The potential impact of Intellectual Property Rights on the Forestry chain in Uruguay.

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INTRODUCTION

This study is the result of an initiative of the World Intellectual Property Organization (WIPO) to analyze the impact of intellectual property rights (IPRs) on forest development, an activity identified as strategic by the government of the Oriental Republic of Uruguay. In this sense, it initially raises the challenge to understand the functioning, to its full extent, of the global value chain of forest production, to later evaluate where and in which way the IPRs affect its current development and future perspectives.

The questions that guided our study are the following: What is the forestry value chain? What is Uruguay's role today in the global forestry value chains? How is it structured, which activities and actors make up the value chain of forestry production in Uruguay? In which stages and links within the chain is knowledge generated? Is it necessary to protect this knowledge? In what way does the IPRs system in force have an impact on the present and future development of the forestry activity in Uruguay? We believe worth mentioning to the reader that this activity was residual a couple of decades ago and today is considered one of the engines that invigorate the Uruguayan economy.

With the purpose of responding to these questions, and through the review of abundant bibliography and interviews with consultants and actors involved in the activity, the study was structured in four sections and one final comment on possible questions to be considered in the future. In the next section – as a conceptual framework – a brief consideration is made with the purpose of moving in parallel, and searching for contact points, throughout the structure and operational mode of a forestry value chain – at least theoretically – and the intellectual property rights. In the second section, we review, very succinctly, the international outlook of the sector, so as to dimension the current role of Uruguay in the global value chain of the forestry complex. In section 3, the way the IPRs affect the forestry chain is reviewed; for this purpose, the technologies used in each stage are identified in relation to the possibility of being reached by the different forms of IPRs. Later, in section 4, a more detailed description is presented regarding the forestry chain production in Uruguay, quickly reviewing the history of its conformation to subsequently move to the description of the stages, dynamics and actors – with their corresponding strategies. Finally, in the last section some central questions are raised, focusing on these topics to be considered in the future development of the forestry sector in Uruguay.

Section 1. THE FORESTRY VALUE CHAIN AND INTELLECTUAL PROPERTY RIGHTS

1. Increasingly, the renewable biological productions are beginning to be considered raw material of multiple industrial applications, modifying the logic of their traditional production. This phenomenon occurs in most of the value chains of biological origin. The challenge is to control more and more the random variables of the natural process (climate, soil, genetics, morphology, plagues and pests, among others), in order to reduce uncertainty, to make the process more efficient -with a better administration of production times- and thus, to add more value through greater productivity by empowering certain specific features in the product to be obtained (more starch, resistance to plagues, greater tenderness, greater pulpability, etc. An additional variant is the growing diversification and segmentation of the final products – which, in biological sense, depends on the genetics and the primary production processes-. A good part of these interventions on the natural processes to obtain greater control on the biological variables depend on the incorporation of innovations.

2. Given the fact this involves knowledge, greater investments and strategic assets for the organizations that carry out these endeavors -companies or public agencies-, a crucial issue is property and its protection, which results in a particular attention on the intellectual Property Rights (IPRs). Please note that these concepts traditionally associated with the matter of human inventiveness (creation applied to industry), in the case of our interest, fall -at least in part– on pre-existing biological material (i.e. a gene composition is "discovered"; a predetermined sequence is determined). This opens, to a certain extent, new challenges. In this sense, the incentives of the private sector to invest in this type of activity (sociably desirable) could be limited by the vacuums -either resulting from lack or inadequacy- of the IPRs regime in force at global level -which was conceived, originally, for activities of industrial profile, which is not perfectly equivalent to biological productions-.

3. In the particular case of the forestry activity, the length of the productive cycle[1] -from the decision to plant all the way up to the industrial transformation of wood- is added to the general characteristics of the mentioned biological processes, which introduces some unique specificities for the activity, which must be taken into account at the moment of discussing IPRs.

4. The forestry sector consists of traditional activities that begin with the extraction of wood from forests for its industrial transformation. The final use is predetermined, to a great

[1] We are here assuming the forestry activity in a sustainable way. That is, not by the irrational exploitation of native forests, but by the planning of the activity from its origin to its final use (which implies a decision of what to plant and waiting for maturity to be able to fell the raw material and then manufacture it); a rational and sustainable exploitation of native forests would demand still longer time periods.

extent, by the type of tree to be planted and even its variety; each variety, in turn, has a life cycle length -with the resulting different business cycles for wood and products-. Wood is, therefore, the most valuable resource to be extracted from the forests, which is used for the production of energy, as well as sawmills, the industry of panels and boards and the production of pulp and paper. Other non-timber forestry products can be important as well -food, additives for food (mushrooms, fruits and herbs), fibers (used in construction, furniture, clothes or utensils), resins, rubber and products used with medicinal, cosmetics or cultural purpose- (FAO 1999). Forestry products -particularly wood- are perceived as "environmentally friendly", which gives them a certain plus in consumer choice over other alternative products (due to their supply of oxygen via photosynthesis). Wood products are essentially derivatives from nature that can be easily recycled, using relatively low energy in their production and are "low in carbon" (FAO 1999). At the same time, the industry continues to explore ways to extract a greater amount of fiber from forest resources -for example, from harvest residues and others, previously considered useless or without economic value- (UNECE FAO 2011).

5. The forestry sector is called to play an important and strategic role to reach some of the future challenges for a responsible development -offering an alternative source of renewable energy and contribute to decrease climate change-. The forestry activity contributes to sequester carbon in forests and harvested products (accumulating and maintaining carbon in the forest ecosystem), appearing as an alternative to new materials as well as substituting non-renewable sources of energy (wood-based combustion reduces carbon emissions in relation to other fossil fuels). The forestry sector can be one of the great contributors to the goals established by countries to replace non-renewable sources of energy with other renewable ones[2] (UNECE FAO 2011).

6. The approach of value chains (OCDE, 2006; Gereffi, 1996; Humphrey and Schmitz, 2004, Kaplinsky, 1998) to study the production of renewable biological resources helps to better determine the location of the critical control nodes and generation of value. It characterizes the involved agents in such a way as to be able to understand the business strategies to be adopted in order to face the problems and challenges that might arise in the future. This approach helps to explain the segmentation of activities between different territorial spaces (or nations) and contributes to shed light on the composition of world commerce. In forestry, the use of this approach is valuable, given that the times of the productive cycle –imposed by the rhythm of growth of raw material- demand an important coordination between the primary phase and the industrial phase. At the same time, the quality and composition of raw material predetermines the further use in the transformation stage (or at least its efficiency). As a result, production networks are formed - with numerous contracts – to coordinate stages and reduce the risk of an activity with an extended cycle, high risk and huge amounts of fixed capital per product unit.

[2] The EU aims to achieve for the year 2020 that at least 20% of its energy matrix derive from renewable sources.

The forestry value chain

7. In the case of the forest complex, the characterization of the chain revolved initially around the natural forests destined for the extraction of firewood (fuel) and wood (with several further applications). As the forest activity developed, in relation to the supply of raw material -and in the framework of a number of technical developments-, the next step was the planting of artificial forests, up stream. This leads to the predetermination from the source -within certain limits- of the final prioritized uses of the wood as input material, and consequently, orienting the type of plantation to be made. This choice, in turn, leads to a selection and improvement process of the seeds and/or specimens to be planted. Simultaneously with the idea of "planting forests", the final use of the tree as raw material of other activities was extended. And this type of sowing became a form of unique agriculture for certain types of soils.

8. Theoretically, felling opens multiple possibilities of use: on one side, the log is used as wood or paper pulp, on the other, breaking off -in initial years-, treetop, branches and part of the trunk -specially when it is thinned- can feed the energy industry or other secondary uses. It is obvious that, in this outlook, both social efficiency and the efficiency of the forestry chain are related not only to the levels of individual efficiency in each process/industry/stage in particular, but also to the overall structure that allows "dismantling" and taking advantage of the greatest possible amount of derivatives of tree felling. Thus –and beyond the profit and logistics that must be implemented-, the idea that today moves forest production is the uptake of the multiplicity of products and sub-products from the industrial exploitation of trees[3].

9. Therefore, in the more modern structure of the forestry chain there is a first stage related to the improvement of raw material -generally developed in specialized nurseries, where the best genetic material is selected to obtain certain species with particular characteristics according to the intended use (more harshness, less knots, faster growing, higher content of lignins, etc.)-, followed by the planting of forests (the forest activity as such)[4]. Once planted, the rapid development of the tree demands particular care during its growth -associated to a whole sector of specialized service providers in the activities of pruning, felling, thinning, sanitary control, etc.- to finally derive into industrial utilization. Here, two great different modes open up: wood as an energy input and wood as an industrial input; we can point out that, by the year 2010, the first use was slightly above in percentage of the total with respect to the other use. As for the industrial use, this is also divided into wood for production of paper -with a previous step through the stage of generation of cellulose- *versus* the wood used for the production of wooden elements -

[3] Trees genetically conceived as raw material for a determined purpose.

[4] There is a growing trend in the use of planted forests for two important reasons: to preserve natural forests, and to guarantee with higher precision the type of necessary input according to the final product expected to be manufactured with the obtained raw material.

from plywood panels, to furniture, through a multiplicity of elements to be used in construction and homes-.

10. The optimization of the complete "industrialization" -or the most complete possible industrialization- of the tree introduces ***technology*** as a key tool, from the selection and improvement of seeds and seedlings to the design and commercial differentiation of furniture, including the processing techniques to convert round wood into cellulosic paste, the treatment of waste (in a double game of reducing environmental impact while providing economic support to its productive use) and/or the techniques to convert vegetable matter into energy. Being technology one of the keys to make forest production more efficient as a whole, necessarily, the different manifestations of the rights of intellectual property are present in the different stages, considering the specificities of the forestry industry. Note that such property rights, on one end, fall on the pre-existing live material -usually covered by rights of vegetable breeders- and on the other, on inventions at industrial level -a matter of legislation of patents and complementaries-.

11. Being ***artificial forests*** the base of the industrial complex, a first aspect to be considered is related to the different applied technologies on the trees to: i) reduce the impact of plagues; ii) shorten their development time; iii) express with greater emphasis certain characteristics of the tree (pulpwood capacity, hardness of the wood, etc.) considering its subsequent industrial transformation. Given that soils and climates are specific for each region and/or zone, the improvement activity is unavoidable in order to adapt the varieties to local conditions. The adaptation and improvement process begins with the identification of the species, followed by the selective inbreeding of varieties and, in more advanced stages, calls for techniques of modern biotechnology to design and multiply the species.

12. Vegetables have a particular reproductive process that enables different possibilities of appropriation and, hence, different incentives to invest in the development of new varieties of plants. In the case of agricultural crops, self-pollination of varieties (soy, wheat) maintains the genetic characteristics unaltered throughout generations. This implies that innovation, once incorporated, can be reutilized by means of the reproduction of the plant without alterations (every genetic modification will be incorporated in the descendants). However, in the case of hybrids (corn, sunflower), second generations lose the sowing potential as well as their uniformity. Therefore, in those cases, farmers are forced to buy seeds again for each campaign. Consequently, for the case of hybrids, market failures that show up in the production of new varieties are, generally, resolved by means of industrial secret (the parents used to make cross breeding are a sort of trade secret, so the possibilities that other companies would have access or could copy the variety of hybrids are seriously reduced), and by the IPRs system in the case of autogamy. In the case of trees, everything works in a particular manner. The processes of generation of new varieties are generally longer, more difficult and more uncertain than in agriculture, which causes advances in the forestry sector to be slower than the ones seen

lately in agriculture (soy and transgenic corn, mutagenic rice, etc.). These circumstances have resulted in greater intervention of public agencies or non-profit cooperatives in the initial development and provision of new varieties. The natural reproduction cycles of a tree, and the time it takes to grow, make the IPRs systems designed for plants not totally adequate to protect the generated tree varieties[5]. The rights of vegetable breeders (VBR) establish protection periods that, for the times handled in the forestry chain, are insufficient (the evaluation and certification of a new variety of a tree, by the established means, takes too long). In any case, the control of this node within the forestry chain sets the base for future competitiveness; its development lies on company laboratories and/or public entities (with their respective experimental fields) like in nurseries (companies that also drive the dissemination in the case of non-integrated ventures).

13. The "objects" on which the rights of intellectual property focus in the first stage of the chain are the ***seeds and/or clones,*** since all the knowledge is found in them. Companies dedicate great amounts of effort (in time and resources) to develop varieties of genetically superior trees, a process that takes from 10 to 15 years. Being the obtained genetics a strategic asset for forestry endeavors (for example, when improved trees are obtained that allow a significant increase of the amount of extracted pulp) the problem related to the appropriation of this type of asset is crucial. We could think of two extreme cases: a) on one side, the forestry complex could be articulated based on the interaction, in the suppliers' market, of "genetically superior trees" or logs (one of the first and more relevant sub-products of tree felling) and independent companies/processors of wood. If this were the case, the need to catalog the technical quality of the trees would arise to enable schemes of traceability[6] and/or genetic contents that would differentiate, in the free play of market forces, the "good" from the "bad" -in this case, the relevance and need for the utilization of IPRs on the improved trees would be of great importance-; on the other end, b) a market would not exist and the industrial companies would be fully integrated from the supply of raw material to the higher industrial phases. In this last case, the complete integration of the companies would generate the incentives for them to invest in the improvement of trees (whose benefit would then be appropriated in the higher stages of the chain) and reduce the incentives to the use of IPRs to guarantee appropriability in the market - the genetic improvements would be preserved as industrial secrets within the company. We point out that the latter scenario is of the type usually found in the case of Uruguay and most of the countries with forest resources.

14. In the primary phase, planting and felling use imported technology with world standards, as well as local developments. The latter concentrate in the process of planting and sowing. The soils and species of trees used are specific to each territory, and require local adaptation processes – that even include the design of machinery for these types of

[5] In any way, most of the produced varieties are hybrids, reason why their seeds are sterile or lose vigor in later reproductions, which would be giving the research effort a "natural" protection.

