year	2024	2025	2026	2027	2028	2029	2030
Labor costs	37.050	37.050	37.050	37.050	37.050	37.050	37.050

There are no labor costs for the wood pellets production until 2017 because the production starts only in 2017.

Logistics

In order to take the product to Europe, it is necessary to take the wood pellets from the farm to the train station (transport to the train station), then transport the product by train to the Vitória harbor (transport to the harbor) and finally transport the product by vessel to Europe (transport to Europe).

This analysis was made separately from the first one because the logistics represent a very important part of the wood pellets costs. These costs are divided in three and are described below in details.

Transport to the train station

The transportation costs that are being used here are the same as the ones calculated in the internal logistics costs for lumber. In the case, in order to transport 30 mst of lumber, the cost is equal to R$ 1.83 / km.

The distance between the farm and the train station is equal to 200 km, by multiplying this distance by the cost for each kilometer, the value of R$ 365.91 for each truck is obtained. By considering that each truck can carry 11.08 ton of lumber, the cost for each ton is equal to R$ 33.07.

Multiplying the quantity of wood pellets produced by the cost per weight, the transportation cost to the train station is obtained. This cost (transport 1) is presented below.

Table 27 Wood pellets transport 1 costs in R$ from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Transport 1	549.215	549.215	549.215	549.215	549.215	549.215	549.215

Table 28 Wood pellets transport 1 costs in R$ from 2023 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Transport 1	494.294	494.294	494.294	494.294	494.294	494.294	494.294

Transport to the harbor

The transport from Pirapora to the Vitória harbour is made by train. The cost to transport the wood pellets from Pirapora to the harbour is equal to R$ 52 / ton[72]. The cost of the transport to the harbour (transport 2) is presented below.

Table 29 Wood pellets transport 2 costs in R$ from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Transport 2	864.473	864.473	864.473	864.473	864.473	864.473	864.473

Table 30 Wood pellets transport 2 costs in R$ from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Transport 2	778.026	778.026	778.026	778.026	778.026	778.026	778.026

Transport to Europe

The last phase of the transport is made by vessel from Brazil (Vitória – ES) to Europe (Netherlands – Rotterdam). The transportation cost to take 1,000 kilograms from Brazil to Europe is equal to US$ 72.5[73]. According to this value, the transportation costs to take the goods from Brazil to Netherlands are shown in the following table.

[72] This value was obtained by a budget made in the train station
[73] Avaliação de produção e exportação de pellets combustível no pólo florestal da região sul do Brasil

Table 31 Wood pellets transport 3 costs in R$ from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Transport 3	2.279.004	2.279.004	2.279.004	2.279.004	2.279.004	2.279.004	2.279.004

Table 32 Wood pellets transport 3 costs in R$ from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Transport 3	2.051.104	2.051.104	2.051.104	2.051.104	2.051.104	2.051.104	2.051.104

The last phase of the logistics is also the most relevant one. The transportation of the product from Brazil to Europe is responsible for 62% of the transportation costs and therefore the farmers must focus on the reduction of this cost in order to improve the performance of the investment.

5. Revenues

It is very important to take into consideration, before starting this analysis that all the prices that have seen in chapter 3 are values received by the entrepreneur, meaning that no taxes over the net income are going to be charged. It is important to highlight this information, because in Brazil, there are taxations that are charged over the net income of the company.

5.1. Productivity index

The AAI (average annual increment) is the main productivity index for farms that plant eucalyptus. This index shows how the tree grows each year in terms of volume, in other words, it says the quantity of cubic meters the trees contained in one hecatare of the forest grows each year.

The productivity index being considered for the economic analysis in this work is equal to 40 m^3 / ha year, that was the value observed in the farms in the North of MG. Since there will be the replantation, for seven years, the productivity will decrease 10%, achieving levels of 36 m^3/ ha year.

The harvesting cycle adopted by the farm is equal to seven years, it means that after seven years, the tree is harvested. After this seven years period, there is another period of seven years in which there is a replantation, a period in which the productivity is 10% lower.

Therefore, for each area, we consider a period of fourteen years (seven years with 100% of productivity followed by seven years with 90% of the productivity) after which another period of fourteen years begins.

5.2. Eucalyptus tree

The prices used as a base in this study are the prices for eucalyptus tree in the north of Minas Gerais for trees with less than 15 cm of diameter74.

It is possible to calculate how much the charcoal is more expensive than the eucalyptus tree. In order to reach a multiple of these prices the equation below will be used for the four quarters of 2009 and for the first quarter of 2010.

$$Mult_n = \frac{Charcoal\_price_n}{Eucalyptus\_price_n}$$

The multiplus and average prices calculated with this equation are shown below.

Table 33 Eucalyptus prices' multiplus

Period	Multiple	Eucalyptus tree prices (R$ / mst)	Charcoal prices (R$ / mdc)
1 Q 2009	2,8	30,0	85,0
2 Q 2009	2,9	30,0	87,3
3 Q 2009	3,1	30,0	92,3
4 Q 2009	3,7	30,0	112,3
1 Q 2010	4,1	30,0	121,8
Average	3,3	30,0	99,7

The average multiplus is equal to 3,3 and this number is going to be used in the long run to estimate the eucalyptus tree values from the charcoal prices' forecasts. According to these informations, the eucalyptus tree equilibrium price is going to be equal to US$ 15 / mst. The forecast for the charcoal prices is going to be better explained in the item 5.4.

