COST STRUCTURE AND PROFITABILITY ANALYSIS OF THE JOHN DEERE 1490D SLASH BUNDLER IN NORTHERN SPAIN

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ABSTRACT

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ALBERTO SANTOS FERNÀNDEZ: Cost structure and profitability analysis of the John Deere 1490D slash bundler in Northern Spain

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Spain is one of the main markets of the John Deere 1490D ECOIII slash bundler in Europe. The Northern Spain has special natural conditions which make the bundling of forest residues an interesting option for the forestry companies of the region. The slash bundling from forest residues has a positive impact in the forestry companies, increasing their revenues and allowing them to complement their business model using residues that traditionally were left in the forest to rot. Those residues let an excess of nutrients polluting the soil, are a focus for pests and create fire risks problems. Thanks to the slash bundling technology now, they can be extracted from the forest and transported to a biomass energy plant to be used as an energy renewable resource.

As local renewable resource, the forest biomass plays a strategic role at national level in Spain too; it reduces the CO2 emissions and the need of importing fossil fuels as oil and gas for the production of energy, which improves the national current account, also reducing the dependency from non renewable sources. The objective of this thesis has been the analysis of the cost structure and profitability analysis of the slash bundling of Álvarez Forestal, a forestry company from Northern Spain. To understand the slash bundling system development in Spain, it is important to place the figures obtained on the context in which the activity is developed, which is the objective of this thesis.

The cost structure and the profitability analysis of the John Deere 1490D ECO III slash bundler carry on in this thesis shows that the slash bundling system, adapted to the Northern Spanish conditions, it is currently a feasible activity for the company studied.

Understand the customer needs the environment in which the customer operates and anticipate trends forms part of the John Deere Forestry business culture, as well of this thesis.

This thesis has been possible thanks to the collaboration of Eloy Garcia, Manager Director of Álvarez Forestal, Aritz Garcia, from Guifor, the Spanish dealer of the John Deere forestry machines and Marica Kilponen, Bioenergy Manager of John Deere Forestry Oy. A confidentiality agreement has been signed to protect confidential information present in the thesis.

Key words: slash bundler, biomass energy, Northern Spain, cost structure, profitability.

Contents

1 Introduction

1.1 Thesis background

The thesis idea came after collaborate with John Deere Forestry Oy on a customer research project and profitability study projects about the John Deere 1490D ECO III slash bundler in Northern Spain.

My interest in the subject started when Marica Kilponen, the Biomass Manager of John Deere Forestry Europe contacted with me in 2009 few months after I started my studies in the Tampereen ammattikorkeakoulu (TAMK). The idea was to carry on a research about the customers of the slash bundler in Northern Spain, gathering information about the ways in which the customers use the machine, besides other vital information to understand their businesses and the overall performance of the machine in the area.

I contacted with the Spanish customers of the slash bundlers to understand their business and challenges that those forestry companies face, getting interested in the forestry machinery sector.

Later came a opportunity to develop a second project for John Deere Forestry, this time related with the cost structure and profitability analysis of the slash bundler with one customer, Álvarez Forestal and analyze the information gathered with the TimberCalc software of John Deere, designed for a better control and traceability of costs for the clients of John Deere forestry machines.

This thesis is based on the information gathered in these projects.

1.2 Structure of the Thesis

The purpose of the thesis is to analyze the economic impact of the John Deere 1490D ECO III slash bundler and the role that the machine plays in the business strategy of one Northern Spanish forestry company, Álvarez Forestal.

The objective has been to place the machine in the geographical and business environment where operates, the forestry business in Northern Spain, where

currently the use of the forest biomass as renewable energy is increasing its relevance. The Northern Spanish forestry companies have been traditionally been raw material suppliers for the paper mills, saw mills and the construction sector of the region, but currently those sectors of activity are suffering an important economic crisis.

Forestry companies want to diversify their traditional business activity; at the same time Spain, that is a country with a high consumption of energy and highly dependent on fossil fuels, wants to reduce that dependency increasing the production of renewable energy from local resources.

The thesis has been structured in the following way: The first part it is an introduction of Spain and the main factors that influence the results of the thesis. It is essential to understand the distinctive characteristics of the Northern Spain, for a better understanding of the forestry business of the area, the business activities of Álvarez Forestal and the performance of the John Deere 1490D slash bundler under the Northern Spanish conditions.