[6] At the same time, traceability allows the control of the quality of the material with respect to certain attributes that contribute to the type of sought after wood (length of fiber, ligning content, etc.).

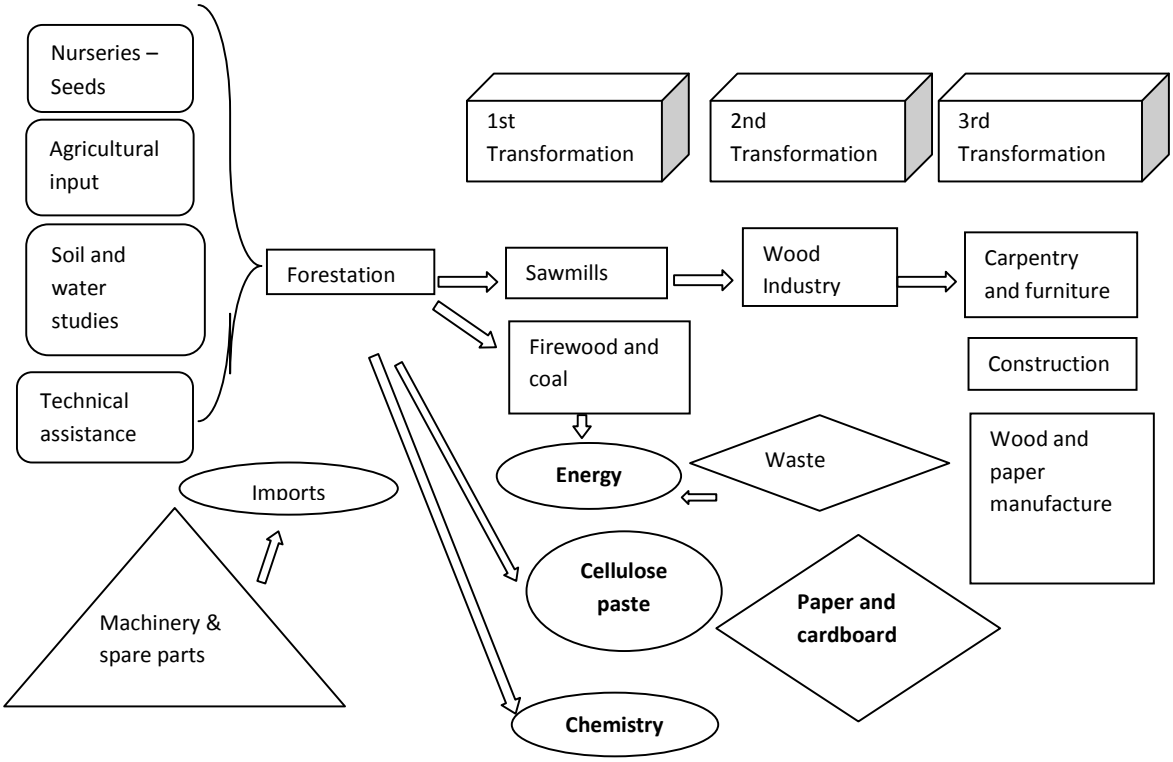
activities, with regard to sowing and planting-. The high component of local adaptation of these assets can reduce the export potential as well as the incentive to protect developments via IPRs mechanisms. Especially if the size of the market and number of companies operating do not enable competition between producers of machinery justifing the protection of developed technologies by means of IPRs.

15. On the contrary, in the logging phase, given the existing standardization to a global level, there are great economies of scale, thus the incorporated technology in the equipment is acquired to international suppliers via market mechanisms.

16. In the ***first industrial transformation*** *(*logs into paper pulp, or from trunks into wooden products), the technologies refer to at least two central types of activities: i) industrial transformation processes; ii) control of waste and its transformation into inputs for any further use (generally production of energy). In these cases it is also about technologies that are relatively standardized at a world level, which are acquirable via the market to a reduced group of international suppliers. These technologies are usually protected via patent rights, and are produced by companies that operate at a world scale. The protection through patents of those technologies in a given country depends on its industrial capacity to reproduce them. At a local level, the developments and efforts focus on the adjustment of processes and the development of multiple secondary activities that permit delimiting losses and waste to transform them into economic goods.

17. In the ***second industrial transformation,*** the use of wood in furniture manufacture and the use of pulp for paper production open eventual issues related to property rights. In particular, the topic becomes relevant in the design of furniture, homes and other goods where the differentiation of products -and consequently of prices- is associated not only with the quality of the initial wood, but also mainly with the design -shapes, colors and functionality of the goods- and the development, consolidation and maintenance of brands and image control (to the consumer) of the final product. In these cases, it is about developments that demand considerable resources and prolonged times -materialized in the generic concept of brand (with the respective variations of property rights)-.

Table 1 – The forestry value chain
Diagram of the forestry chain – (reduced version)[7]



Source: Own elaboration based on Morales, V., 2012; study 002/07 of the Mercosur Secretariat and Yearbook OPYPA 2008.

[7] For an extended version see the annex at the end of the document.

17. The other area – redefined in the last decades – is the use of vegetal matter to feed steam-generating power stations that subsequently transform steam into electricity and, as such, reconfigure the energy matrix. In this field, the technology can be divided between the one used to collect and process biomass produced in forest activities (in the primary phase and industrial phase) and that used in the application of the ***biomass to generate energy***. There is a substantive space for innovation in both fields. Acquiring biomass can be done in two ways: i) with plant and wood residues for conventional use; ii) or new concepts of artificial forests destined exclusively for these purposes (this is currently under development around the world). In the first of these cases, critical technologies refer to the development of logistics of acquisition and transport of residues – of cleaning/maintenance of forests, of felling and of sawmills -, as well as the reorganization at industrial-plant level to guarantee, at reasonable costs, the access in time and form to raw material, located always close to the factory that uses wood as an input. In the second of these cases, it is about forests generated expressly for the production of energy with fast growing species, planted with other densities, demanding other types of care and subject to mass extraction. In the utilization of biomass, the industrial process is relatively standard where the technology is incorporated, to a great extent, in the equipment in power plants (usually provided by boiler factories, where technological developments are frequently carried out for the purpose of gaining greater productivity). However, new developments in the utilization of biomass continually emerge, and can be protected by the IPRs.

18. Visualized the activity as a production chain of multiple steps, where each one of the stages has a productive cycle of determined times, its development can take place in different geographical locations. One possibility is the integral development within a single country -from the raw material to further industrialization steps-, while in other cases, the initial phases -plantation and log production- are generated in one space, and the industrialization in another, having impact on the conformation of the world trade of semi-elaborated products (logs, chips or wood) or final products (furniture, construction wood, paper, etc.); it will all depend on the type of company predominant in the sector and on the strategies implemented, given the conditions of the surrounding environment.

19. One of the more relevant characteristics of the business strategies consists of determining the type of innovation activity they implement -both in the tree planting process as an element of energy transformation and in the subsequent production stages- and the consequences on the forms of protection of knowledge -by means of property rights in their different forms, or through organizational protection mechanisms (through stage integration)-.

20. In this setting, the Uruguayan forest industry is being developed. After establishing the fiscal incentives a few decades ago for the plantation of forests, the next stage involved the development of related manufacturing activities. In this sense transnational producers of cellulosic pulp, relevant at global level, settled in the country, though it is yet to be

determined whether there is space for further progress towards the production of paper with an international projection. Although there are also relevant foreign investments in the timber activity, they are at an early stage of development, reason why there are still several questions unanswered (added to the fact that plantations of this type of production will not be mature enough to enter into massive production until years to come)[8]. Other possible developments based on wood are still unknown -and hence, an opportunity for Uruguay-.

21. Given this scenario, and considering that there are possibilities of expansion in the base of the productive network -3 million potential hectares for artificial forests to be planted-, the analysis of the rights of intellectual property in some of the different stages of elaboration of the network is a key factor from the perspective of the generation of future basis of genuine competitiveness.

[8] Between 2014 and 2020 the plantations made for the production of timber for sawmills, plywood boards and engineering timber will mature, and their production and supply will oscillate between 4 million m3/year for the period 2011-2016 and over 10 million m3/year for the period 2017-2021 (Uruguay XXI, 2012). Given the main markets of this type of product are developed countries (especially the United States), after the global real-estate crisis the outlook is not clear yet regarding the future of the sector. This is another relevant question to be considered for the future, to understand the development of this production in Uruguay – even more, taking into account the internal consumption volume is not enough to even sustain one plant of international scale.

Section 2 – International outlook of the forestry chain

22. Forests constitute approximately 30% of the arable land in the world (4 billion hectares). These are mostly concentrated in five countries (Brazil, Canada, China, US, and Russia), which represent half of the world forest area (FAO 2011a). At the same time, this can be classified into primary forests -those formed by natural species that have not been transformed or manipulated by man (36%)-, forests naturally regenerated -those in which human activity has taken place (57%)-, and planted forests -made up of trees (with native or introduced species) deliberately planted by human action (7%)- (FAO 2010a).

23. The total gross value added of the forest sector in the world economy ($US 468 billion) explained the 1% of world GDP in the year 2006 (Lebedys, 2008). The forest industry is of utmost importance in Russia, US, Canada, Sweden, Finland, Chile and New Zealand. Global exports of forest products have been growing at an annual rate of close to 6.3% for the period 1993-2008. However, different estimates, in the face of low expectations of world growth for the next few years, place such growth at 3.7% for the period 2010-2030. On the other hand, it is important to point out that, being a sector which is strongly dependent on export markets, its competitiveness resides in maintaining and increasing the efficiency of its operations (Carlsson and Ronnqvist, 2005).

24. In Latin America and the Caribbean the production, consumption and trade of the majority of forest products increased steadily in the last years, with a marked development of the planted area, investment in technology, external capital and research in this subsector. Thus, the production of pulp and paper recovered in the region represents 13% of world production, and corresponds mainly to Brazil (64%), Chile (24%) and **Uruguay (5%)**, while forest exports of the region in 2009 represented 7% of the word total, being the main exporting countries: Brazil (47 %), Chile (30%), Uruguay (7%) and Argentina (4%) (FAO, 2012).

25. Fifty years ago (with the creation of the Forestry Department), Uruguay decided to promote and encourage the development of the forest sector, showing today the first effects on the real economy of such a decision. The activities of production of wood and wooden products, paper and paper products and presses represented in 2011, 16.4% of the industrial GDP of Uruguay (BCU). Those trees -planted over 20 years ago- today have begun to be mature establishing a challenge downstream for the following links in the global value chain (GVC).

26. The ***forestry value chain*** begins with the plantation, harvest and production of logs or firewood pieces; there, where all the processes previous to industrialization of wood take place. Throughout the world, in the year 2009, 10 million people were employed in the primary production of forest goods and the administration of protected areas (FAO 2010a). The supply of wood is changing, slowly, from natural forests to planted forests. Eastern Asia, Europe and North America are the regions that have most planted forests. At

the same time, the greatest growth in the supply of wood comes from countries that developed planted forests in the last decades (in Asia, Latin America and Oceania) (FAO 2010a).

27. This chain underpins a very large volume and amount of world trade. During the 2006, 2008 biennium total imports were of the order of 319,438 million dollars, growing at an annual rate of 9.4% between the years 2001 and 2008. 71% of this trade corresponded to the category of second transformation goods; representing the products without transformation and first transformation, 5% and 24% respectively of world purchases of the chain. With growth rates of 11.3% and 9.8% respectively, the category of products without transformation and second transformation were those that gained participation in the imports of the chain, during the surveyed period (Rebizo and Rodriguez Tejeda, 2011).

28. Wood inputs used for energy come directly from the forest or from residues generated during industrial transformations (like the case of black liquor in the production of cellulose). The renewed interest in wood as a source of energy originates from the pronounced increase in the price of oil, as well as from the dependency of developed countries -especially Europe- on import of energy from regions in conflict, and the commitment of countries to reduce greenhouse-gas emissions to mitigate climate change (Kyoto Protocol) -all issues that, in a certain way, are related-.

29. The wood extracted from forests includes trunks, chips and other residues that can be used as fuel or for industrial production. The world production of trunks was 3.4 billion m^3 in 2009. In the period from 2003 to 2007 the United States was the largest trunk producer, followed by the EU, India, Brazil, Canada and Russia (European Commission 2011).

30. The division between the industrial production of wood and wood as an input for energy varies from country to country. The world average shows that half is used as bio fuel, but there are strong differences between regions: in Latin America, Africa and Asia, close to 80% of wood is used for this purpose, while in Europe, North America and Oceania its use does not exceed 15% (FAO 2009). On the other hand, industrialization of wood reaches values around 15% in India and Indonesia, close to 50% in Brazil and China, 73% in Russia, 80% in the EU, 90% in the US and 99% in Canada (European Commission 2011).

Table 2: Forest areas and planted forests

Region	Forest Areas			Planted Forests		
	Area (thousands of ha.)	**Annual growth rate (2000-2010) (%)**	**% of world forest area**	**Area (thousands of ha.)**	**Annual growth rate (2000-2010) (%)**	**% of world forest area**
Latin America and the Caribbean	890,782	-0.46	22	14,952	3.23	6
Russia	809,090	n.s.	20	16,991	1.01	6
Asia and the Pacific	740,383	0.19	18	119,884	2.85	45
Africa	674,419	-0.49	17	15,409	1.75	6
Canada	310,134	0	8	8,963	4.41	3
United States	304,022	0.13	7	25,363	1.18	10
Europe (excl. Russia)	195,911	0.36	5	52,327	0.47	19
Western Asia occidental, central, North Africa	122,327	0.07	3	15,082	1.49	5
World	**4,032,905**	**-0.13**	**100**	**264,082**	**2.09**	**100**

Source: FAO (2011a)

31. In relation to the chained industrial production, and the expectations of growth of the population and their income, the demand for pulp, sawmill products and wooden panels is expected to grow, which, in turn, will have an impact on the increase of demand for wood (FAO 2009, 2010ª). However, the demand for trunks is expected to grow less than the total demand for wood and fiber, since it is estimated that a high percentage of paper will be recycled and reutilized by the paper sector (FAO 2009).