[74] According to the CIFloestas, the eucalyptus reee used in the charcoal production has less than 15 cm of diameter.

The revenues of the farm in R$ thousands are presented below.

Table 34 Eucalyptus tree revenues in R$ thousands from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Revenues	5.597	5.597	5.597	5.597	5.597	5.597	5.597

Table 35 Eucalyptus tree revenues in R$ thousands from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Revenues	5.038	5.038	5.038	5.038	5.038	5.038	5.038

5.3. Lumber

The lumber is a product that like the eucalyptus tree does not have a very high historical prices series. The calculation of this price is going to be done in a similar way to what was made to the eucalyptus tree.

However, for his product, the eucalyptus tree is going to be used as a base for the calculation. According to the AMS, the average lumber prices for the North of Minas Gerais both in 2009 and in 2010 was equal to R$ 40 / st. Since the eucalyptus tree average prices were equal to R$ 30 / st in the same period, the multiple that calculates the lumber prices from the eucalyptus tree prices is equal to 4/3.

Therefore the lumber prices in the long run are going to be considered equal to US$ 20 / st. The revenues projections for the lumber are presented below.

Table 36 Lumber revenues in R$ thousands from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Revenues	7.463	7.463	7.463	7.463	7.463	7.463	7.463

Table 37 Eucalyptus tree revenues in R$ thousands from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Revenues	6.717	6.717	6.717	6.717	6.717	6.717	6.717

5.4. Charcoal

According to Calais, "in an integrated production system, a market loss in the final product, (…) has impacts in all the production chain. A good example of this is the charcoal market, which achieved very high prices in July 2008 but in March 2009 was negotiated for low level prices". According to the prices published by the AMS, the price reduction in U.S. dollar was of 63% (from US$ 106 / ton to US$ 39 / ton)[75].

This decrease in prices occurred mainly due to the steel, which suffered a reduction of 60% in its prices from July 2008 (US$ 890 / ton) to March 2009 (US$ 355 / ton)[76].

By analyzing this information it can be supposed that the price relation between the charcoal and the steel is very strict. This hypothesis was proved in chapter 3.

In order to analyze the relation between charcoal and steel markets, the historical prices of these products are going to be analyzed. The following table presents the annual average prices for these two products.

Table 38 Steel prices vs charcoal prices

Year	Steel prices (US$ / ton)	Charcoal prices (US$ / mdc)	Steel price / charcoal price
2004	430	33	13
2005	422	35	12
2006	427	43	10
2007	503	58	9
2008	798	82	10
2009	411	48	9
2010	511	71	7
Average	**499**	**53**	**10**

The equilibrium price of the steel that will be used in this thesis is the average price of the commoditie from January 2004 to April 2010. According to the IBS, the

[75] These are prices negotiated in the north of Minas Gerais.
[76] The steel prices are published by the IBS.

average price for the product in this period is equal to US$ 499 / ton. Consequently, the charcoal equilibrium price that is going to be used is equal to US$ 49.9 / ton[77].

The annual revenues in R$ thousands, according to this prices are shown below.

Table 39 Charcoal revenues in R$ thousands from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Revenues	7.753	7.753	7.753	7.753	7.753	7.753	7.753

Table 40 Charcoal revenues in R$ thousands from 2024 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Revenues	6.978	6.978	6.978	6.978	6.978	6.978	6.978

[77] The calculation of the charcoal price is made by dividing the steel price by the multiplus defined before (equal to ten). From the charcoal price, the eucalyptus tree price, in the item 3.4 is estimated.

5.5. Pellets

The wood pellets that are being produced hace the objective of being exported to Europe. According to studies made by the pellets@las[78], the main port that is being used in Europe to import wood pellets is located in Roterdam. The graphic with the historical wood pellets prices from July 2007 to September 2009 is shown below[79].