The forestry business is not only influenced by natural factors like geography, climatology or tree species that can be adapted to those conditions, but by political factors too. The Spanish Regional Governments have a great degree of political autonomy, which affects to the forestry business. Those governments follow general rules, but they can establish priorities locally, having a huge impact in the way in which the forestry companies do their business.

The region of Cantabria, where Alvarez Forestal mainly develops its business activities, first must be placed in the general context of Spain, and later its forestry business sector explained. Every forestry business in the world starts with the tree on which it depends. In Cantabria, for geographical, economic and political reasons, the timber and residues are mainly extracted from the Eucalyptus Globulus. The Eucalyptus Globulus is the base of the forestry sector in Cantabria, and Álvarez Forestal.

The next step in the thesis is to introduce Deere & Company, and the forestry machines and their role, focusing specially in the John Deere 1490 ECOIII slash bundler.

After that, Álvarez Forestal it is introduced, presenting the business activities of the company, its future business plans and the valuable that the slash bundler provides to their present and future business activities.

The last part of the thesis is where the cost structure and the profitability analysis are performed, bringing the final conclusions.

1.3 Methodology

The thesis is result of a qualitative and quantitative approach to the subject.
The qualitative approach was used to gather data about the forestry companies and their use of the slash bundler machine in the Northern Spain by phone interviews. During those interviews, a questionnaire provided by John Deere Forestry was used.

The quantitative approach took place with the use of the TimberCalc program to analyze the data that the customer provided.

2. General Introduction about Spain

Spain it is located in the southwestern Europe, which mainland forms along with Portugal the Iberian Peninsula. Spain is one of the largest countries of the European Union with a total area of 506. 370 square kilometers including the Balearic Islands in the Mediterranean, Canary Islands in the Atlantic Ocean and Northern Africa cities, being bordered by the Mediterranean Sea the North Atlantic Ocean and the Pyrenees Mountains in the North. Its capital is Madrid, and it is an urban society and developed country, with 47.042.984 Citizens of which 79% live in cities and with a population density of more than 93 habitants per square meters (CIA word fact book and Spain Today, 2011)

2.1 Geography

As a consequence of its location and geography, the Spanish territory is characterized by its extraordinary diversity and high altitude, over 600 meters, being the second-highest country in Europe, surpassed only by Switzerland (Spain Today 2011, 9).

The main geographic characteristics in the Spanish mainland are the northern mountains ranges which extend from the Atlantic North West to the Mediterranean north east, being the Cantabrian Mountains and the Pyrenees the main mountain ranges; a high central plateau called *Meseta* in the center and two depressions, the Guadalquivir and Ebro river valleys. (Spain Today 2011, 10)

FIGURE 1: Physical map of Spain (Spain Today 2011, 10)

2.2 Climate

Due to the location and geography of Spain, the Spanish is divided in several main climatic divisions:

The Atlantic or Oceanic climate: Characterized by warm but not extremely hot summers, cold but not extremely cold winters and abundant and regular rains. This is the climatology that corresponds to the North West of Spain, Galicia, Asturias, Cantabria and Basque Country (Violet color in the map).

The Continental climate: Typical from the central part of the Iberian Peninsula, with a wider difference in the temperatures, characterized by hot summers and colder winters and less abundant and irregular rains.

The Mediterranean climate: Southern and Eastern Spanish regions are characterized by their dry-hot summers and their mild rainy winters (yellow color in the map)

FIGURE 2: Climatic regionalization (Spain Today 2011, 11)

Those differences in the climatology affect to the precipitation distribution inside the country. It varies substantially depending on the area, as can be seen in the map. The North West of Spain is the area with the highest average precipitation, exceeding 600 mm and rising occasionally to 2.000 mm. (Spain Today 2011, 13). Rest of the country marks lower average annual precipitation records, being considered semi arid in some Southern Spanish regions. Due to the influence of the Atlantic Ocean climate in the area, North West of Spain is also called colloquially “The Green Spain”

FIGURE 3: Average annual precipitation (Spain Today 2011, 13)

2.3 Ecological regions

The Spanish geographical, climatic and soil composition diversity has a direct influence in the creation of the different ecological regions of the country.

The Spanish vegetation is diverse and rich in tree species. However, one has also to include the human intervention in the landscape. That human intervention has changed the natural landscape thanks to an intensive use of the natural properties of the different regions. In the Spanish North West, the geographical, climatic and soil composition made possible a radical change in the natural landscape by the direct action of the human being. The forest owners replaced the original beech and oak forest of the region with fast growing foreign species as Insignis Pine (Pinus Radiata) from North America or Eucalyptus (Eucalyptus Globulus) from Australia, being this last one also introduced successfully in the Southern province of Huelva.