32. One of the first industrial transformations of trunks takes place in sawmills, which convert the logs into wood. In general, sawmills specialize in a particular type of wood (hard or soft). The market of soft wood or conifers is the most important and is strongly concentrated in the north (Osimani and Paolino 2004); Europe and North America represent close to 2/3 of the production and global consumption and are, at the same time, net exporters (FAO 2009). The world production of sawn timber rose to 362 million m^3 in 2009 (6.7% lower than a decade ago). The most recent trends indicate that China and India are becoming big players within this production -they doubled their production between 1999 and 2009-.

Table 3: Consumption of wood for energy and for industry.

- 2011 -

Region	Energy (1000 m^3)		Industry (1000 m^3)	
	Production	**Consumption**	**Production**	**Consumption**
Latin America and the Caribbean	281,307	281,301	195,091	190,749
Russia	44,700	44,225	136,700	100,202
Africa	615,636	615,636	72,059	69,635
Canada	2,715	2,733	132,232	134,001
US	43,614	43,515	336,895	328,125
Europe (excl. Russia)	105,002	104,116	370,742	398,901
Asia	754,627	754,753	244,515	291,801
Oceania	15,881	15,882	52,378	41,104
World	**1,868,386**	**1,867,067**	**1,541,971**	**1,544,777**

Source: FAO (2011a)

33. The panel industry, on the other hand, transforms trunks, branches and several other residues from the sawmill, into flat and thin wooden panels -laminated panels, fiberboards, particleboards and plywood are products of this industry-. The panels have multiple uses -for instance, construction-. Though the production and consumption of

wood panels are still half of the production of sawn timber, their rapid growth leads to believe that they will soon equate (FAO 2009). The production of wood panels grew from 171 million in 1999 to 259.9 in 2009. At the same time, a great shift from plywood (which represented most of the panel industries in the '60s) is taking place toward the production of fiber and particleboards. Asia-Pacific, Europe and Latin America and the Caribbean are net exporters of panels. While Europe exports basically fiber and particleboards, the other two regions export plywood. The trends are not expected to change in the future, and the global percentage of trade over the total production and consumption will remain around 26/27% (FAO 2009).

34. Another relevant use for solid wood is the production of furniture (FAO 2010a). Some sawmills move towards stages downstream, acquiring machinery, adhesives and industry paints, and design and brand services (Kaplinsky et al 2003). Given that furniture is sold mainly to the end consumer, personal available income is what mostly affects demand. In the particular case of the demand for wooden furniture, it is also important to take into account prices and costs of the competition (furniture made with other materials, like plastic, metal, glass, aluminum and fiber plants -rattan or bamboo-). The consumer's taste and the quality of the product also play an important role when deciding to purchase or not wooden furniture -particularly in high-income customers (FAO 2010a)-. In general, wooden furniture has maintained 45% of the total furniture market -global competition has been maintained thanks to the relocation of production in countries with lower labor costs, maintaining, at the same time, the quality reputation (FAO 2010a)-. The world production of furniture, for 2009, was estimated in $US 376 billion, while world commerce was $US 92 billion. The United States was -by far- the greatest importer for an amount of $US 10.7 billion.

35. Manufactured boards are a solution to the need for adaptation presented by the wood sector to the new materials with which it competes. At the same time, new products and processes are being developed that make efficient use of those trunks of less diameter to produce structural and decorative materials. Such innovations allow wood to maintain and expand its portion of the market -especially since architects and specialists acknowledge the characteristics of "renewable" and "recyclable" of wood- (UNECE FAO 2010, FAO 2011a). Additionally, thanks to innovations in marketing -like "ready-to-assemble" or "self-folding"- and to the decreasing trade barriers, world furniture trade has grown rapidly in the last decades, from $US 42,000 million in 1997 to $US 97,000 million in 2007 (You, 2007).

36. Wood is also used for the production of cellulose and paper. Cellulose is a commodity that results from the dissolution of wood chips into individual fibers – either by chemical, semi-chemical or mechanical methods-. Depending on the process used, the firmness, appearance and characteristics of final use of the paper to be obtained will be affected. The cellulose market, in turn, is divided by the type of fiber. Soft pulp comes from different species of pines and firs that grow in the northern hemisphere. This wood has, in

comparison, long fibers and its pulp is used, generally, to strengthen paper, as well as a more opaque look and good printing properties (Carlsson and Ronnqvist, 2005). Hard wood, instead, comes mainly from eucalyptus and birch -which typically have short fibers-. Birch is typical of the northern hemisphere; whereas the eucalyptus is from warmer areas (like Brazil, Australia and the Iberian Peninsula). The pulp and paper industry contributes most to the forest GDP -for the period between 1990-2006 it represented, on average, almost half of the value added of the sector- (Lebedys, 2008). Central America and North America produced in 1999 more than half of the pulp in the world (51.5%), losing participation, and registering ten years later 40.2% of the total; on the other side, Brazil's and China's relative contribution increased, representing in 2009 8.4% and 4.4% of the world production of wood pulp. It is worth pointing out that the cellulose sold in the market represents only 25% of the total produced -the leading companies are heavily transnationalized-[9]. Most paper pulp is produced and used by the same company -intra-company consumption-; hence, the sector is characterized by the presence of large totally integrated transnational firms[10]. Some of them, in spite of having their own production of pulp, demand additionally more in the market; others, do not have any production at all and depend on the market for their supply. (Carlsson and Ronnqvist, 2005). The cellulose and paper industry is a mature industry, intensive in resources and capital; therefore, presents high fixed costs and usually operates with large economies of scale (Osimani and Paolino, 2004). The main producers of cellulose are in the US, China, Canada, Brazil, Sweden, Finland, Japan, Russia, Indonesia and Chile.

37. Wood pulp is one of the most important resources for the production of paper and cardboard, even when recycling has steadily increased. At the same time, paper and cardboard is one of the most globalized group of products, with a high percentage of exported production and high consumption of imports (FAO 2009). Historically, North America dominated the production and global consumption, but due to a rapid growth of Europe and Asia-Pacific, the three markets today share similar market percentages. The world production of paper and cardboard was 376.8 millions of tons in 2009 -almost 20% more than 1999-. During the last decade, Asia moved from third place -with 28.5% of the world product- to the first place -with 41.5% in 2009- (mainly due to the fact that China replaced the US as the main producer of paper and cardboard in the world).

38. According to existing data in Uruguay, and compared to information from FAO, Uruguay represents 1/15 of the forests planted in Latin America -0.4 of the world- with the possibility of increasing four times the cultivated area. According to data from FAO, in the year 2010, Uruguayan exports of forest products represented 0.54% of forest exports at a world level. In a breakdown, we can see this relation adopts the following values: logs: 2%, wood pulp: 1.9%, fiberboards: 0.14%, sawn wood: 0.13% and paper and cardboard: 0.04%. Clearly, today, the predominant activities are those that add less value.

[9] Close to 30% of the pulp produced internationally is commercialized in global markets.
[10] The five first companies in the world produce about 25% of the world market of pulp.

39. The cumulative annual average growth rate for exports of timber and paper products of Uruguay, between the year 2000 and 2011, is above 20% according to data from the Ministry of Livestock, Agriculture and Fisheries of Uruguay. And, according to estimates of FAO (2004), for the period 2000-2020 the expected growth rate of forest exports is around 14% annual cumulative, expressed in value[11]. In perspective, a small country like Uruguay has great chances of increasing its global participation[12]. Therefore, it makes sense to explore the future possibilities of expansion of the forest chain there.

[11] In 2005, Uruguay occupied the 5th spot in world exports of industrial round wood (non-tropical broadleaf) preceded by Russia, US, Latvia and France. A part of those exports constitute round wood for sawmilling and sheet industry (120,000 m3 in the year 2007) and the main target was Southeast Asia (China, Korea Vietnam, Singapore, Malaysia, India).
[12] Given the size of the Uruguayan internal market, forest production only has chances to grow abroad.

Section 3 - Technology, Innovation and protection of IPRs in the Forestry Value Chain

40. At a world level, innovations in the forestry value chain have resulted in an increase in the competitiveness of the sector. Relevant innovations were introduced in the mechanization of the harvest, in the implementation of new practices of logistics for the transportation of logs, in the introduction of plantations in several regions, in the development of new methods for the extraction of fibers and new products, among others. Meeting the current challenges -for instance adding added value, complying with environmental regulations or satisfying the growing demand for wood- also requires additional innovative efforts.

41. Typically, in a market economy, difficulties to appropriate the results of an innovation lead to a subinvestment in the creation of knowledge. Guaranteeing exclusive rights for its exploitation in the market during a period of time is one of the possible ways to resolve this flaw in the market[13]. However, (a) the IPRs instruments are not equally applicable to all activities and (b) the agents do not necessarily respond in the same way to these legal instruments.

    (a) Innovative efforts can have (or not) as a result an invention that can be protected by the IPRs mechanisms. To guarantee some type of IPRs, such inventions must, at the same time, comply with certain types of requirements. For example, for an invention to be patentable, it must be novel, possess inventive step (for a person with skills common in the area concerned), and have an industrial application (usable). Incremental innovations, such as those generated in developing countries to adopt technology brought from abroad to local conditions, generally possess tools limited in IPRs protection, such as Utility Model patents. Additionally, there are other types of inventions -like those involving living beings- that, depending on the country, are excluded in important aspects from the protection system.

    (b) Private agents may have different incentives to use IPRs instruments to protect their inventions -"*cross-sector" types* of studies focusing on the use of the patent system through different industries to show that that is the case (Mansfield, 1986; Levin et al, 1987, Arundel and Kabla, 1998)-. The different nature and technical characteristics of inventions in all economic activity generate different responses to the IPRs system. When the inventions imply difficult technologies to apply reverse engineering, be copied or reproduced, other different mechanisms to those offered by the IPRs instruments may be a better option. Agents might prefer to maintain their invention a trade secret, instead of having to reveal it in order to gain a right to temporary exclusivity over it. Additionally, when the inventions do not meet certain

[13] Other possible institutional arrangements are patronage and procurement. Patronage refers to the public funding of discoveries and inventions in exchange of their full public disclosure. Procurement consists of the government contracting private agents to deliver a solution to a particular technological problem (David 1993).

requirements (like originality or inventive step) or the IPRs instruments provide less protection than desired (in terms of scope or coverage), there are alternative protection methods -like the trade secret or *lead-market advantage-.*

42. In this section we will focus on when the IPRs system could be useful and efficient to protect activities in the forestry value chain, as well as which are its limitations, always taking into account the reality of this activity in Uruguay -which is why particular attention will be paid to those areas in which innovative efforts are focused, as well as the type of mechanisms that are being used to protect knowledge. Table 4 shows the type of innovation that can be identified all along the forestry value chain -then, we analyze each in particular-. Finally, we seek to reveal the rationality behind the choice of one method or another for protection.

43. In Uruguay, forest activities focus mainly on the primary phase of the value chain and the first stage of industrial transformation. The launch and development of most activities rely basically on the adoption of external knowledge and technology –according to the interviews-. In this sense, local innovative efforts -developed by companies with Uruguayan capital, as well as transnationals- address three areas: the adaptation to local conditions of technologies brought from abroad (for example, questions related to logistics and the use of imported machinery), the development of new specialized inputs that need to be adapted to local conditions (like new varieties of trees that could adapt well to Uruguayan soil and climate), and technologies developed to solve local needs (like the generation of energy).

Table 4

Main links of the forestry value chain in Uruguay	**Type of innovation**
Primary activity	**a) Genetic improvement of trees** **b) Practice and machinery for cultivation, silviculture and harvest**
First industrial transformation	**c) Innovation of process to increase efficiency and productivity of activities in sawmills, boards and cellulose production** **d) Innovations to increase the supply of renewable energy**

3.1. Technical inputs for primary activity

a) The genetic modification of the trees

44. Improving the genetic characteristics of trees is crucial to increase the amount of wood produced (to be able to satisfy the growing demand), as well as to improve the quality of the wood (in terms of quality of fiber, ability to produce pulp, content of lignin, etc.). In this sense, to obtain fast-growing and larger trees is an important objective sought in nurseries to increase the final amount of wood obtained. At the same time, to achieve strong homogeneity (in height, diameter, space between branches or ramification) in the trees to be planted will surely provide commercial advantages, as well as the reduction of costs and will allow to better project the steps to be taken for the future. When the logs are destined for the production of cellulose, genetic manipulation is addressed to obtaining trees with better pulpability (more fiber and wood density, the necessary characteristics to produce cellulose). However, when the logs are destined to the production of sheets, the preferences sought are different -more solid wood, and with fewer knots-.

45. The planting and behavior of trees -as occurs with grains- is maximized when they adapt to specific edaphic and climate conditions of the place. Some species are naturally better adaptable than others for each agronomic condition. In the case of Uruguay, pine tree and eucalyptus were evaluated -together with others- as the most adequate to be adapted to the forest production there. The eucalyptus has the property of fast growth and can be used for the production of cellulose as well as solid wood -considering there are varieties[14] that have better yield for one or the other activity-. Therefore, by means of genetic manipulation, we seek to identify and better adapt the species and varieties to be planted in a particular location.