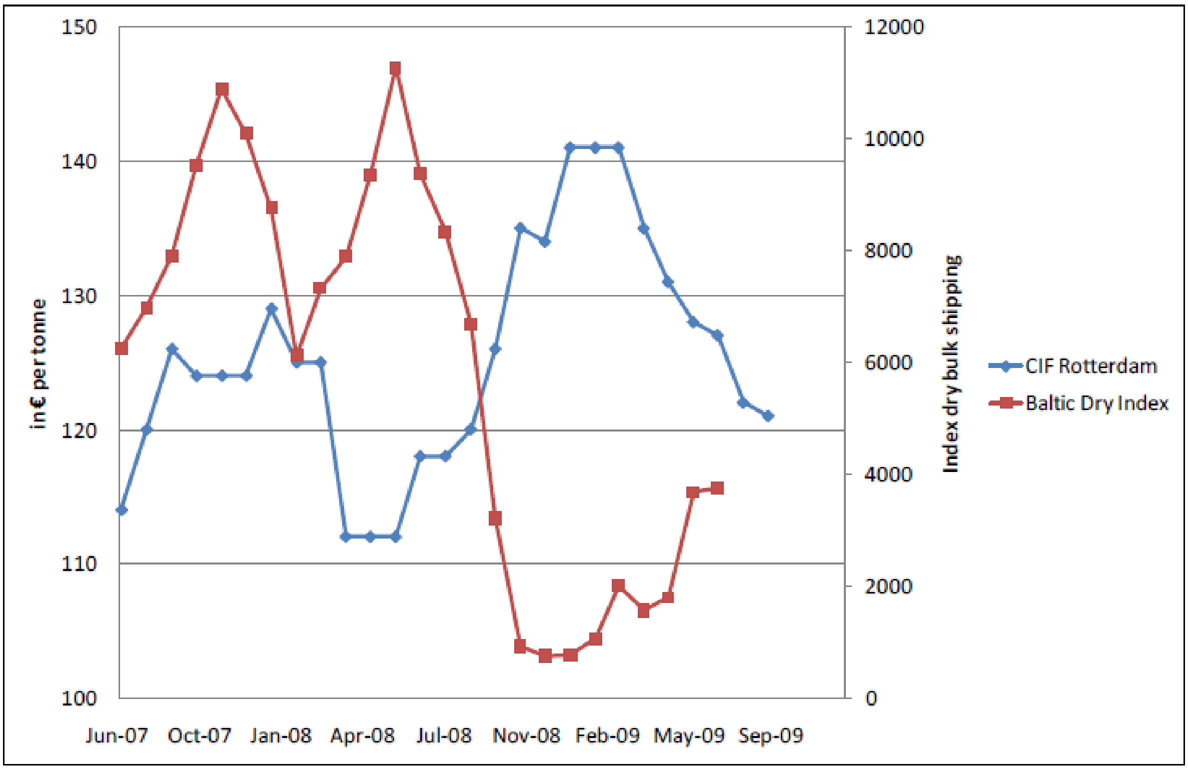

Figure 30 Wood pellets historical prices[80]

The Brazilian company will try to produce the wood pellets tied to long term contracts with European companies, therefore, the prices that are going to be used in the work are the average of the graphic above.

The average of the graphic is being considered equal to 125 euros / tonne. The revenues for this commodity in this price level are presented in able 41.

[78] Pellets@las isa project supported by the European commission under the EIE program.
[79] Like it was Said in the chapter 3, the graphic presents the prices for long term contracts, which are prices that are higher than the spot market
[80] This graphic was taken from a pellets@las report published in published by pellets@las in december 2009

Table 41 Wood pellets revenues in R$ thousands from 2017 to 2023

Year	2017	2018	2019	2020	2021	2022	2023
Revenues	5.525	5.525	5.525	5.525	5.525	5.525	5.525

Table 42 Wood pellets revenues in R$ thousands from 2023 to 2030

Year	2024	2025	2026	2027	2028	2029	2030
Revenues	4.972	4.972	4.972	4.972	4.972	4.972	4.972

6. Economic analysis

6.1. Financing mechanisms

The production will be financed by two main sources, the capital from the enterpreneurs and the loan that is acquired from the Brazilian government, that gives especial credit lines for the forestry sector.

The project will have a high leverage, 60% of the money will be obtained from government financing, whilen the other 40% are being financed by the entrepreneurs.

The loan is being acquired in the government bank called Nossa Caixa and the interests that are paid in this loan is equal to 6.75% yearly[81]. Since the taxes in Brazil are equal to 34%, including the tax shield, the effective cost of capital from this source is equal to 4.5%.

81 http://www.nossacaixa.com.br/publicos/Paginas/agronegocios/bndesfiname/bndespsiagro/ProdDefault.aspx

6.2. Cost of the own capital

The cost asset pricing model (CAPM) will be used in order to determine the cost of capital of the enterpreneur. The weighted average cost of capital will be different for each of the activities because they are exposed to different sectro risks..

There is this differentiation because the market in which the company is entering is different according to the product it is selling. Eucalyptus tree and the lumber can be sold either to paper or steel producers, while the charcoal are dependent on the steel sector and, therefore it can have higher risks.

In order to calculate the cost of the capital, it is needed to know the formula of the CAPM. This is described below[82].

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

The risk free of the market will be considered such as the basic interest rate of the Brazilian central bank, that is equal to 10.75% yearly[83]. The expected return of the market is the one year variation of the Brazilian stock exchange and it is equal to 14.56%[84]. The beta values are different for each of the markets and are described in details below.

Cellulose and paper

It is necessary to calculate the beta of the sector in order to reach the opportunity cost of the entrepreneur. The beta of the sector is the average of the Brazilian cellulose and paper companies' betas weighted by its respective market values.

The Brazilian companies that are listed in this sector are Fibria, Klabin and Suzano cellulose e papel. The company's betas and its respective market values are shown below[85].