Olives and Citrus plantations in the South and in the Mediterranean area, along with the human managerial of the Dehesa ecosystem, characterized by the presence of the Cork and Holm Oaks in the Central and Southern Spain, are also other examples of this human intervention in the natural landscape.

FIGURE 4: Ecological regions (Spain Today 2011, 14)

2.4 Economy and energy policy

Despite the financial crisis that deeply impacted the Spanish economy since 2008, Spain is the 13th largest economy in the World, member of the European Union since 1986 and member of the Euro zone since 2002, with a gross domestic product distribution by sector of 3, 3% in the agriculture 25, 8% in the industry and 70, 9% in the service sector in 2011 (Invest in Spain, 2011) and a gross domestic product per capita of 23.063 Euros in 2008.

The main trading partner of Spain is the European Union, which accounts for the 66, 4% of the total exports and 52, 8% of total imports of the country. Also, the European Union counts as the main origin of the 52, 2 million international tourists received by Spain in 2009. (Invest in Spain, 2011)

FIGURE 5: Spanish exports by sectors in 2011 (Data: Invest in Spain)

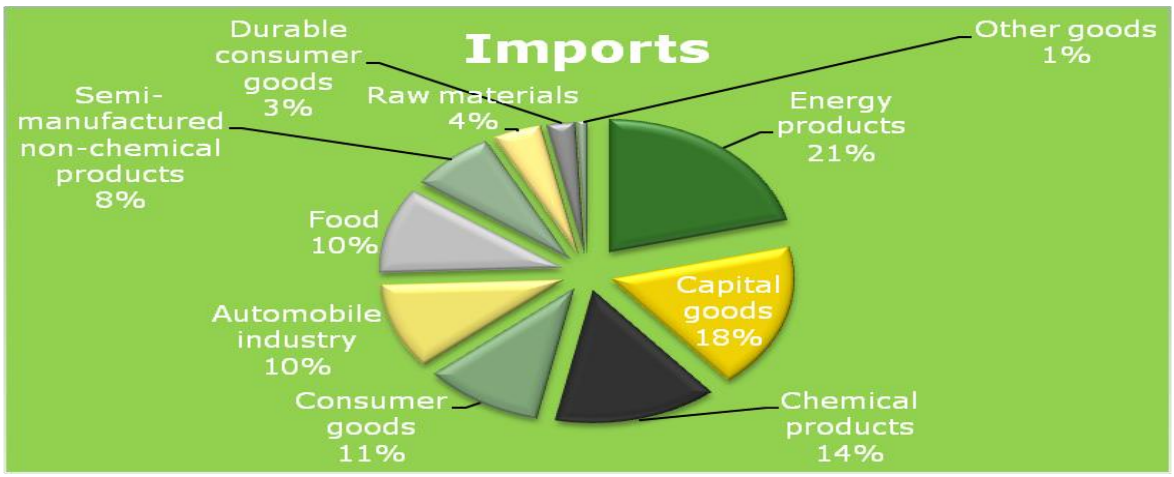

FIGURE 6: Spanish imports by sectors in 2011 (Data: Invest in Spain)

The main economic sectors of the Spanish economy are tourism and the service sector. The industry is also important presence in the Spanish economy, for example, Spain is the third largest passenger car manufacturer of the European Union and first manufacturer of industrial vehicles (ACEAN, 2012).

The Spanish economy requires a high consumption of energy, which makes of Spain one of the most fossil fuels dependent countries of the European Union, with almost 80% of its primary source of energy imported (Spanish NREAP, 2010)