46. Planted forests are made up of genetically improved trees. These are obtained in two ways: either by identification and selection of those that behave exceptionally within a certain variety -which are then cloned and propagated-, or by crossbreeding the best trees -in such a way that their descendants contain the best characteristics of both parents (which can be different varieties within the same species)-. For example, the Eucalyptus Globulus has the greatest pulpability, but presents problems of plant rooting in Uruguayan soil, reason why it is being crossbred with others that adapt better -the Eucalyptus Grandis and the Eucalyptus Dunis-.

47. The genetic modification of trees is more complicated, slower, more costly and uncertain than the agricultural processes carried out with annual-cycle crops. One of the major differences lies in the length of the reproductive cycle of trees; their features can only be

[14] There are around 700 different varieties of eucaliptus, and not all of them adapt to the conditions in Uruguay. The varieties planted there are Eucalyptus Grandis, Eucalyptus Dunis, Eucalyptus Globulus and Eucalyptus maidenii.

evaluated when the tree reaches maturity -which will happen in much longer than a year, contrary to the case of agricultural crops-. Their size adds yet more difficulties, and, given they are perennials, the times for them to give seeds are much longer yet (in relation to annual crops that produce them in the same period they were planted). Consequently, the genetic material of trees is generally propagated by cloning -especially with the eucalyptus, which has hard wood and a complex reproductive cycle-. Forest cloning gives the advantage of being able to select the best clones, provide greater homogeneity -very relevant characteristic to determine the quality of logs and wood, as well as for harvest processes- and a greater capacity of repetition -which helps in planning for the future- (Carlsson et al 2004, Paitt 2004).

48. At a world level, tree improvement programs are responsible for much of the experience acquired in forest productivity, either directly -providing better material for planting- or indirectly -serving as a model for silviculture programs- (Bryam and Raley 2011).

Selection and production of trees for planting: seeds, clones, continuous improvement and more

The large forest ventures -mainly those associated to transnational companies of the sector- seek to generate new genetic material by means of two procedures:

i) *Crossbreeding.* By means of previous identification of varieties of a species that have particular features, but not all together (better plant rooting, greater foliation, greater pulpability, etc.), the aim is to carry out crossbreeding between these -by manual pollination- to obtain hybrids that meet these characteristics in a single specimen. Many of the clones originate from these crossbreedings. The hybrid seed is obtained, but it cannot be planted again because it segregates. So after obtaining the hybrid, it is propagated or cloned -there is no return to the "parents"-.

ii) *The identification of exceptional trees.* Identified in the field, after several essays of growth and performance made in forest sites, they are determined to be superior to the rest of the trees, hence worthwhile to be used commercially.

Developing new material for commercial production -which occurs when the activity is initiated in a new country- takes between 10 to 15 years depending on the starting point. It generally begins by bringing collections of different species[15], which are planted to evaluate their development. From here the most promising varieties are determined[16]. The following step is to establish "breeding populations", which are forests where, for example, Eucalyptus Grandis[17] of all possible origins are planted -to do this, seeds from other improvement programs in other countries are exchanged[18]-, to determine which variety adapts best to the conditions of the place where they will be planted[19]. Then, within these populations, the best trees

[15] In Uruguay the forestry law was oriented towards some species in particular.

[16] The first tests determined that the most promising varieties for Uruguay were Eucalyptus grandis and dunis.

[17] In general, the eucalyptus grandis is very "domesticated" -much studied and adapted at a world level-.

[18] According to the interviews for this study, there is an exchange of genetic materials between companies by means of legal agreements. This is done by certain large and top companies. In those agreements IPRs mechanisms are not used to protect the genetic developments, but those interviewed indicated that they would have never exposed themselves to disseminating material that was not their own -so we can only deduce that there is a sort of implicit agreement between companies, that aren't many-.

[19] In Uruguay, in the case of UPM and its nurseries -Forestal Oriental, UPM's nursery, is the result of a project initiated by Shell in Uruguay at the beginning of the '90s; Shell had a very high component of innovation in its forestry project and started with the process of introduction of new species, they are now entering into the second generation of genetic

are identified, which will be introduced in the clonal tests to determine the genetic component and the environmental component that explain their behavior. Trees identified as superior are those that later propagate and are planted commercially.

Seeds vs. clones. This is tied to the maturity of the improvement program. First, the improved seed is produced (that was crossbred previously). The superior state of improvement is through the selection of clones. By planting the improved seed, a population is obtained with a Gauss distribution -for example, for the diameter of the tree-. That is, if it is produced from the plantation of seeds, the forest results heterogeneous, situation that is resolved through cloning. For this, the best trees are selected, which are those that are cloned -the production of an improved seed is an intermediate stage-[20].

*In vitro culture or micropropagation i*s a group of techniques and methods of tissue culture used to multiply plants asexually in a fast, efficient manner and in great quantities. It is used to obtain plants free from disease or obtain great numbers of plants that do not propagate efficiently. From a fragment (stalk) of a selected mother plant uniform descendants are obtained, with identically genetic plants, called clones[21]. This helps to overcome difficulties such as slowness in the germination process, irregularities in obtaining seedlings to make up a homogenous population, as to age and size, obtaining seeds at irregular intervals and with little viability, etc. (Acosta Solano, C., 2011). Micropropagation does not change the genetics of the material. It is a technique that reduces the time from the selection of the tree, until the commercial phase. To take to the commercial phase, hundreds of thousands of parent plants have to be made and, given that at the beginning the propagation curve is very flat, it allows speeding up the final propagation of the tree. Micropropagation is just to propagate in a vegetative way a tree in test tube conditions. The advantage is that, in the middle of the culture (moving the concentration of hormones), the trees stop behaving like a tree (that grows straight upward) and becomes a shrub, which produces many sprouts, allowing to increase the propagation rate. From one plant, ten can be made in a matter of a month, and so on. When a plant species propagates, theoretically, there is a possibility of mutation. But in the case of micropropagation, it is not common.

Genetic improvement is a wheel that every year is fed with new materials.

For its part, a molecular marker is a DNA segment with a specific location in a chromosome, whose heritage can be tracked in individuals of a population. It enables to re-obtain gene combinations whose interaction governs a determined phenotype, a process with a highly improbable occurrence. Some of the characters selected by means of molecular markers go from resistance to disease to others related with the quality of the product. They can be used to:

i) Organize, maintain and increase genetic diversity (genetic progress).

ii) Decrease the genotype/environment interaction ("assisted selection").

iii) Decrease the time required to complete the selection cycles.

iv) Achieve objectives of the genetic transformation of trees.

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improvement, as a result of the first 10 years of work- the types of improvements obtained followed the following sequence: first, specimens were selected by growth and wood density and by tolerance to frost -trees with some type of susceptibility to common diseases and frost are discarded- (that is, by adaptability to soil and climatic conditions of the region). In this sense, the first filter was -and continues to be in their experiments- growth (volume by hectare). The second filter is the density related to cellulose yield. From there, the clones are selected, and the registration is initiated. The final filter is a micro-pulping test: making cellulose or paper in laboratory conditions to better characterize the wood from the tree.

[20] Technically, cloning is relatively simple. It is cutting a segment and planting it somewhere else. The complication is that the adequate and precise environmental conditions must be generated (which are produced in a nursery) in order for the transplant to root in the ground. In Uruguay, there are nurseries with this capacity at UPM, Montes del Plata, Weyerhouser, Cofusa and another company that propagated eucalyptus globulus -variety that is acquired by the independent foresters-.

[21] Cloning consist of extracting from the parent plant stems that, after a process of plant rooting, make seedlings. The parent plant is exposed to a process of nebulization receiving 90% of humidity at a temperature between 250 and 350 bringing about rhizogenesis, that is, the growth of a new root, and in a little more than two months a new plant is obtained. Transgenic products, instead, are obtained by genetic manipulation with the objective of developing a particular product (El Pais Empresario, forest guide; and Faculty of Agronomy of Uruguay).

The two most studied objectives in genetic forest engineering are the increase in the production of biomass and the changes in the structure of wood. The increase of the growth rate, the increase of the volume of the trunk and shortening of the cutting shifts are important objectives of many improvement programs of trees, as well as the upright trunk, the rest period and growth habits (ramification). As for the structure of the wood, what is sought is to modify the content and composition of lignin. Other objectives are the introduction of resistance to insects and fungi, tolerance to herbicides and improvements related to the capacity to grow in marginal soils, exhibiting resistance or tolerance to biotic and abiotic stresses (like droughts, frosts, floods, high salinity, etc.) (Biotechnology and Vegetal Improvement II, INTA).

49. The companies that have their own reproduction programs are usually large transnational firms, totally integrated, that produce their own wood and pulp. They begin experimenting and evaluating, with breeding and reproduction programs, which is the best variety to be planted, identifying and isolating, in the process, the "superior" trees. When the best variety is identified, it is evaluated at a laboratory level and is propagated (through cloning methods) and it is used in their own reproduction programs -generally own plantations or, on third party lands, by very comprehensive contracts-. The described process -to obtain and improve a tree for commercial use- can take between 10 and 15 years. The most advanced reproduction programs in Uruguay have exceeded 20 years and have increased in 80% the productivity and quality of wood in some species.
50. Companies devote great efforts -in time and resources- to identify superior trees and obtain their own clones. Such trees can be protected by the IPRs system through the *Plant Variety Protection* (PVP) system, established by the *Union International pour la Protection des Obtentions Végétales* (UPOV)[22]. UPOV is a global agreement that establishes a minimum standard for the protection of plant varieties it is known as a *sui generis* system, since the rights of invention are different than those granted by the patent regime-. Today, there are two alternatives for protection under UPOV: UPOV 1978 or UPOV 1991 -depending on the dates on which the agreements were originally signed- which leads to the coexistence of two protocols of protection for vegetable varieties.
51. According to what the interviewers said, the main weaknesses of the PVP system to adequately protect the reproduction of trees are:
    a. the protection time considered by PVP -25 years- is too short in relation to the reproductive cycles of forest plantations;

    b. the protection granted by PVP, based on the morphological description of the trees (observable characteristics), is quite weak. But it would be strongly favored if considerations relative to the genetics of the tree were included -which is not the case-;

[22] The requirements for protection adopted by the UPOV differ from those of the patent system. To be able to protect a plant variety it must be: a) new, clearly distinguishable by one or more characteristics from any other existing variety; b) sufficiently homogenous or uniform, taking into account certain characteristics of its sexual reproduction or plant propagation; and c) be stable in its essential characteristics (Beier and Strauss, 1985). Compared to the requirements of the patent system, the last two conditions take into account the special characteristics of this type of invention (for further infomation please visit http://www.upov.int/upov_collection/en/).

c. in areas where planted forests prevail -like in Uruguay-, obtaining clones is the main reproduction activity - according to interviewees, the protection of clones is extremely complicated and still not duly regulated.

52. At a global level, the use of IPRs to protect the best genetics in trees is relatively recent and with slow expansion[23]. In the forest activity, there are other much more extended forms of protection: contracts -to provide genetic material to another company for purposes of research, or to provide material to a subcontractor-, trade secret; and property arrangements -vertical integration-. These mechanisms are the most widely used in Uruguay.

53. The climatic and soil adaptations a company makes with the genetic material, minimizes the risk of appropriation on the part of third parties at international level -the material should be adapted to the new destination, which reduces the incentives-. At a local level, in the case of Uruguay, there are a few companies with technological capability and resources to clone developments of others -which is what companies declared-. They thought something like this happening would be unlikely, since they are just a small number and know each other well, which implies an implicit agreement that would avoid this type of conduct. The importance of prestige and trust at a local level is an important factor that makes it less attractive to protect the genetic material through IPRs methods.

54. In short, in the case of the better genetics of trees on the part of companies, vertical integration, trade secret and contracts provide the necessary conditions of appropriability for companies to invest in reproduction activities. According to answers from those interviewed, the limited use of the PVP system responds to a great variety of motives; the most relevant are related to the weak protection that it offers, the lack of practice in the use of this type of protection for this activity -in comparison with the trade secret and property arrangements- and the perception, on the part of firms, of the small possibility their material could be misappropriated by a competitor.

b) Sowing, planting and harvesting practices

55. In the process of sowing, planting and harvesting, companies use, in different degrees, imported technology and their own local developments -the latter concentrate on the stage of sowing and plantation-. The characteristics and types of soil are particular to each locality,

[23] This is mainly due to the fact that the advances in biotechnology have expanded the group of available tools to modify trees, which has inclined companies to protect their developments. The application of these modern techniques has been crucial to carry the best genetics in trees to a level of sophistication comparable to the one reached by agriculture (Merkle and Dean 2000). However, compared to grains, the application of genetic engineering to the forestry activity to obtain genetically modified plants (transgenic trees) is still far behind. This is due to several reasons: technological, economic and institutional. Institutionally, it should be mentioned that the forest activity is strongly regulated by a certification system used to accredit that the products derived from it were produced in an environmentally responsible way. One of the most important certifiers – the Forest Stewardship Council (FSC) – strongly opposes genetic modification of trees, even in stages of research (Carson et al 2004). Therefore, the improvements in trees are heavily conditioned by environmental questions and the protection of the biodiversity of forests.

which necessarily implies a local adaptation process in sowing and planting, affecting the machinery to be used for such processes. In the harvesting process -much more standardized, considering the trees are homogenized, and with large economies of scale-, however, the imported technology prevails. The harvesting machines are provided by a reduced number of international suppliers that lead the global market.

56. For soil preparation, sowing and tree pruning, the local companies developed different techniques adapting existing knowhow in the forestry chain at a global level. The incremental innovations derived from that, though they have a strong impact in terms of efficiency and productivity, are not new, thus the difficulty in the possibility of protecting them through the IPRs system; finally, they become part of the knowledge asset of the company.

57. Some local companies that manufacture agricultural machinery have developed machines for sowing the forest production. For the design of the machinery, they interact with sawmills and pulp mills, their main clients, since these have the greatest extensions of planted forests. These firms, although they have trademarks to differentiate their products from their competitors in the local market, do not protect their developments with other legal instruments of IPRs -like patents-. Their developments are especially adapted to the needs of the local market, so they do not perceive much risk that someone might improperly take possession of them.