[82] Gitman, L.J. *Princípios de administração financeira*10th edition, p.202
[83] This is the Brazilian's central bank goal for the year of 2010
[84] The variation between September 2009 and September 2010, considering the index average in these months
[85] The market value of the companies refers to September 2010 and the betas refers to the period between November 2008 and November 2010

Table 43 Forestry sector beta

Company	BETA	MARKET VALUE (MR$)
Fibria	1.085	13.7
Klabin	0.94	4.5
Suzano celulose e papel	0.91	6.3
Cellulose and paper	**1.01**	**24.5**

The beta of 1.01 was calculated by the average of the companies' betas compounded by its market value. According to the beta of the market, the opportunity cost for the entrepreneur in the cellulose and paper sector is equal to 14.62%.

Steel

It is also necessary to calculate the beta for the steel sector, which is the main market to which the charcoal is sold. The main Brazilian companies of the sector are CSN, Gerdau, Metalúrgica Gerdau and Usiminas. The table below shows the companies' betas and its market value.

Table 44 Steel sector beta

Company	BETA	MARKET VALUE (MR$)
Gerdau	1.295	29.8
Metalurgica Gerdau	1248	10.9
Usiminas	1153	24.6
Steel sector	**1.23**	**65.3**

Such as for the cellulose and paper sector, the calculation of the steel market's beta was calculated by the average beta of the sector's companies compounded by its relative market values. The beta of 1.23 corresponds to an entrepreneur's cost of capital equal to 15.46% according to the CAPM model.

6.3. Weighted average cost of capital (WACC)

The weighted average cost of capital (WACC) depends on the sector to which the enterpreneurs is selling its products. The WACC for each of the sectors are detailed below.

Eucalyptus tree and lumber

The eucalyptus tree and the lumber can be sold either to companies from the cellulose and paper and from the steel sectors. Therefore, the beta for these products will be equal to the minimum beta between the two sectors (paper and steel).

The beta for these products is equal to 1.01 and, therefore the entrepreneurs cost of capital in this case is equal to 14.62%. By using 40% of the capital from the entrepreneur and 60% from third sources[86], the company's cost of capital in these markets is equal to 8.52%.

Charcoal

Since the charcoal has as its main consumer the steel sector, the beta considered for this market is equal to the steel's beta and therefore 1.23. According to this, the entrepreneur cost of capital is equal to 15.46% and the cost of capital for the company will be equal to 8.86% in this scenario.

Wood pellets

There are no Brazilian companies that are specialized in the wood pellets production. Since the beta for this sector in Europe is not known, it will be considered such as the maximum beta between the steel and the cellulose and paper sectors in this activity.

Therefore, with a beta of 1.23, the cost of capital considered for the wood pellets market is equal to the WACC for the charcoal[87].

[86] Loan at 6.5% of interest rates
[87] The cost of capital for the charcoal is equal to 8.86%

6.4. Perpetuity

In this model, it is going to be assumed that, there will be continuity in the business in the long run. However, neither new investments nor increase in the productivity level are being considered.

According to these assumptions, it is possible to say that there will be no growth in the business and consequently in its cash flow.

6.5. Financial statements

The income statement that is going to be used in this work is the one that was taught by professor Marco Taisch in the discipline Finance in the first semester of the academic year 2008/2009.

Table 45 Income statement[88]

Revenues
Cost of good sold
Gross profit
Operating expenses
Sales expenses
Administrative expenses
EBIT
Interests
Gain/loss
Income before taxes
taxes
Net income

Since all the activities to maintain the forest are being outsourced, these are going to be considered operating expenses. The objective of the work is to assess the potential gains of the projects and not to project all its statements. Therefore, the important statement to the analysis is the cash flow statement, which needs only the EBIT to estimate the free cash flow for the firm (FCFF). The way this estimative is done is shown below.

Table 46 Cash flow statement[89]

EBIT
Taxes (-)
Depreciation -)
Amortization (-)
Δ NWC (-)
Δ CAPEX (-)
FCFF

[88] The administrative costs are being considered such as 2% of the production costs while the sales exenses are considered 3% of the sales

[89] The working capital is considered as 5% of the sales

6.6. Economic results

The economic results that are analyzed in this paper are the net present value (NPV) and the internal rate of return (IRR). The project with the highest NPV will be considered the best alternative and, therefore the chosen. The IRR is being analyzed but is not used for decisional purposes.

The following pages present the economic results for each of the alternatives. The financial statements are presented in the annexes.

Eucalyptus tree

The eucalyptus tree market has as its weighted average cost of capital the value of 8.52%. According to this value, this alternative's net present value is equal to R$ 3,305,832 and it has an internal rate of return of 10.47%.

Lumber

The lumber market has the same weighted average cost of capital of the eucalyptus tree market, 8.52%. The net present value of the alternative corresponds to 3,677,225 and an internal rate of return equal to 10.68%. , therefore presenting better results than the eucalyptus tree market.

Charcoal

The weighted average cost of capital of the charcoal market is higher than the first two alternatives because it depends almost exclusively of the steel market, which has a high volatility[90]. The WACC of the alternative is in this way equal to 8.86%. According to this discount rate, the net present value of this alternative is equal to R$ 2,424,407 and an IRR of 10.32%.

Although this alternative presents its economic values lower than the first two alternatives, the production of charcoal can also have the production of wood pellets such as a secondary production. This alternative is analyzed in the next topic.