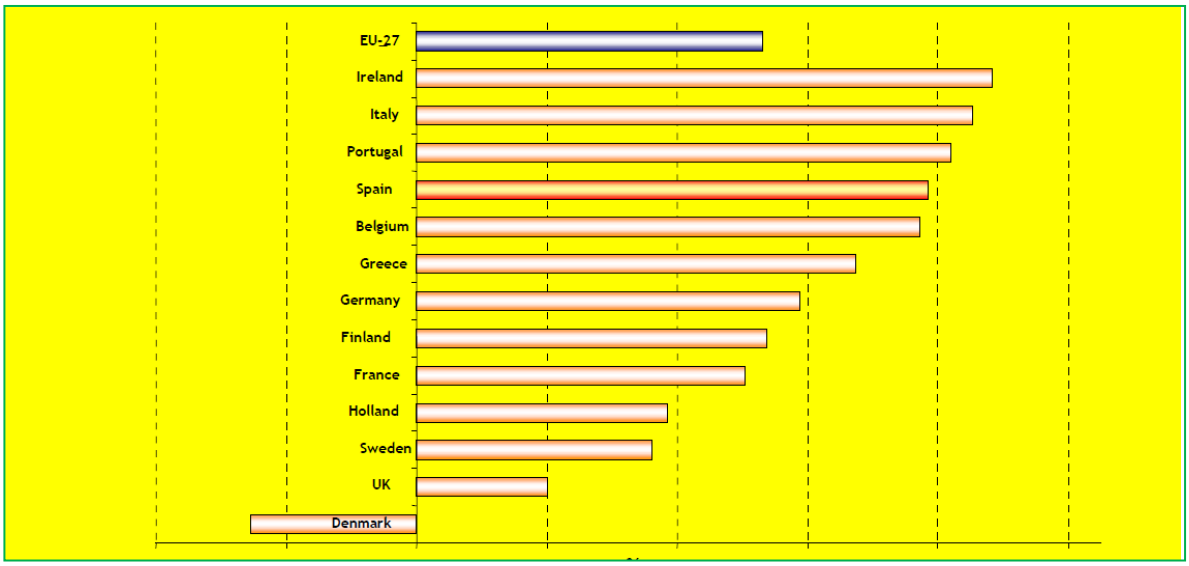

FIGURE 7: Spanish dependency of primary energy resources. (Data: Spanish NREAP, EU Commission p.20)

The Spanish total consumption of primary energy in 2010 was 129.298 Thousand tons oil equivalent or Ktoe, and it is expected that the total consumption of primary energy will increase until 156.930 Ktoe in 2020 (Spanish NREAP, EU). The European Union has an ambitious renewable strategy for the 2020, the European Union established that in 2020, 20% of the European energy production should come from renewable resources (European Union Commission) and biomass in general and forest biomass specifically has a strategic role.

Currently Spain has around 200 MW of electric and heat power generated from forest and pulp industry residues in 2011, with potential for, including other sources of biomass as agricultural crops in the production of energy and heat on the power plants, 775 MW in 2020 (APPA, 2011). The Spanish Renewable Energy Plan 2020 includes the mobilization and consumption of 18 million tons of biomass per year, 50% of it from forest renewable resources.

The biomass has a vital strategic component for the forestry sector: diversification of the business activity. The Spanish forestry sector has been traditionally dependent of three sectors:

1. Paper production industry, which main player in Spain is ENCE.

2. Construction sector, which is currently stopped in Spain, due to that it, was one of the biggest sectors of the Spanish economy affected by economic meltdown.
3. The furniture production sector.

The biomass energy from forest residues has had a positive impact in the forestry companies. It allows the diversification of their business activity, adding value to residues that before did not have it. Also in this new business activity also participates the Spanish paper industry, which main company, ENCE is progressively moving its business from paper production to energy production. ENCE has a key role in the development of the forest biomass energy in Spain. It is the biggest company in the electricity and heat production from biomass resources, with a current 202 MW installed, and previsions of adding 180MW to the current production capacity, with a total of 382 MW power installed in the 2020.

Other characteristic of the production of energy from the forest biomass is that has a great potential as employment source. Forest biomass energy production employs 9, 8 workers per MW (Euskadi Forestal 79, 2010), being the renewable energy that creates more employment. It requires an intense use of labor for the production of energy, keeping the forestry activity when other sectors reduce activity and personnel. Besides the employment in the forestry, employment is also generated in the biomass power plants during their construction and normal operation. The current and future development of the biomass energy will have a positive impact in the Spanish labor market, characterized by one of the highest unemployment rates of the European Union.