58. In the case of harvest machinery, the technology is clearly imported. There are 12 applications for invention patents presented in Uruguay that protect this type of machinery and the process to be used in the harvest stage. Most of these inventions belong to transnational companies of the forestry chain.

3.2. First industrial transformation

c) Process innovations to increase efficiency and productivity in sawmills, boards and cellulose production.

59. The technology used in the production of boards and sawmills, as well as the production of cellulose, is incorporated in the machinery -which is produced by a few companies around the world, predominantly of Italian and German origin-. Local efforts focus, as a consequence, on the introduction of incremental innovations to adapt the imported technology to local needs and inputs, and on the design of manufacturing plants.

d) Innovations to increase the supply of renewable energy

60. The forestry chain (in its primary and industrial links) generates a variety of residues that can be used for the production of energy based on biomass. In this sense, there are significant innovative efforts related to the collection of such residues, their reuse to generate energy

and the development of boiler equipment (Uruguay has more experience in this, compared to other machineries).

The production of energy based on Biomass

The energy industry raises the importance of taking advantage of biomass, at first, from the utilization of a co-product not being used, which implies a greater and better use of the forest and a greater development for the foresters.

In the case of Uruguay, the issue was addressed from the treatment-of-residues point of view for the production of electric power as a function of the country's policy towards a change of the energy matrix. In mind was the double goal of reaching self-sufficiency -by means of the utilization of native fuels- and changing towards a more environmentally sustainable matrix in such a way so as to be able to generate an impact in the decrease of greenhouse-gas emissions.

In 2006, a mathematical projection on the future availability of biomass was carried out in Uruguay, obtaining as a result the availability of an immense mass of residues or co-products in the forests, which could be used to produce an important amount of megawatts. However, more recent analysis observed that such biomass is not usable unless new technologies are introduced; searching for residual biomass is not always profitable, since a series of obstacles must be overcome (like the question relative to stockpiling fields).

In any case, there are three instances in which the wood could be used for the generation of energy.

The Agricultural Phase: the technological changes for forest use caused a decrease of the available biomass (subproduct) for the generation of energy -foresters do not speak of residues because they understand that, depending on the development and technology applied, there are more co-products than those that have been used up to the present-.

In the first place, the use of wood is constantly growing because, if it is useful for the chipper, it can have an industrial use[24].

The other great co-product of this stage is the bark -which cannot be used in the chipper-. In turn, the treetop is left, which can have a variable size according to its use and variety. In the case of eucalyptus -predominant tree in Uruguayan forests- the treetop tends to be smaller and with fewer branches.

In the agricultural phase of solid wood, since the challenge is to have trees with a larger diameter[25], rather than a greater number of trees by Ha, during growth, 2 or 3 intermediate thinning interventions are carried out, eliminating the more defective trees -with bifurcation problems, for example-. This results in the generation of an important volume of wood (trunks) at field level, due to thinning. Traditionally, with smaller residues, the "ramero" is carried out -which consists of the more-or-less organized accumulation of the material produced in the harvest, so further work is not hindered (like reforestation or handling of regrowth in the case of eucalyptus)-.

Due to the steady introduction of the mechanized harvest in Uruguay[26], the machinery being used is heavier, leaves residue -branches and waste of smaller size- in a more disseminated manner (and, at the same time, uses it as a floor to circulate on the fields) and this complicates its reutilization -it does not leave the customary "rameros" between rows, tidy, etc.-. On the other hand, what is left for solid wood, from thinning, is more abundant.

[24] The round wood is logged in several lengths: increasingly longer, in fiber, up to 7.2m long (minimum 2.4m), and the diameters limit today are around 45cm down to a minimum of 5cm.

[25] Today, there is no solid-wood industry for diameters of less than 15-16cm.

[26] Almost all the harvest has been mechanized today. Machines were imported for forest use (one that loads and processes and another that self-loads) and this combination is found all around the country. As was mentioned in the interview: "…basically, the equipment was imported and what was adapted is the mechanics, the logistics of the process… if more equipment is needed it will surely be imported…".

In any case, the forest residue does not generate serious problems of contamination -although it is a serious problem in the control of ants and other plagues-.

The Industrial Phase: in this stage the idea of residues can be more accepted since the remnant material generates environmental problems, because this accumulation of sub-products does generate gas emissions and creates logistical problems. Of any piece entering the sawmill, half of it does not go to the main process (in the case of fiber/cellulose, the bark remains in the field, instead when it goes to sawmills or panel, the bark goes to the factory).

Most of the sub-product is sawdust, which accumulates next to the manufacturing plant in mountains, in whose interior risky chemical processes of different types take place -it becomes compost, there are actions of microorganisms, it catches fire-. This big problem could be solved reconverting the waste for use in energy.

The energy forestation: planting to produce energy. In this case, the time between sowing and harvesting would not be longer than 3 or 4 years to obtain biomass, which is going to be processed in a completely different manner than the other forest productions. The only product, in this case, would be biomass. According to the interviewed experts, there is no innovation in that area in Uruguay[27].

The specialization in the energy sector is very high. A sawmill may add the energy specialization as a complement, but it is difficult that an energy producer add the industrial part.

61. In forest production, the sub-products like bark, branches, leaves, peaks and other parts which are not used in the industrial phase -although efforts are being made to take advantage of all this material or, minimize the residues, which is not the same thing (much of the genetic manipulation is heading in this direction, by obtaining trees with fewer branches, or with smaller tops)- can be used for the production of energy. The industrial phase can, also, add biomass from sawdust -residue from the sawmill activity-, chips, lignin, black liquor[28] -derived from the production of cellulose- and other derivatives.

Avoiding the misappropriation of non-wood forest products (NWFP)

NWFP are products of biological origin derived from the forest -or from trees planted outside of the forest- different from wood (FAO 1999), such as products used for food or additives for food (spices and condiments or aromatic plants), fibers (used for construction, clothes, the manufacture of utensils or furniture); resins, rubber, and other derivatives used in medicine, cosmetics or cultural purposes. The NWFP are relevant for the population in developing countries -several million homes depend on the NWFP to reach minimum nutritional values, as well as to cover certain needs in health care, as well as being a source of income (FAO 1999)[29]-. Some NWFP also act as export commodities. The emergence of new market niches for "natural products" or the development of new market mechanisms (like "clean trade") have benefited the commercialization of these types of products. Beyond their economic

[27] In Brazil, many initiatives are being developed for energy based on biomass. They are preparing a project of energy forestation of thousands of hectares and, within 4 or 5 years, they expect to have a development. They plan the installation of 3 factories for pellets that are used, for example, for industrial heating and also for domestic use, which is made from compacted fiber. In Brazil several factories will be constructed to export to Europe, which means that the harvesting technology and use of energy forestation will not have major problems.

[28] One of the main ingredients of black liquor is lignin, a material derived from the extraction of fiber from the wood to create paper.

[29] For example, in the Amazon (Peru and Brazil) more tan 1.8 million people derive a significant portion of their income from extractive resources of the jungle -nuts (Bertholletiaexcelsa) and rubber trees (Heveabrasiliensis) – (Reis, 1995).

significance, their conservation is very relevant as a source of biological diversity. Therefore, the true challenge is to be able to guarantee the long-term survival of the NWFP to be able to address, at the same time, the satisfaction of economic and social needs of the population and preserve biological diversity[30].

Considering the potential impact of the NWFP, is that there are concerns about their use and appropriation. The idea is to avoid the misappropriation (commonly known as "biopiracy") and ensure the compensation for their use. The availability of tools -patent system and arrangements for keeping trade secrets- is inadequate for the NWFP (Zhang 2004, Twaorg 2004). The case of herbal medicines is paradigmatic. The standard intellectual property agreements established by the TRIPS agreement (Trade-Related Aspects of Intellectual Property Rights) are of difficult application for these types of products given they do not meet the minimum requirements of patentability. In particular, it is difficult to find any aspect of inventiveness (medical herbs, in essence, are raw vegetal materials -leaves, flowers, seeds- that are used in fragmented form or as powder with no type of new or significantly sophisticated process or knowledge to be protected).

The TRIPS agreement does contemplate, through an amendment, a protection against "bad patents" consistent in the misappropriation of genetic resources and traditional knowledge. The convention on biological diversity of 1992 provided a wide-ranging legal framework to structure agreements of cooperation in the access and the resulting benefits of the use of genetic and biological resources. The convention requires, as a condition to be able to apply patents to biological material, that the source and origin of the biological resource, as well as the use of traditional knowledge in the invention be explicitly stated. Because of this, developing countries can have a greater control on the use and manipulation of their genetic resources (before being able to commercialize and register the product in a third country, the consent of the authorized legal authority is needed), and at the same time this enables them to receive a percentage of the benefits originating from any commercial development based on their own biodiversity and traditional knowledge (AsaneOwusu 1999).

[30] It has been documented that the production of pharmaceuticals based on medicinal plants extracted from the jungle has resulted in an over exploitation (or excess of recollection) with a possible risk of extinction (Zhang 2004).

Section 4 – The forestry Value Chain in Uruguay

4.1. Brief overview on its recent evolution[31]

62. Uruguay is in the same latitude as the main forest ventures of the southern hemisphere, in a climate area similar to the south of Australia, New Zealand, South Africa, and central areas of Argentina and Chile, with climate and soil conditions that ensure very good levels of competitiveness at international level[32] (Uruguay XXI, 2011). These special conditions make Uruguay a favorable place for the forest activity. In the world, the average growth is 27 m^3/ha/year and for Uruguay it is 25 m^3/ha/year (King and Skolmen, 2000; Meskimen and Francis, 2000; and Skolmen and Ledig, 2000). The cloned plantations of best quality in Uruguay have a productivity that varies between 25 and 32 m^3/ha/year, still very distant from the 40 to 50 reached by Brazil (forestry information from Uruguay, 2008). In any case, according to the experts interviewed for this work, although the results in Uruguay can still be improved by means of developments being implemented today, they will never reach the values of Brazil given the different climatic and edaphic conditions.

63. The previously mentioned potential of the forest activity has been the reason of public policies for several decades. In 1966 the Department of Forestry was created as an executive agency of forest policy depending of the Ministry of Livestock, Agriculture and Fisheries (initials in Spanish: MGAP). Two years later, Act 13,273 was enacted -and regulated in 1975-, which declares of national interest the defense, improvement, extension and creation of forest resources and the development of forest industries. At the same time, this act declared "forest plots" all those areas, wooded or not, which are inadequate for any other exploitation or purpose of permanent and useful character, based on their soil conditions, altitude, climate or location.

64. In parallel, a Forestry Fund was created to cover expenditures related to the application of the Forestry Act and the existing types of forests were classified (Gras and Solorzano, 2008). As in other countries of Latin America, forest policies had two great objectives: the conservation of natural forests and to broaden the forest base of the country with plantations in areas non-competitive with other production (for example, agricultural or cattle). The instruments for the promotion of the sector were not only economic, but also included technical assistance, training and research (Osimani and Paolino, 2004).

[31] This sub-section attempts to describe briefly the steps taken in the last fifty years to be able to understand the origin of the Forestry Sector in Uruguay, and think, later on, about its potential future. It does not pretend to be comprehensive and is not an evaluation of the success or failure of the implemented policies. It is simply a telegraphic narration outlining what happened in the normative area.

[32] UPM (ex Botnia, leading company in the forestry industry) has an improvement program that reached 45m^3 by ha/year (in Sao Paulo or Minas Gerais -the best standard of world production- they are at around 60, reaching 100 m^3).

65. The forest activity in Uruguay, though having received incentives from the government for many years, started to experience an upsurge thanks to the incentive system established in 1988, with the Forest Promotion Act (Act No. 15,939/87) in force, regulatory decrees and later modifications. This group of measures establishes that the natural and artificial forests in priority areas declared "protected", and the "yield" forests included in the projects for quality wood -defined by the Ministry of livestock, Agriculture and Fisheries[33]- will have the following benefits:

    - the exemption of all national taxes on rural real estate and on the rural real-estate contribution;

    - that the value of the plantations and their extensions not be computed for the determination of income, to the effects of taxes on imputed income of agricultural exploitation and the taxable amount of the estate tax;

    - that the income derived from the exploitation of forests not be computed to the effect of determining the agricultural income taxable amount.

    At the same time, as of 1988, a system of subsidies by planted hectare was established, for one time only, that is not computed as taxed income for tax effects, in order to encourage the forest activity. Though over the years the measures have adapted to the reality of the moment, the truth is that from that date onward, there have always been measures attempting to encourage the forest exploitation activity.

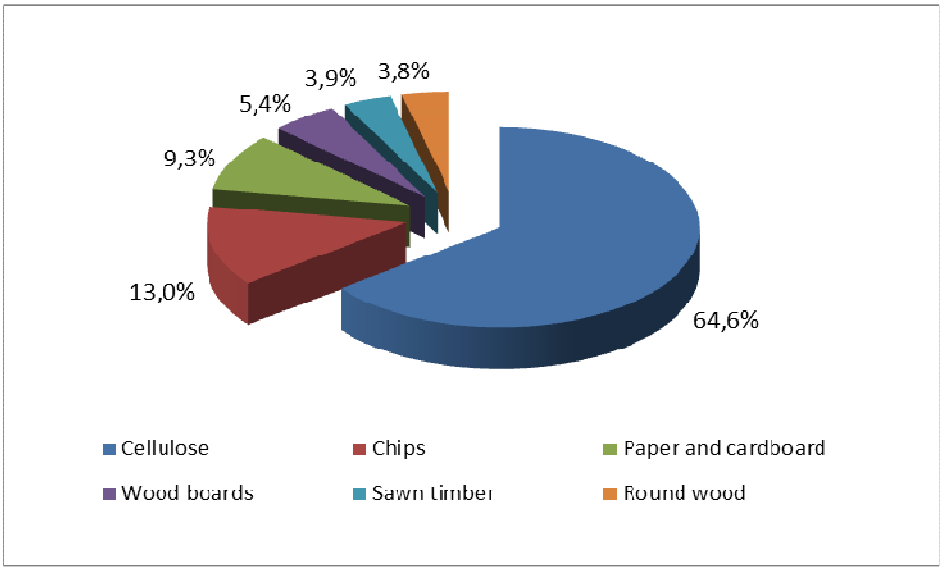
66. The initiatives of forest promotion drove the plantation of certain species -and their varieties- because it was considered that those had better perspectives for the development of the sector. These were pine, eucalyptus, loosestrife and poplar -all fast-growing species for solid wood or cellulose, adaptable to climatic conditions in Uruguay-. The private initiatives that established in Uruguay focused mainly on the first two species (no records of initiatives on the last two exist) and, in the last few years, there has been a shift towards eucalyptus, as the only species, in its different varieties.