[90] This volatility is measured by the beta of the companies in the steel market in the Brazilian stock exchange (BOVESPA)

Wood Pellets

The cost of capital for the wood pellets market is equal to 8.86%, like in the charcoal market. According to this value, the net present value and the internal rate of return are equal to 1,412,999 and 18.20% respectively.

The comparison of the wood pellets alternative does not make sense if compared alone. This happens because this activity depends on the charcoal production[91]. The economic results of these two activities (charcoal and wood pellets) combined are shown in the next paragraph.

The WACC of the combined activity is equal to 8.86%, which is equal to both of the markets. The net present value is equal to the sum of the wood pellets and charcoal alternatives and, therefore equal to 3,837,405. The alternative's internal rate of return is equal to 10.94%.

Summary

It can be concluded from these values that the alternative which presents the best economic performance is the production of both charcoal and wood pellets. The table below presents a summary of these economic indicators.

Table 47 Economic indicators

Activity	WACC	NPV (Million)	IRR
Eucalyptus tree	8,52%	R$ 3.306	10,47%
Lumber	8,52%	R$ 3.677	10,68%
Charcoal	8,86%	R$ 2.424	10,32%
Wood pellets	8,86%	R$ 1.413	18,20%
Charcoal + wood pellets	8,86%	R$ 3.837	10,94%

[91] The Wood pellet activity uses the residues of the charcoal production and therefore depends on this alternative in order to exist

Although the wood pellets production shows the highest IRR, this alternative is possible only in the case of a mixed production of charcoal and wood pellets. The best alternative however is the one that presents the highest net present value.

Sensitivity Analysis

According to the table 47, the best investment alternative for the entrepreneurs would be in the production of both charcoal and wood pellets. However, the wood pellets and charcoal prices can vary significantly and therefore, the economic results can be different depending on the pricing scenario. The lumber market on the other hand is the second best choice of investment and presents a scenario of more stable prices.

This part of the work has the objective of presenting a sensitivity analysis to verify until which price level, the investment in wood pellets and charcoal still is the best investment option for the entrepreneurs.

The table 48 presented in the next page shows the relation between the net present value and the variation of charcoal and wood pellets prices for the activity number five, the investment in the production of charcoal and wood pellets.

The green cells represent the scenarios in which the activity number five is still the best investment choice, while the red cells, represent scenarios in which the option number five would have been replaced by the activity number three, lumber production, as the best investment choice.

Table 48 Sensitivity analysis

		Variation in charcoal prices						
		-3%	-2%	-1%	0%	1%	2%	3%
Variation in pellets prices	-3%	2.278	2.604	2.930	3.256	3.581	3.907	4.233
	-2%	2.472	2.798	3.124	3.449	3.775	4.101	4.427
	-1%	2.666	2.992	3.318	3.643	3.969	4.295	4.621
	0%	2.860	3.186	3.511	3.837	4.163	4.489	4.815
	1%	3.054	3.380	3.705	4.031	4.357	4.683	5.009
	2%	3.248	3.573	3.899	4.225	4.551	4.877	5.203
	3%	3.442	3.767	4.093	4.419	4.745	5.071	5.397

The table 48 shows that small variations for worse prices would mean that the option number five wouldn't be the best investment option anymore.

7. Conclusion

The four investment alternatives (eucalyptus tree, lumber, charcoal and charcoal plus wood pellets) present its internal rate of return (IRR) higher than its respective weighted average cost of capital (WACC) and therefore all of them are feasible projects in economic terms.

However, only one of these investment alternatives can be chosen and the choice of the best scenario is made by taking into consideration the alternative that presents the highest net present value, which in this case is the last alternative, the production of charcoal and wood pellets.

The use of the cost asset pricing model (CAPM) changed the cost of capital for the different alternatives. The products that can be used both in the paper and steel products (eucalyptus tree and lumber) have a lower WACC than the ones that are used only in the steel sector (charcoal).

According to this assumption, the net present value of the charcoal is equal to R$ 2,424 thousands and the eucalyptus tree NPV equal to R$ 3,306 thousands. The choice between these two products in this case would have been the eucalyptus tree production.

However, if both WACC were both equal to 6.97%[92], the charcoal's NPV would be higher than the eucalyptus tree's NPV and therefore, would change the decision of the best project between these two alternatives. It shows the effect of using the CAPM instead of a simple cost of capital calculation.

This work concluded that the best alternative for this farm would be the production of wood pellets and charcoal. Small variations in the charcoal and wood pellets prices however, would result that the investment in lumber would be the best choice. According to this consideration, the investment in lumber must be also considered until the level of uncertainty in the market is decreased.

There are some additional analysis that could be made for this farm, such as the analysis of the main costs of these alternatives or a more detailed analysis about its financial risks, such as the exchange rate exposure. These further analysis could consider measures that can reduce this risk and the main costs of the project.