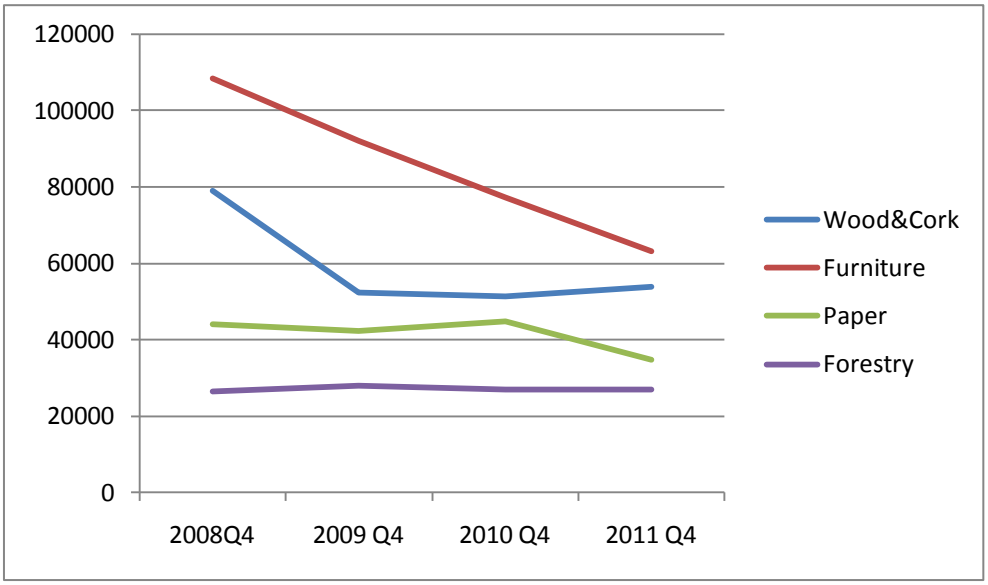

FIGURE 8: Evolution of the employment by sector. (Data: National Statistic Institute, Spain)

Authorities understand that an increment of the production of energy from forest residues biomass in Spain will have a positive impact in the economy. It will diversify business activities, giving value to residues that before did not have, allocating investments in rural areas, where traditionally the unemployment rate has been high, and producing economic growth.

2.5 Political system and territorial organization

Spain is a Parliamentary Monarchy; the Head of the State is the King Juan Carlos I and the president of the Government are Mariano Rajoy, of the Popular Party which controls the Lower House and the Upper house of the Spanish parliamentary system.

The Spanish territorial organization is organized into municipalities, 50 provinces (EU-NUTS III) and 17 autonomous communities and 2 cities (EU-NUTS II). Those communities and cities have own elected governments, which have a whole array of competencies, from Public Health to Forestry and natural environment.

FIGURE 9: Spanish Administrative Division, Spanish Government

2.6 Influence of the factors in the thesis

The presented factors have a decisive impact in the thesis and reports in which the thesis is based on:

Spain is not a uniform but a diverse country, with different climatic areas. That has a direct impact in the forestry sector, being some areas more suitable for a concrete type of forestry activity than others, with a great diversity in the number of tree species that has different commercial uses. Certain foreign tree species have been perfectly adapted to some Spanish areas, like the Eucalyptus Globulus in Cantabria, while in other areas that adaptation it is not so successful or it is impossible. This fact means that each area has truly particular characteristics that must be taken in consideration when the forestry sector of that area has to be analyzed.

Northern Spain is a mountainous area. That condition makes necessary the intensive use of forestry machinery to reduce production costs, due to the difficulties to extract the biomass from the tree plantations due to the peculiar characteristics of the terrain.

Spain is a service sector economy being one of the top worldwide tourist destinations by number of visitors but also it is modern industrialized country, which means it is a country that consumes an enormous amount of energy.

Spanish forestry sector has been traditionally dependent of three sectors or industries: construction, furniture and paper industry. The collapse of the construction sector in Spain and the decline of the profitability of the paper mills is making that the forestry sector is moving to the supply and production of renewable energy from the forest biomass resources, being also a key element for the future creation of employment for the Spanish economy.

The Spanish Autonomies have a strong political power, and control key areas that affect to the forestry sector, from regulation to types of subventions that the forestry companies can receive from the region, depending where are located.

3. Eucalyptus Globulus in Cantabria.

Cantabria is the Spanish region where Álvarez Forestal is located, and where mainly develops its forestry activity. The company also develops its forest activity in other Northern Spanish areas, such Galicia. In their forestry works, the main tree which the company processes it is the Eucalyptus Globulus, and occasionally, Pinus Insignis.

The natural characteristics of Cantabria make of the region a perfect habitat for the Eucalyptus Globulus plantations. Not only its natural conditions, Atlantic climate, substantial rains, right altitude and soil composition allows that, but also that the 30% of the forest of the region belongs to private owners. Those owners were the ones that have introduced tree searching an improvement of the profitability of their forest. The productivity and qualities of the Eucalyptus Globulus are significant. The tree only represents the 11% of the forest of Cantabria, but it produces the 91% of the timber of the region (Greenpeace, 3).