67. After the incentives that promoted the forest activity in the last 20 years, today the sector has experience in the activity as well as qualified and professionalized labor; the activities of forestry, extraction and elaboration of wood products represented, in the year 2010, 3.5% of the Uruguayan GDP, and its exports meant 13% of the total in the country -in the year 2010, the 1,260 million dollars exported by the forest sector placed it, together with the agriculture and meat-packing industries, in the category of the three most important agro-industrial export sectors-. From the overall exports of these three sectors we must highlight that the forest sector went from representing 10% of the exported value in the year 2004, to

[33] To gain access to the mentioned tax benefits, the Forestry Department (DGF) of the MGAP will have to approve the management and organization project for the exploitation and regeneration of forests. All modification to the referred plan must to be previously approved by DGF.

31% in the year 2010 (the same amount in dollars exported by the meat-packing industry) representing, at the same time, the activity that exported most dollars by hectare, showing signs of being the most productive of the three (Forest Agenda 2011, Uruguay)-. It is estimated that 19,000 people are directly employed by the forestry chain[34]-13,000 workers in the area of silviculture, 3,500 in the industries of mechanical transformation (sawmills and boards), and 2,500 in cellulosic industries (cellulose paste, paper, cardboard and chips)-. Adding the indirect jobs, the sum is equivalent to 1.3% of the working population in the country- highlighting the fact the employed personnel in the forestry sector has almost doubled in the last five years- (Uruguay XXI, 2011).

Chart 1 – Main exported forest products. (Participation in dollars, Year 2010)



Source: Own preparation based on data from Uruguay XXI, 2011

68. As a result of the measures and activities carried out in the forest sector, today Uruguay has approximately a million hectares[35] of artificial forests that add to the 750,000 hectares of native forest. Of the artificial forests, approximately 70% is eucalyptus and 30% pine. Experts estimate there are three million more hectares which could be incorporated -only 1.5% of the area declared "forest priority" is planted-, but it is unlikely they will become a part of the

[34] Industrial chains with base on the Forestry Sector, Office of Planning and Budget, Ministry of Industry and Energy, Directorate of Industry, February 2011.
[35] Given the technical conversion rate between the hectares for use in forest production, in terms of space, and the surface actually planted, of the 1,000,000 forest hectares affected in Uruguay, 800,000 would be real or net. According to official data, there are currently 885 thousand hectares of planted forest representing 5% of the national territory (Uruguay XXI, 2011).

forest production in the medium term -therefore, there is no visible limitation in terms of the land factor to the growth of the sector with the current market conditions[36]-.

69. In Uruguay, both the public and private sectors are committed to making innovative efforts to identify, reproduce and propagate superior trees. In the public sector the role of the National institute of Agricultural Research (INIA) is worth noting -the main institution related to the improvement of trees-, with its "National Forestry Program" initiated in 1992, which has achieved successful genetic improvements in eucalyptus and pines. For eucalyptus, five varieties of trees were developed in three species: Eucalyptus grandis (2), Eucalyptus globulus (2) and Eucalyptus maidenii (1). Additionally, ten lines of clones of eucalyptus grandis were generated. The genetic material developed by INIA is mainly used by small forest producers -who have no capacity to carry out their own development-. In the private sector, five of the biggest and most integrated companies have their own reproduction program and develop their own varieties, according to their planned final use.

The forestry chain and the public support programs to the production in Uruguay

In Uruguay, beyond government measures and actions to promote and favor the development of the forestry sector, there are other government instances that accompany the growth and conformation of the chain in the country. In this sense we can mention INIA (National Institute of Agricultural Research) and LATU (Technological Laboratory of Uruguay), following their own lines of research, as well as advising and collaborating with companies in the sector in those areas of their concern. The University of the Republic also has important research groups on the matter.

The National Forest Program of the INIA started its activities in 1992 in Tacuarembó. Since 2000, it supplies the national seed market with different varieties of eucalyptus (especially grandis and globulus) and ten lines of clones of E. grandis. The property rights of the five varieties of seeds that the INIA[37] has currently registered and sells were obtained in the year 2000, since in the forestry area, neither INIA nor the private sector had any experience in this respect. Today, they have 50,000 hectares dedicated to the production of seeds, a more than relevant number considering the program is relatively small.

INIA works with hybrids and publicly disseminates their improved materials -and this is where a greater need for protection is required-. In genomics, no company or other institution reaches the same technical levels -they are the only ones in Uruguay in forestry to have PCRs and sequencers-. Additionally, we should mention that INIA decided not to protect and started to release, as of 2003, their clone lines (by micro and macro-propagation) -stored in the germoplasm bank and not yet registered[38]-.

The Strategic Plan for the period 2007-2011 prioritized as thematic areas the genetic improvement of Eucalyptus and Pines, silvicultural management, diversification of species, sanitary protection and environmental impact. The research was conducted in a national network of tests, in forest company and producer sites in different areas of the country and through several channels of articulation with institutions of the area. We should also point out the recent launch of the INIA-LATU Unit in Fray Bentos

[36] At the same time, the emergence of a new problem came up in another interview, in relation to the increment of the price of land. Forest investment, which had shown a new impulse in 2006/2007 -especially with foreign investment funds-, came to a halt due to the high cost of land.

[37] INIA, due to internal policies, does not commercialize material that has not been previously registered. Given the difficulties to register "trees"- as will be explained later – INIA took a long time to be able to commercialize its material.

[38] This is so since the registration of clonal material presents two problems: it is easily multipliable and the registration must go through a long process of clonal tests that takes a minimum of three years.

for the study of the environmental impact of forestry, and the active participation in the events of the National Agency for Research and Innovation (ANII) to incorporate the contributions relative to the implementation of the SNI.

Precisely, LATU's forestry area[39] promotes and technologically supports the development of the productive chain of wood, supporting the industrialization of products of high value added through the: i) characterization of the wood of national plantations, to promote knowledge of the available raw material and its relation to their final uses (fundamentally for national planning and to promote the rational use of wood); ii) development, adaptation and technology transfer for processes of transformation of wood; and iii) consultancy on optimization, development and technology transfer of processing of forest products and services of high-level analysis and tests thanks to the good level of equipment they have[40] (they provide R+D services, consultancy and analysis of product tests, offering assistance to companies in process as well as product). They work on the engineering of wood, like lamination and preservation, as well as carpentry. Their function is to contribute to the improvement of production, especially of small and medium-sized firms, generating quality products. Nonetheless, also big companies present an important interaction with LATU.

In cellulose and paper they have two laboratories, one in Fray Bentos and the other in Montevideo, which is bigger, with a pilot plant where all industrial processes can be carried out, from chipping to paper and its characterization.

In the energy sub-chain, although LATU has certain demand, resources were not applied to a great extent to this area. They have a line of work in energy of forest biomass, they characterize and determine the quality, and they share some projects with institutes like INIA with the objective of achieving plantations with higher wood density with low rotation, that specifically produce material to generate energy (in this case genetic materials are also being sought that would allow an improvement of the caloric power of wood).

4.2. The forestry chain in Uruguay: Links and actors

70. After a few decades of forest development in Uruguay, the value chain of such activity, downstream, presents three productive sub-chains: cellulosic, elaborated wood (treated round wood, sawn wood, boards, carpentry work, furniture, moldings, etc.) and energy[41]. The three present different logics and, although certain complementarities between the two first and the production of energy from residues they generate may exist, the three compete for raw material (trees to be planted, although they can be used as input for the three productions, they determine a better performance according to their final use -based on each variety's morphological and biochemical particularities-, not making them necessarily perfect substitutes).

71. It is important to mention a few issues that came up in some interviews, about the fact that there are still areas of conflict in relation to the forestry activity: a) with the traditional

[39] Since the beginning of the '90s they have already made an important investment in equipment for cellulose and paper, and another one in the period 1998-2003, in equipment and laboratories for wood that are used by all companies of the industry, large and small.

[40] It has a laboratory, a sawmill, equipment to determine fundamental and mechanical properties of wood at a real scale, a real-scale dryer, etc., almost everything thanks to investments with Japanese funds.

[41] A fourth one could be mentioned, associated to the chemical industry (resins, essential oils, bioplastics, etc.), which in the world presents important advances, but in Uruguay, only signs of incipient productive ventures are observed.

landowner sector[42], b) with environmentalist sectors[43], and c) a conflict related to territorial planning[44]. Lastly, in an interview someone mentioned that the main problem with the forestry industry was the health of the trees. However, this issue did not arise with the rest of the interviewees, or it was barely mentioned[45].

72. For the year 1990, 60% of the forest production was used in the ***energy sector*** -the whole Uruguayan industry was supplied with wood for the generation of energy-. Although the relative values have changed (the wood sector for cellulose has experienced a strong growth since then), the absolute values of wood for the production of energy have maintained or slightly increased -since industry keeps being supplied with wood for this purpose-. Currently, there are companies of the sector that have electric power plants from biomass[46]; the energy industry makes the use of biomass relevant, since the utilization of a sub-product not being used until now implies a greater use of forests and a greater development for foresters. Uruguay, in 2006, made a mathematical analysis on the availability of biomass in the future that turned out to be more than significant. Under this modality, worth noting are the large companies in the sector -that set up plants for their own consumption, dumping the surplus into the national network[47]- with values that are relevant within the energy matrix of the country[48]. In parallel, there are some projects of plants to process biomass and provide energy to the electricity network, exclusively.

73. In spite of the role of forest production in the energy matrix, the core of the forest industry in Uruguay has always been the ***paper industry*** -given this industry is characterized as energy-intensive, in parallel to the production of paper, they also control the energy market of wood-. Traditionally, there were two paper companies in Uruguay, which functioned on

[42] Mainly because they compete for the land factor and this leads to an increase of the value and, hence, the cost of opportunity, making certain activities unviable.
[43] This is related, mainly, to the existing strong sensitivity to everything relative to forestry in general -in particular with energy-, since there is still no certainty about the response a site could have to planting 10,000 trees per hectare, in terms of extraction, soil management, etc., with cutting cycles of 3-4 years -for plantations used to feed boilers with the pure destination of energy generation-. Energy forestation as such, extended, is being tested all around the world.
[44] Uruguay passed a law of territorial organization, that it did not have, in the previous five years, that is being implemented and generating organizational guidelines. The law empowers the departmental governments and departmental guidelines are being created. As this is still under process, many departments have lifted precautionary measures, and have done it with forestation in certain soils.
[45] However, we believe that more attention should be paid from the State, since, in case of the propagation of an epidemic, it would not be resolved in the most convenient way if left in private hands. The characteristics of public good of this type of problem show that it is the State who should be in charge of finding a solution, in order to obtain the most efficient and convenient response for the whole of society.
[46] In the year 2011, 18% of the Uruguayan energy matrix corresponded to biomass residues and 12% to firewood (MIEM, DNE, Energy Balance 2011).
[47] The National Administration of Power Plants and Electric Transmissions (UTE) is a public company that generates, transmits and distributes electric energy in all of Uruguay.
[48] The installed plants to generate paper pulp demand a large amount of energy. UPM, generates 110 MW, with a surplus of 32 MW; the Montes de Plata plant, that will begin operation in 2013, will also generate its own energy, with a capacity of around 160 MW of clean and renewable energy, of which around 90 MW will be used to supply (self-sufficiently) industry needs, dumping the rest, -between 55 and 75 MW- into the national network, which is equivalent to the average consumption of some 200,000 homes. For its part, the wood industry also generates energy based on wood; Bioener -a property of Urufor- has a capacity of generating 12 MW and Weyerhaeuser, and installed capacity of 10 to 12 MW (Uruguay XXI, 2011).

the logic of supply of wood on the part of third parties[49], producing in their interior the rest of the process (pulp, paper and, as a derivative, energy). The arrival of large international companies to the sector changed the logic of the business, installing plants for the production of cellulose paste, exclusively[50], and integrating the productive links from the plantation to cellulose at the interior of the company. The predominant idea in these initiatives is to produce their own raw material, outsourcing/contracting the indispensable, and with a trend to full self-provisioning. This strategy (integration upstream) diverges from the previous ones (integration downstream), for many reasons. The first one, mainly, is not that they are not also integrated downstream -these transnational companies are not only part of the main producers of cellulose in the world, but also of paper-, but the production of paper -for reasons of cost and response to the taste of the consumer- usually settles close to the final market –outside Uruguay-. The integration upstream, instead, given the scale of the plants, is due to the double necessity of guaranteeing a continuous supply of the key input -wooden chips- as well as good and uniform quality.

74. To guarantee a good and uniform quality of raw material, the big firms that produce ***cellulose*** mounted their own nurseries and forest plantations -*at the same time, this helps to resolve problems of intellectual property by vertical integration-.* A proof of the impact of these new endeavors is that, from the year 2008, the main product exported by the forestry chain in Uruguay is "Cellulose paste", representing for the year 2010 64.5% of the total exported -and only one of the projected plants is currently operating-. The second exported product was "chips", with 13% of the total, followed by "Paper and Cardboard" with 9.3% in the year 2010 (all elements of the paper chain) (Uruguay XXI, 2011).