[92] Cost of capital without considering the CAPM model

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9. Annexes

Table 49 Eucalyptus tree income statement (R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues	-	-	-	-	-	-	5.597	5.597	5.597	5.597	5.597	5.597	5.597	5.038	5.038	5.038	5.038	5.038	5.038	5.038
Cost of good sold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gross profit	-	-	-	-	-	-	5.597	5.597	5.597	5.597	5.597	5.597	5.597	5.038	5.038	5.038	5.038	5.038	5.038	5.038
Operating expenses	1.028	1.133	1.253	1.389	1.543	1.717	1.921	686	746	812	812	812	812	801	2.320	2.320	2.320	2.320	2.320	2.320
Sales expenses	-	-	-	-	-	-	168	168	168	168	168	168	168	151	151	151	151	151	151	151
Administrative expenses	21	23	25	28	31	34	38	14	15	16	16	16	16	16	46	46	46	46	46	46
EBIT	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	3.470	4.729	4.668	4.602	4.602	4.602	4.602	4.069	2.520	2.520	2.520	2.520	2.520	2.520
Gain/loss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Income before taxes	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	3.470	4.729	4.668	4.602	4.602	4.602	4.602	4.069	2.520	2.520	2.520	2.520	2.520	2.520
taxes	-	-	-	-	-	-	1.180	1.608	1.587	1.565	1.565	1.565	1.565	1.384	857	857	857	857	857	857
Net income	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	2.290	3.121	3.081	3.037	3.037	3.037	3.037	2.686	1.663	1.663	1.663	1.663	1.663	1.663

Table 50 Eucalyptus tree cash flow statement (R$ thousands)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P
EBIT		(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	3.470	4.729	4.668	4.602	4.602	4.602	4.602	4.069	2.520	2.520	2.520	2.520	2.520	2.520	
Taxes (-)	-	-	-	-	-	-	-	1.180	1.608	1.587	1.565	1.565	1.565	1.565	1.384	857	857	857	857	857	857	
Depreciation -)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Amortization (-)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Δ NWC	-	-	-	-	-	-	-	280	-	-	-	-	-	-	(28)	-	-	-	-	-	-	
Δ CAPEX	8.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FCFF	(8.000)	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	2.010	3.121	3.081	3.037	3.037	3.037	3.037	2.714	1.663	1.663	1.663	1.663	1.663	1.663	30.076

Table 51 Lumber income statement (R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues	-	-	-	-	-	-	7.463	7.463	7.463	7.463	7.463	7.463	7.463	6.717	6.717	6.717	6.717	6.717	6.717	6.717
Cost of good sold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gross profit	-	-	-	-	-	-	7.463	7.463	7.463	7.463	7.463	7.463	7.463	6.717	6.717	6.717	6.717	6.717	6.717	6.717
Common costs	1.028	1.133	1.253	1.389	1.543	1.717	1.921	686	746	812	812	812	812	801	2.320	2.320	2.320	2.320	2.320	2.320
Harvesting costs	-	-	-	-	-	-	1.322	1.438	1.564	1.701	1.701	1.701	1.701	1.531	1.531	1.531	1.531	1.531	1.531	1.531
Transportation costs	-	-	-	-	-	-	52	52	52	52	52	52	52	47	47	47	47	47	47	47
Operating expenses	1.028	1.133	1.253	1.389	1.543	1.717	3.295	2.176	2.362	2.564	2.564	2.564	2.564	2.379	3.897	3.897	3.897	3.897	3.897	3.897
Sales expenses	-	-	-	-	-	-	224	224	224	224	224	224	224	202	202	202	202	202	202	202
Administrative expenses	21	23	25	28	31	34	66	44	47	51	51	51	51	48	78	78	78	78	78	78
EBIT	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	3.878	5.020	4.830	4.624	4.624	4.624	4.624	4.089	2.540	2.540	2.540	2.540	2.540	2.540
Gain/loss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Income before taxes	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	3.878	5.020	4.830	4.624	4.624	4.624	4.624	4.089	2.540	2.540	2.540	2.540	2.540	2.540
taxes	-	-	-	-	-	-	1.319	1.707	1.642	1.572	1.572	1.572	1.572	1.390	864	864	864	864	864	864
Net income	(1.048)	(1.156)	(1.278)	(1.417)	(1.574)	(1.751)	2.560	3.313	3.188	3.052	3.052	3.052	3.052	2.699	1.677	1.677	1.677	1.677	1.677	1.677

Table 52 Lumber cash flow statement (R$ thousands)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P
EBIT		-1048	-1156	-1278	-1417	-1574	-1751	3878	5020	4830	4624	4624	4624	4624	4089	2540	2540	2540	2540	2540	2540	
Taxes (-)	0	0	0	0	0	0	0	1319	1707	1642	1572	1572	1572	1572	1390	864	864	864	864	864	864	
Depreciation -)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Amortization (-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Δ NWC	0	0	0	0	0	0	0	373	0	0	0	0	0	0	-37	0	0	0	0	0	0	
Δ CAPEX	8000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FCFF	-8000	-1048	-1156	-1278	-1417	-1574	-1751	2186	3313	3188	3052	3052	3052	3052	2736	1677	1677	1677	1677	1677	1677	30653