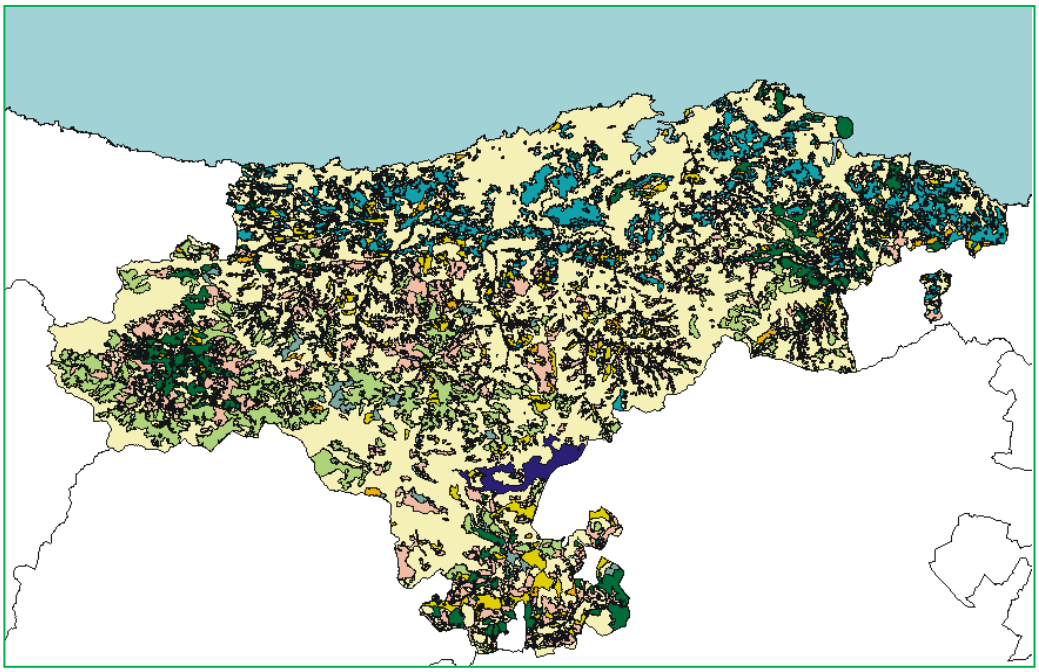

FIGURE 10: Eucalyptus Globulus Plantations in Cantabria, in light blue. RRSP 2005

The main specie of Eucalyptus, not only in Cantabria but in the whole Iberian Peninsula, is the Eucalyptus Globulus or Blue Gum, originated from Oceania. (Touza et Gonzalez, 2007). The Eucalyptus is the base of the Spanish paper industry because of the inherent quality of its pulp that is used as raw material. Also, there have being test for the introduction of Eucalyptus Nitens in the North Western region of Galicia, as woody energy production crop (Pazos et al., 2007)

Eucalyptus started its international expansion during the 19th Century, including the North West of Spain, where it was introduced in small plantations, reaching industrial scale plantations during the 20th Century (Touza et Gonzalez, 2007). The history of the Eucalyptus in Cantabria starts in the XIX Century. During that century, a high percentage of forest of the region, especially the forest located close to the coastal area, and that belonged to the Spanish State, was sold to pay national debts, becoming private properties.

The introduction of the railway, the demand of timber from coal and iron mining industry and the demand of the construction sector due to the increase of population originated by the Industrial Revolution in the Northern Spain, had as a consequence that most of the natural forest of the region was cut, and is then

when the Eucalyptus started to be introduced, because its productivity. Its growing is faster comparing with the native species of the region (Regional Rural Strategic Plan, 2005)

The profitability of the animal husbandry declined and the price of timber that was imported increased at the beginning of the 20th Century. These two factors made that the private and public lands that were used as pastureland or were unproductive before, were reforested with Eucalyptus searching higher private and public profits. (Regional Rural Strategic Plan, 2005)

During the 1940 decade, the public paper industrial production started to increase even more, due to the higher demand, demand that will continue rising during the next decades too. Imported pulp became very expensive. To avoid the import of that expensive pulp, a great number of hectares of forest in Cantabria were again reforested with Eucalyptus in the coastal strip of Cantabria (Regional Rural Strategic Plan, 2005)

Nowadays Cantabria has 359.457 hectares cataloged as forest, of which 251.619 hectares, the 70%, is in public hands and a bit less 30%, 92. 385 hectares are private property, being the private forest the prevalent in the coastal area, were the conditions are more optimal for the development of industrial plantations, than in the mountainous area of Cantabria are, were the forest is mainly public ownership. This private property counts for 70% of all the extraction of wood of the region (Regional Rural Strategic Plan, 2005).