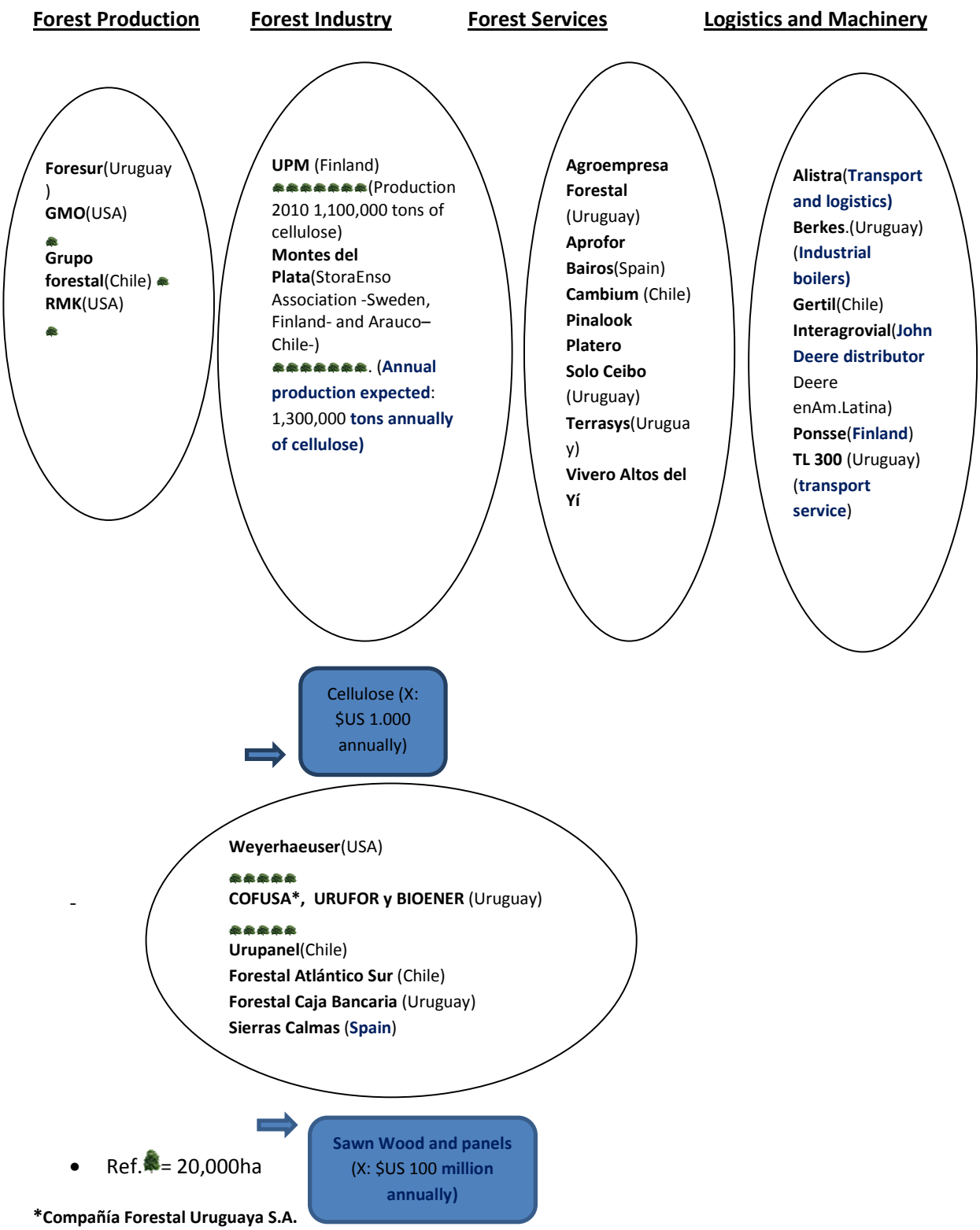
75. ***The cellulose sector,*** while not being the only one, has clearly turned into the main industrial activity within the chain in the last years (more specifically from the moment the Botnia plant began its operations -currently UPM-, in 2007). In the year 2010, it presented a ratio of 6 to 1 in relation to the harvested wood for cellulose production in relation to any other use (Forestry Agenda 2011, Uruguay). Precisely for this reason, the largest proportion of harvested species belongs to the eucalyptus (input for this industry), being the harvest of pines relatively much smaller.

76. ***Sawn Wood and boards****:* The sector of mechanical transformation of wood is the second in production levels and is basically located in the north of Uruguay. Its main products are sawn wood, plywood panels and MDF (*Medium Density Fiberboard)* -currently exporting $US 100

[49] Though these companies had their own plantations, they kept them in reserve to control the level of prices of the raw material. If the market price rose in excess, they supplied themselves from their own plantation pushing the prices down.
[50] Only one plant is in operation today. It is estimated that at the beginning of 2013 the second plant that belongs to a company of international capital will begin operation -the construction of the production plant is being completed- and the investment plan has been announced for the location of a third plant. Between the two plants in operation they represent the consumption of more than half the planted area for forest production. At the same time, and contrary to the paper mills already in Uruguay, these companies are almost totally integrated, and their policy is to use artificial forests to guarantee self-supply. It is important to point out that due to verticalization, the issue of intellectual property is resolved by integration.

million annually-. It is important to point out that the sawmills and lamination plants are technically different processes. Uruguay has companies in both activities.

Main actors of the forestry chain in Uruguay



- Ref. = 20,000ha

***Compañía Forestal Uruguaya S.A.**

Source: Own preparation based on data from Uruguay XXI, 2011 and Forest Agenda 2011 Uruguay, of Rosario Pou and Associates.

77. In relation to the input for the wood industry, the result of the promotion actions on the part of the Uruguayan government from the late '80s, it is estimated that between 2014 and 2020 most of the plantations for the production of wood for sawmills, plywood and engineering wood will reach maturity. As a consequence, important quantities of quality wood are expected -in volumes that will oscillate between 4 million m^3/year for the period 2011-2016 and over 10 million of m^3/year for the period 2017-2021[51]-. This is an opportunity to make new industrial investments and for new companies associated to this activity to emerge, as well as for exporting wood with greater value added and various sub-products (Forest Agenda 2011, Uruguay).

78. Today, there are not sufficient sawmills or laminating plants in Uruguay to process all this wood, which is why there is concern on how and who is going to take advantage of the maturation of the solid wood planted 20 years ago. A major complication arises in the interviews carried out -since it does not depend solely on Uruguay-; the international crisis -in particular on the real-estate sector- has strongly affected the markets for these wood products, leading to an oversupply in the sector at present.

79. Additionally, Uruguay has no furniture factories to advance towards another stage of elaboration of wood products -there is, basically, an artisanal production, that is far from reaching an industrial scale-. This is due, mainly, to the strong imports of furniture from Brazil, which represents a discouragement for the installation of factories in Uruguay -market that, in turn, has not sufficient scale to compete with the products of the neighbor country-. However, apparently, there are spaces for productive complementation, which are being discussed at Mercosur level. Consequently, though in this sector there could be space for protection actions of IPRs -particularly in brands and design-, for the Uruguayan case there is a previous limitation associated to the scale of the market.

80. The rest of the forestry production -of **forest products different from wood** (NWFP)-, according to some studies, is gaining importance in Uruguay (Rosario Pou & Associates 2012, Sans et al 2007). Fungi, essential oils, resins, honey, bee wax and pine cones, are some examples of these products -in which economic relevance varies depending on the product in question-. Fungi generate income of subsistence to the farmers that live on the Uruguayan coast (Sans et al 2007). Honey production is for export[52] and has some economic relevance -Uruguay occupied the 20th place as world exporter of natural honey in 2010-, since it generates some 16,000 jobs (4,000 direct ones and 12,000 indirect ones) and involves from

[51] The solid-wood process implies, on one hand, planting fewer trees. On the other, contrary to pulp mills, the plantations for solid wood perform a thinning at 10 years, where the best trees remain standing, and are not harvested until they reach 16 years. Most of the forests with this purpose, for the year 2016 will have already been thinned. According to the interviews, for the installed capacity, and taking into account the perspectives of the world market, they will find themselves with an overstock of raw material. The interviews also revealed that in relation to pine, an opportunity of patenting is possible (extracting resins, chemical products, etc.), but the wood companies -owners of the plantations- would seem not interested in that.

[52] Only 10% is used in the internal market (950 tons), which is used as natural honey or input for industrial production (of crackers, candies, drinks and medicine) (Uruguay XI, 2010).

small producers to large export companies (Uruguay XXI, 2010). The production of resins and essential oils is gaining importance. Today, there are two companies that produce pine-based resin, which is used for the production of ink for the graphic industry. The essential oils derive from eucalyptus leaves and are used for medicinal purpose and the production of aromatic fragrances (Rosario Pou & Associates 2012).

81. Finally, related, as well as complementary to the central axis of the chain, to complete the scheme of existing production, we should mention the suppliers of equipment and machinery -except in some particular cases (sowing machinery and boilers), the machinery, equipment and capital goods are imported, mainly due to a problem of scale- and the local companies offering forest services -including in this sector from logistic services, to nurseries, to pruning, weed control and plagues, thinning, administration and harvest-.

4.3. The forestry chain in Uruguay: functional dynamics and productive and technological strategies

82. For several decades Uruguay has been favoring the development of the forest sector; which; though it doesn't seem to have reached its ceiling, already has a significant impact on Uruguay's economy (with growing participation in exports and gross domestic product). At the same time, it occupies an "uncomfortable" place in the global forestry value chain: it exports cellulose -hand in hand with paper companies that use the local territory as a supplier of raw material-, round wood and wood -with little elaboration- while having weak local development of transformation downstream –whith the imminent challenge of the entry of trees with a certain amount of timber capacity-. The future steps depend, to a great extent, on the strategies adopted by the established companies, as well as the measures implemented by the government.

83. The company is the agent that predominantly develops and carries out all innovation, which relates directly with its productive strategies. In general, innovation is one more business tool. Thus, in its strategies of acquisition and generation of knowledge -which result in innovation- generally, the protection mode plays a determinant role. Hence, for the purpose of understanding the impact and space for the application of IPRs in the Uruguayan forestry sector, we first have to unravel what type of strategies are being pursued by the companies in the sector in each link of the chain. This, in turn, demands the characterization of the different links of the value chain, by type and number of companies that constitute it, and the possible strategies that they can adopt based on the role that knowledge plays in each stage.

84. While many works mention that the forest chain starts in the forest (Rosario Pou & Associates, 2011; FAO, 2012; UNECE FAO, 2011), human intervention gives origin to the chain -given the advance of reforestation and planting of artificial forests- in the genetic improvement of the produced tree. The identification of desirable features is carried out by

observation of the best species, which, later, are reproduced by cloning techniques (that can be accelerated by micro-propagation) at the interior of specialized nurseries; these, thanks to the recent advances in applied biology, look increasingly more like a laboratory. For this reason, the larger companies have paid attention to the development of their own varieties, so as to have control over the chain from the source, guaranteeing a continuous efficient and homogeneous supply, as well as high quality.

85. Cloning falls into the category commonly known as precision agriculture. Together with processes of hybridization and selection, forest companies are improving the varieties and specimens to be obtained, depending on the use to be given to the input. In the case of paper mills, with cloning the purpose is to reproduce those selected tree varieties -or generated by hybridization- that have among other advantages, better pulp abilities and growth; the eucalyptus of greatest pulpability in the world is the Globulus, which is the most planted species in Uruguay[53]. In those that produce boards and solid wood, instead, those specimens with attributes of straightness and fast growth are cloned, preferably with few branches and resistant to disease, cold and droughts; the paper companies aspire to grow in volume of wood by hectare, whereas the lumber companies pretend to grow in volume by tree. And, as with the previous companies, the objective in the case of generation of energy differs, since the greatest attribute sought is related to the content of lignin and its caloric/energy potential. In other words, though they could share some interests (like which species are the ones that adapt better to climate and soils of Uruguay) the companies belonging to different groups do not aspire to the same type of tree, and the research that companies that produce cellulosic paste carry out does not coincide with what the companies producing solid wood look for, nor those that could arise to generate biomass for energy[54].

86. The conclusions from the interviews carried out for this study reveal that there is no clone market. Each company develops and produces their clones for their own use -the transnational companies in Uruguay (lumber and pulp) have their own programs of improvement, because they are large firms-. In the cases in which those firms do not plant in their own forest ventures, they provide the genetic material to their producers -clones or seeds- with 20-year contracts ("promotion agreements"). These agreements are typical in places where work is done on planted forests -like the case of Uruguay-, which enables local development in the matter[55]. These issues do not happen in those places where natural forests are exploited -for example Finland, where the native forest is very important-.

87. The interviews carried out also reveal that dissemination or exchange is not seen as a problem or threat. There a few nurseries with cloning capacity -though the technology is

[53] The main problems related to this species are related to pests and less rooting.
[54] It would not be the same type of tree -it would have different attributes- if we explored the industry of chemical and pharmaceutical derivates.
[55] This type of development, while it is carried out in Uruguay with local qualified labor, is usually in the hands of transnational companies.

simple, it requires infrastructure and know-how distant from a common producer-, and a large company would not do it because in Uruguay everyone knows everyone else -that is, the small size of the market imposes a prestige factor of high cost[56]-.

88. Though there are studies and advances in the cloning and genetics of the tree, mainly due to issues related to certification and natural preservation, transgenic advances within the forestry sector are scarce -the main global quality certifiers are turning away from transgenic manipulation, because the forest industry vindicates its environmental commitment-.