Table 53 Charcoal income statement (R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues	0	0	0	0	0	0	7753	7753	7753	7753	7753	7753	7753	6978	6978	6978	6978	6978	6978	6978
Cost of good sold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross profit	0	0	0	0	0	0	7753	7753	7753	7753	7753	7753	7753	6978	6978	6978	6978	6978	6978	6978
Lumber production costs	1028	1133	1253	1389	1543	1717	1921	686	746	812	812	812	812	801	2320	2320	2320	2320	2320	2320
Charcoal production costs	0	0	0	0	0	0	1618	1743	1878	2025	2025	2025	2025	1842	1842	1842	1842	1842	1842	1842
Operating expenses	1028	1133	1253	1389	1543	1717	3539	2429	2624	2837	2837	2837	2837	2643	4162	4162	4162	4162	4162	4162
Sales expenses	0	0	0	0	0	0	233	233	233	233	233	233	233	209	209	209	209	209	209	209
Administrative expenses	21	23	25	28	31	34	71	49	52	57	57	57	57	53	83	83	83	83	83	83
EBIT	-1048	-1156	-1278	-1417	-1574	-1751	3911	5043	4844	4627	4627	4627	4627	4072	2523	2523	2523	2523	2523	2523
Gain/loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income before taxes	-1048	-1156	-1278	-1417	-1574	-1751	3911	5043	4844	4627	4627	4627	4627	4072	2523	2523	2523	2523	2523	2523
taxes	0	0	0	0	0	0	1330	1715	1647	1573	1573	1573	1573	1385	858	858	858	858	858	858
Net income	-1048	-1156	-1278	-1417	-1574	-1751	2581	3329	3197	3054	3054	3054	3054	2688	1665	1665	1665	1665	1665	1665

Table 54 Charcoal cash flow statement (R$ thousands)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P
EBIT		-1048	-1156	-1278	-1417	-1574	-1751	3911	5043	4844	4627	4627	4627	4627	4072	2523	2523	2523	2523	2523	2523	
Taxes (-)	0	0	0	0	0	0	0	1330	1715	1647	1573	1573	1573	1573	1385	858	858	858	858	858	858	
Depreciation -)	0	0	0	0	0	0	0	137	137	137	137	137	137	137	137	137	137	137	137	137	137	
Amortization (-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Δ NWC	0	0	0	0	0	0	0	388	0	0	0	0	0	0	-39	0	0	0	0	0	0	
Δ CAPEX	8000	0	0	0	0	0	1369	0	0	0	0	0	0	0	0	0	1369	0	0	0	0	
FCFF	-8000	-1048	-1156	-1278	-1417	-1574	-3120	2330	3466	3334	3191	3191	3191	3191	2864	1802	433	1802	1802	1802	1802	30031

Table 55 Wood pellets income statement (R$ thousands)

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Revenues	0	0	0	0	0	0	5525	5525	5525	5525	5525	5525	5525	4972	4972	4972	4972	4972	4972	4972
Cost of good sold	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gross profit	0	0	0	0	0	0	5525	5525	5525	5525	5525	5525	5525	4972	4972	4972	4972	4972	4972	4972
Pellets production costs							880	883	886	889	889	889	889	857	857	857	857	857	857	857
Logistics							3705	3705	3705	3705	3705	3705	3705	3334	3334	3334	3334	3334	3334	3334
Sales expenses	0	0	0	0	0	0	166	166	166	166	166	166	166	149	149	149	149	149	149	149
Administrative expenses	0	0	0	0	0	0	74	74	74	74	74	74	74	67	67	67	67	67	67	67
EBIT	0	0	0	0	0	0	700	698	695	692	692	692	692	565	565	565	565	565	565	565
Gain/loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income before taxes	0	0	0	0	0	0	700	698	695	692	692	692	692	565	565	565	565	565	565	565
taxes	0	0	0	0	0	0	238	237	236	235	235	235	235	192	192	192	192	192	192	192
Net income	0	0	0	0	0	0	462	460	459	456	456	456	456	373	373	373	373	373	373	373

Table 56 Wood pellets cash flow statement (R$ thousands)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	P
EBIT	0	0	0	0	0	0	0	700	698	695	692	692	692	692	565	565	565	565	565	565	565	
Taxes (-)	0	0	0	0	0	0	0	238	237	236	235	235	235	235	192	192	192	192	192	192	192	
Depreciation -)	0	0	0	0	0	0	0	354	354	354	354	354	354	354	354	354	354	354	354	354	354	
Amortization (-)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Δ NWC	0	0	0	0	0	0	0	276	0	0	0	0	0	0	-28	0	0	0	0	0	0	
Δ CAPEX	0	0	0	0	0	0	3544	0	0	0	0	0	0	0	0	0	3544	0	0	0	0	
FCFF	0	0	0	0	0	0	-3544	540	815	813	811	811	811	811	755	727	-2817	727	727	727	727	6134