4. The John Deere 1490D slash bundler

4.1 Introduction to John Deere Company

The John Deere 1490D Eco III slash bundler machine is manufactured by John Deere Forestry Oy, a division of Deere & Company, an American corporation leader in the agriculture, construction and forestry machinery sectors, which in the current year reach 175 years, being one of the oldest industrial companies in the United States. The company was named after its founder, John Deere; a

blacksmith that manufactured the first commercial steel plow in Grand Detour, Illinois in 1837 (John Deere, 2012)

Deere & Company is a public company. Deere & Company, together with its subsidiaries operates in three business segments: agriculture and turf, construction and forestry and credit (NYSE, 2012)

The company obtained exceptional results in 2011, with record sales of 29. 5 billion $ of which 5.372 million $ were revenues of the Construction and Forestry Division with a record net income of 2. 8 billion $ and an operating profit margin of 13%, with a cash flow from operations of 3 billion $. Around 58% of the business revenues came from the North American market, USA and Canada and 42% from the rest of the World (John Deere, 2012)

4.2 The John Deere Forestry Division

4.3 The harvesting systems

The forest work is divided by the type of the operational harvesting system of the machines. The two main tasks in the forestry work are the felling of the trees and the extraction of the timber from the logging site. How these operations take place, is what establishes the difference between the two main working systems in the forestry business: the Full Tree (FT) system and the Cut- To - Length (CTL) system.

The Full Tree (FT) system is the dominant system in the North American forestry sector, in USA and Canada, and in Brazil; the main machines that belong to this group are feller bunches, that are the machines in charge of felling the trees and the Skidders that are in charge of extracting the timber out of the forest.

The Cut-To-Length system is the dominant forestry working system in Europe and in countries like Uruguay and Chile in South America. The CTL's system main machines are the harvester, which is on charge of felling and bucking the

timber, and the forwarder, in charge of the extraction of the timber out from the logging site.

FIGURE 11: John Deere forest machinery range, CTL highlighted. John Deere Forestry 2011

The Full Tree forest machines are produced in the Dubuque and in the Davenport factories, while the Cut-To-Length f machines are produced in a factory located in Joensuu, Finland. Also in Joensuu the John Deere harvester heads for the machines are produced (John Deere, 2012)

The Cut-To-Length system is the forest harvesting system that is predominant in Europe. The harvesting operation requires two machines. Those machines work as a team, performing different tasks: the harvester, which is designed to process the trees, do the felling, the delimbing and the bucking of the trees while the forwarder, is in charge of loading the produced logs in the back of the machine with an extendable boom, extract them out from the forest and transport them to the storage area, piling them for drying.

The CTL system was originated in Scandinavia, and it still is the predominant system. Subsequently it was extended to the rest of Europe. In some logging areas, to make possible the extraction of the logs by trucks or allow the

machines to arrive deeper into the forest or tree plantations, forest roads must be built. In some cases, construction excavators are equipped with tree harvester heads for the harvesting operation, performing the role of the harvester machine (Bergroth, Pallander, Kärhä, 2006)

The Cut-To-Length system it is perfectly adapted to the requirements of the European forestry companies. They work in human managed forest or plantation forests, while North American companies do not. With this system, the final cut of the trees is done, depending species, after 18 or 30 years. The objective is the best balance between productivity and the quality of the wood. In Spain, for example, saw mills that provide wood for furniture producers, pay a lower price for pine timber from pine trees older than 35 years old, due to the quality of the wood is poorer, which means that the trees are not allowed to develop large diameter stems, making them suitable to be processed by the harvester heads.

The CTL system is specifically designed to give veritable forest productivity, at the same time takes that cares of the quality of the timber that is harvested. The saw mills and furniture producers demand that the quality of the wood that they buy responds to its quality standards. Responding to that demand, the forestry machinery manufacturers have been continuously developing new improvements and products to increase productivity and the quality of the timber. That has been taken too to the forest residues.

The Cut-To-Length harvesting it is an integrated system; one of its biggest advantages is that, except for the final removal of the tree stumps and the reforestation, it allows to the forestry companies the mechanization of most of the forest operations that take place in a forest plantation.