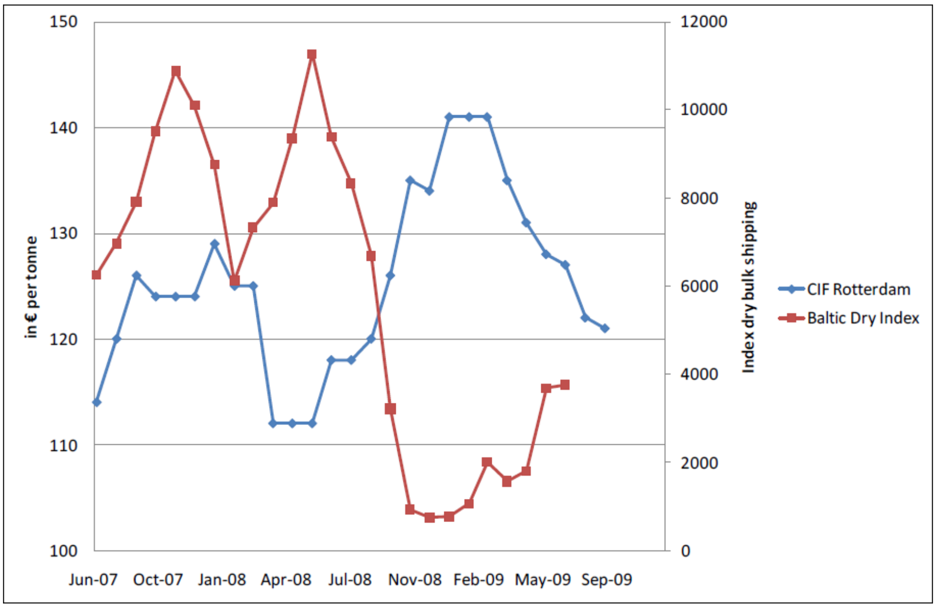

Figure 31 BPPP prices (CIF)

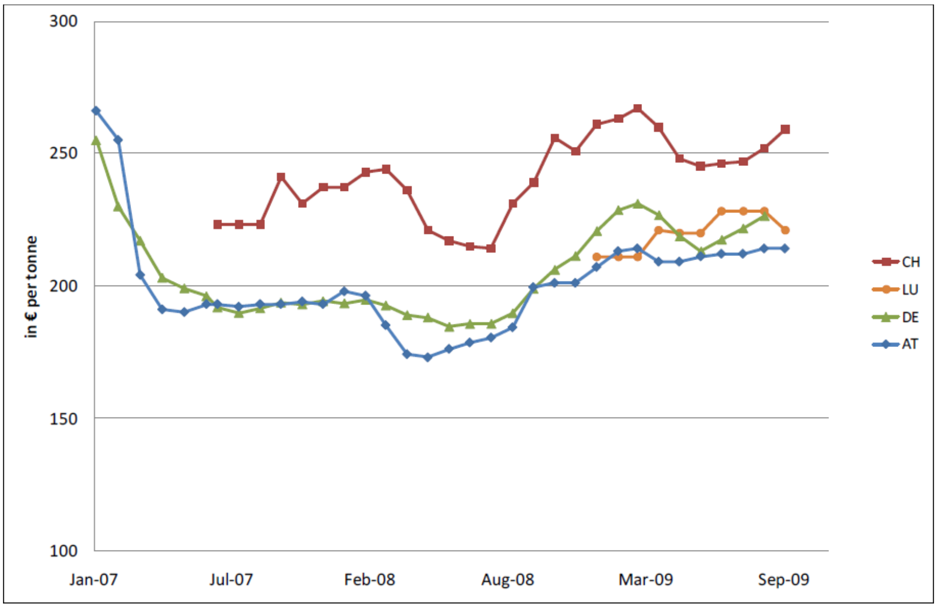

Figure 32 LPHR prices (VAT included)

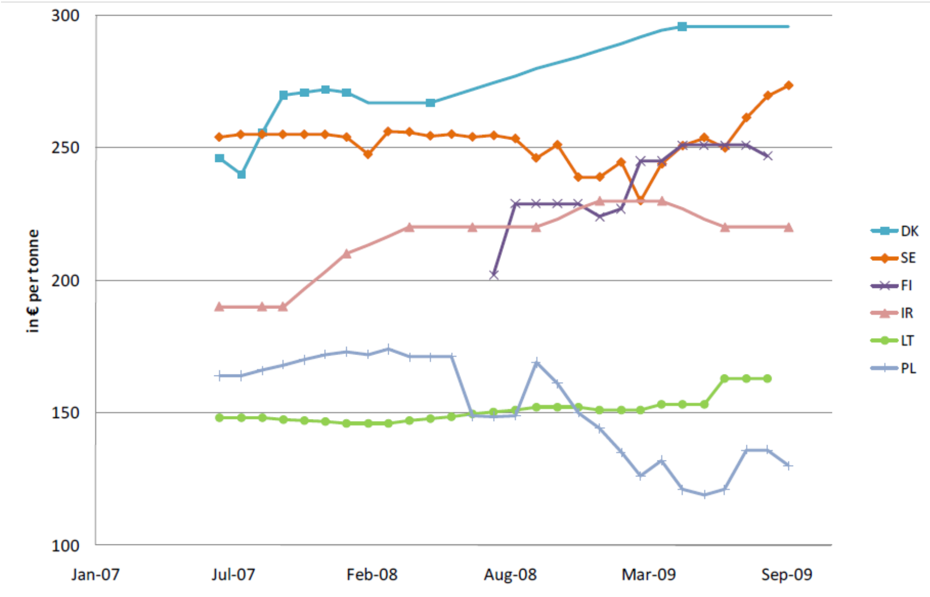

Figure 33 BPRH prices (VAT included)