During the operations residues are generated, in the form of slashes or young stands. Those residues have an extraordinary energy potential, as the TEKES Wood Energy Technology Programme 1997-2003 final report presents (Hakkila, 2004, 26):

Energy wood thinning: Is the harvester operation of young trees. It takes place in a forest where owner has not been taking care of the forest. Forests

require to be cleaned from smaller trees to allow the rest of the trees of the plantation reach their growing potential. Due to the small size of the trees the main use for the biomass generated would be fuel.

Early thinning: This is the first commercial logging operation that takes place in a young stand plantation. Pulpwood for paper production it is the primary destination, but also a high percentage of those stems do not meet the minimum dimension requirement, so have a great potential to be used for energy production.

Late Thinning: This thinning looks to remove the excessive accumulation of biomass in the crown of the trees. The tree growing in plantations makes that the trees cannot get the correct amount sunlight that they need, especially in plantations of conifers, as pines and spruces.

Final Harvester: Also called clear cutting, is the final felling operation of the tree, felling, delimbing and bucking, it is when the stem is transformed in logs and transported to the storage area. This operation generates a large amount of biomass residue, slashes that until the invention of the slash bundler, those residues had no value, were left to rot in the area, increasing the risks of pests, pollution of the ground by an excess of nutrients and uncontrolled fires. In Spain, this is the stage in which the slash bundler is intensively used.

For the Eucalyptus of Álvarez Forestal the minimum diameter of the biomass stem for the pulp industry it is 8 centimeters. Biomass that does not reach that standard is selected for bundling (Gonzalo, A. 2011, 14). About Eucalyptus in Northern Spain, forest owners decide to perform that operation when the trees have ten or twelve years, but Álvarez Forestal waits until 15 years in their own plantations (Gonzalo, A. 2011, 14).

4.5 The John Deere 1490D ECO III slash bundler

The John Deere 1490D ECO III Slash bundler is a forestry machine designed to compact the slashes that are left at the logging site after the trees are processed and extracted. The machine performs the tasks of compacting and bundling those residues for an easier extraction. The bundles are similar to the log, which allows using the same forwarder used in the timber extraction, and

the same kind of road truck transport to the final delivery to the energy plant, improving the logistic operations and reducing the operational cost, because no additional equipment is needed.

The slash bundler reduces the material volume by 80%. The bundler is tied with a string and placed in the ground again with the boom. Each bundle is 2, 40X0, 90 size and has a weight between 250 and 450 kilos, in the case of bundles from Eucalyptus slashes (Gonzalo, A. 2011, 15)

4.6 Slash bundles supply chain

One of the advantages of bundling the slashes and other residues that are generated by the forest works is that they guarantee a smooth supply chain, which it is one of the key main critical issues from the energy production point of view: assure the supply of the biomass in time, in quantity and with the quality required.

The slash bundling process with the John Deere1490D slash bundler consists of the following steps:

The trees are processed by the harvester on the logging site, generating the residues of biomass. In Northern Spain, those residues are piled and let to dry on the field for 15 to 20 days. This drying let them lose leaves leaving a correct amount of nutrients on the ground.

After this time period, that varies depending on the region the slash bundler enters in the site and starts to convert the loose biomass into bundles.

Later a forwarder collects those bundles with the extendable boom and loads them following the same system as if they where timber logs. The slash bundles are taken to a storage area outside of the forest and piled.

When the transport it is required, a log truck loads the slash bundles and transports them from the storage site to the energy plant for the final storage.

Slash bundles have to dry enough to be burned, when the condition of the biomass is the optimal, it is loaded into a site chipper, which transforms the slash bundle it into woodchips, to be finally burn at the power plant.

Figure 12: Biomass residues supply chain with the slash bundler (VTT)

4.7 Álvarez Forestal

The company works in the forestry sector since it was founded in 1970 and it belongs to the Armando Álvarez Group and has a broad experience as wood supplier of paper mills and saw mills of the northern region.

Since the beginning, the company focused in the exploitation of fast growing species forests, especially Eucalyptus Globulus and Pinus Insignis, in the North West of Spain.

Nowadays the company is still entirely focused in the forestry sector, covering the full work cycle of the forestry works: the set up of abandoned terrains or terrains where the forest has been already exploited; its reforestation and proper maintenance, the felling of the adult trees and the forwarding out of the forest of timber and the biomass obtained and the transport until the final destination (Álvarez Forestal, 2012)

The company also is developing its own project biomass energy power plant based on Eucalyptus bark and slashes residues from the commercial felling. The new plant will start its construction during this year and should be operative two years later. 30 million Euros will be invested in the project and will produce energy for 22.000 homes. (ABC, 2012)

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