89. However, from the interviews conducted the fact arises that companies have become more reluctant to establish agreements for the exchange of materials for research. The persons interviewed indicated that registration is becoming more popular, in Brazil, new clones are registered or patented on the grounds it could be due to the threat of transgenics. If the industry -for reasons of competitive convenience- were to turn to transgenic experimentation, those who have not registered their variety run the risk that another company could use it freely to introduce a gene (for example resistance to glyphosate) and patent the transgenic with the variety incorporated to the patent. This can be avoided if the materials are previously registered under the plant breeders' legislation[57].

90. Within the group of **nurseries** existing in Uruguay, five that can develop clones are mentioned -since they possess the more advanced technical capacities-, which are, at the same time, the largest in size. Three of them belong to the largest transnational companies of the sector located in Uruguay, which shows the strategy of vertical integration they have, protecting this way their strategic assets, since they do not sell to third parties -except in case of contracts, that are granted in the form of lease or by association with the producer, where the genetics is supplied (in seeds or clones) and they are ensured the purchase of the wood, with a confidentiality agreement (the material provided cannot be multiplied)-.

91. The legal framework for the protection of plant varieties in Uruguay dates back to 1981 (Act 15,173). In September of 1994, the country adhered to UPOV 1978 (Act 16,580); and in 1997 the National Institute of Seeds (INASE) was created, and is now in charge of the registry of all new varieties.The Seed Law No. 16811 dating to February 21, 1997 was later modified, in fundamental aspects, by law 18467 of February 27, 2009.

92. Beyond their programs of reproductive development, the companies in Uruguay do not use the PVP system of protection for genetic improvement -with the exception of INIA and UPM (only firm that registered some material)-. Several reasons could explain this conduct. First, not all companies have material plausible to be protected, being that the reproduction

[56] Ms. Monteiro (engineer), who is the head of the Maresia forest clonal nursery, explained in an interview in the "El País" newspaper (2011), that limitations of the personnel thwarted a response to all the sector's demands.

[57] In this sense, UPM has started since 2005 to register its varieties at the INASE of Uruguay -it is the only company that does it-, not without problems for the lack of experience in these activities -the main complication seems to be due to the lack of good botanical descriptors for the clones of eucalyptus grandis- varieties that they were registering and UPOV does not admit the characterization by fingerprinting.

programs are still in their first stages -we could say that UPM is the major exception, which is why, probably, it is the only one to register any variety to date-. On the other hand, Uruguay still has little experience in the development and protection of genetically improved trees -being a relatively new activity, given its maturing time-. At the same time, there is no market for improved trees (contrary to seeds in the case of agriculture), so the developments made by the companies are for their own consumption -on the other hand, the absence of a market and commercial transactions makes it pointless to look for external legal protection-. Finally, the PVP system does not seem to be the most adequate for the forestry activity -at least the way it is designed today-.

93. In addition to the nurseries -as indicated before, a key stage in the generation of knowledge, since the varieties and species to be planted are defined there, what will have and impact on the subsequent productivity of the chain-, the two pulp mills present today in Uruguay control (by property or contract)[58] half of the hectares of planted forests -around 400,000ha-, whereas the two main producers of semi-elaborates -in pine and eucalyptus, respectively- manage some 100,000 ha, (Forest Agenda, 2011). At the same time, there is a group of investment funds (four of foreign capital and some others of local funds) that each manage an area that varies between 10,000 and 30,000ha, which would account for another 150,000ha[59]. Therefore, we can safely say that 75% of the ***forested area*** is under the control of a little more than 10 companies or investment funds, which are those that impose the logic of the system to the whole chain (including the technology to be used, the possibility of future expansion and other key questions).

94. Other components of the value chain are the ***investment funds***, which approach the business as a speculative real-estate investment, and their strategy or decision-making is not oriented toward the forestry activity. Taking into account the expected profit for the investment made, the business is already profitable -to materialize once the land is sold- more than interesting considering the amounts initially invested[60]. To this first real-estate "bet" -and with the purpose of maximizing financial performance (with the least possible effort)-, taking advantage of the government's fiscal incentives, they added the planting of trees -mainly pine-. Thus, once commercialization begins, the profit of the initial investment will increase (deducting plantation and maintenance costs, which are very small compared to the potential return on investment). In short, by not making the forestry activity the core of their business and looking for the greatest possible liquidity for the investment made, the less capital invested, the easier it will be for them to get out, so little is expected of them to invest in innovation and hence, face problems of intellectual property[61]. In any case, they are

[58] UPM owns 140,000 net hectares; and manages another 50,000 by contract.

[59] Of this group, we would have to deduct, for the total sum, certain amount of production that they sell to the 4 previously mentioned companies, which could be duplicating values over the total.

[60] According to the interviews, these investment funds bought land currently valued at $US 3,000 at values between $US 300 and $US 400 the hectare.

[61] Today, around 8 million m^3 of wood per year are being harvested. Experts predict much higher values starting 2015, with a peak of pinewood in 2020. At that time new investments should be evaluated that go beyond the simple commercialization of wood, which could be a challenge for many of the investment funds. In any case, a lot will depend

actors that, if they remain in the business through reforestation, they will plant whatever the main local demands indicate (large pulp mills and/or sawmills) -in matters of innovation and intellectual property, they are mere passive observers-.

95. Several local companies provide ***forestry services.*** In general, the services provided include plantation, weed control, pruning, plague control, fire prevention, inventories, thinning, harvest and stockpiling in the forest. In general, the service companies, though they could present more specialization exclusively in one of the activities, prefer to provide a complete mix of services to their clients. In short, their asset, above everything else, is to offer an efficient coordination and management of the offered package. The companies providing services to the transnational companies -the more dynamic ones- continuously improve their processes in association with the latter.

96. Most of the ***equipment and machinery*** used to provide service is imported. In terms of harvesting -where the most sophisticated machinery is used-, the companies providing service use imported machinery in its entirety[62]. This is especially true in the case of large and complex machinery, due to scale problems. The input threshold of these markets is very high and the potential demand of the Uruguayan internal market is not sufficient to enter[63].

97. In the case of silviculture stages, especially for the preparation of soils and plantation, thanks to the fact the innovation of machineries in these activities requires certain adaptation to the type of soil and tree -which demands a geographic specificity and enables a market niche for local producers- there are companies in Uruguay that develop and manufacture equipment. This is equipment for the sowing stage, of similar characteristics to the agricultural activity -at least in origin-, which has led agricultural machinery companies of Uruguay to also serve this sector. The only company in Uruguay dedicated exclusively to forest machinery[64], though it never registered the development of its products -while its brand is registered-, has started to worry, for not having protected its developments, since it started to export in the last few years to Argentina, Paraguay, Colombia, Ghana and Mozambique: their external sales represent 15% of its billing.

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on the actions taken by the government. Today, these investment funds, that mainly planted pine, either export it as round wood, or dump it into the internal market of sawmills. The decision depends on the benefit obtained according to the operation.

[62] According to Agenda Forestal 2011, the harvest for cellulose differs from that of wood for sawmilling and veneer peeling. That is, there are "…two types of mechanized methods: i) in the harvest of wood for cellulose two harvesters with barking head, forwarders and equipment for loading trucks are used; whereas ii) in the harvest of wood of great dimensions for sawmilling or veneer peeling feller-bunchers, harvesters, forwarders and truck loading equipment… are used". These are all large-size imported machines.

[63] As one of the interviewed persons said: "in the harvest stage, the large multinational companies, leaders in the world of machinery for the forest sector are already set up".

[64] There is only one Uruguayan company -Hartwich- exclusively dedicated to the production of forest machinery for the sowing stage. According to an interview with one of the owners, their main buyer in Uruguay is UPM, with whom they work jointly for the development of machinery -their developments meet the needs of UPM, and UPM ensures them the purchase of a number of machines-. In this relationship there is no formal agreement with the company, simply mutual trust.

98. The relevant market in Uruguay is fiber -input primarily for cellulose-, at an internal level as well as for export. As was mentioned previously, ***the production of cellulose*** is concentrated in two plants belonging to companies of transnational capitals[65] -one is in operation and the other is scheduled to begin operations this year-. Each installed plant meant an investment project of massive scale for Uruguay, with a great impact for the economy of the country. In matters of innovation, while different adaptive developments were generated, the most relevant assets in terms of knowledge -the critical ones- come from abroad.

99. The ***solid wood*** package -everything that is not fiber-, that at the beginning showed certain perspectives of an important industrial expansion -with the installation of more factories of boards and sawmills of great size[66]- today is more limited, basically due to the fall in real-estate investments in Europe and the US (main target markets for these products). As a result, there are few companies operating. Although here there are more companies than in the paper sector, production is also strongly concentrated -only the two largest firms can be mentioned with capacity to compete internationally[67]-. As was stated, Uruguay, due to its characteristics, cannot be competitive in the market of solid woods at international level in products by volume, so it must produce in high standard, to consequently be able to compete in quality; this is only possible if quality wood is obtained, hence the relevance of the programs of improvement of the species at the source.

100. As in the case of cellulose companies, the factories installed by the firms of this activity (sawmills, as well as for multi-laminated wood) were turnkey plants brought from abroad[68]. In all cases, the interviews indicated that there was a process of adaptation made locally, which is desirable for the country, since it implies the development of local capacities, but it does not fall within the scope of activities to be protected by the IPRs[69]. Another flaw cited is that, in relation to the production of solid wood, the chain still has to be integrated to the interior of the country. For example, there is no competitive national production of MDF (medium-density fiberboard), which is the trend in boards and laminated wood -formerly called agglomerated board-.

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[65] There is an idea to install a third plant, but this is still in the planning stage.

[66] For example, the Weyerhaeuser company mentioned during the interview that, at the beginning, "...they had thought in a pool of industries of 4 to 5 industrial parks, when the price of land was lower, and the prospects were different. Today, the focus is on laminated wood, probably to increase the capacity and there is no prospect of a second plant. Probably a sawmill makes sense and more fiber processes, MDF boards and those types of products…".

[67] One of them is http://www.weyerhaeuser.com/, one of the most important timber companies in the world, of American capital, with a branch in Uruguay -that integrates all the stages except transport-, harvesting a million m3 in the year 2011 -they produce plywood boards-. The other company belongs to an economic group of Uruguayan origin. This group owns COFUSA -a forestry company, supplier of wood; mainly planting eucalyptus grandis- and URUFOR -sawmill that produces wood for export (according to statements from experts of the sector "probably the best eucalyptus sawmill at world level, with sales amounting to a thousand dollars the cubic meter")-. At the same time, they are the only investment group of Uruguayan origin with shareholding in UPM.

[68] Sawmilling is the first transformation that turns wood into a base, which is the largest square obtainable (In Uruguay it is not common) or, directly, once the process is carried out, it is converted into a board. In the sawmilling industry, the aim is to maximize the quantity of the product in the direction that industry is headed. This technology is also imported, although it varies, there is a marked preference for the machinery of Italian origin, where they have a very strong technological development in sawmilling, as well as in drying.

[69] During the interview with COFUSA they mentioned that they do not have any registration of the process, but they do with brands.

101. When patent applications in Uruguay are analyzed, the great majority of those related to the production of pulp and wood are from foreign origin. Only one patent for the production of wood was presented by a Uruguayan applicant (over a total of 25 patents). 88% of the patents belong to companies based in the United States, or in Finland.

102. In relation to the patents requested for the production of cellulose, 100% correspond to foreign applicants from Finland (17), USA (5), Brazil (5), Netherlands (2), Spain (1), United Kingdom (1), Austria (1) and Canada (1). The local efforts were focused on the use and adaptation of such imported technology.

The Weyerhaeuser improvement and research program in Uruguay

The research and development team of the company begins to operate as such in the year 2007, when Weyerhaeuser sets up in the country with that name. This unit works in direct contact with the company's research teams in the United States, and at the same time, maintaining a cooperative relationship with INIA in Uruguay and with universities in the United States. They have three programs in forestry research: one that improves genetics, another for productivity and sustainability -with a two-pronged approach-, and the third of biomass that attempts to explore new alternatives.

In the first one they do not have much exchange with UPM or Montes de Plata -or any other company-, because they have very different objectives. At the same time, in the issue of protection of research in genetic improvement, while they do not perceive the development of a market for the sale of genetic material, they do believe they "*have to be cautious*". The company does not have much material to protect yet -they have been developing varieties locally for only a few years-, and even if they had something to protect, Uruguay would not be the place to do so, but the world. They currently have germoplasm material that they haven't registered yet -maybe in 4 or 5 years they will, since they consider it a strategic asset-.

In the subject of productivity, they perform process research, which could be considered a company secret, but they have nothing registered in Uruguay, though they do in the United States (forestry techniques, like pruning, intervention, etc.). In contrast, the company's interest is to conduct all sustainability research with the participation of prestigious researchers -not necessarily from the same company-, working jointly with other firms and that the information be made public. Within this area also plagues and disease are being researched. Considering it is an area with clearly defined characteristics of public good, they do not see the need to protect it -but rather the contrary, to disseminate it and help to generate more research, so as to potentiate the system and not be exclusively dependent on their own developments-.

Finally, in bioenergy and biomass -where registration is indeed a more sensitive matter-, in Uruguay, still no registrations have been made.

103. The third industrial branch derived from wood is the *generation of energy based on biomass.* There are three strategies/production instances here. The one deriving from the utilization of the sub-products on the part of already-existing forest industrial plants for the generation of energy (black liquor in the case of paper mills, wood residues, in the case of solid wood) in boilers installed beside them. In this case, these provide energy to the plant

and their surpluses are dumped into the network[70]. A second one is the installation of energy generation plants from forest products to feed industries that are not related to forestry activities[71]. The third one -with certain similarities to the previous- has to do with the installation of plants for the exclusive generation of energy from biomass for the general electricity network. In these last two cases, the critical point is the continuous provision of raw material to feed the boilers, which results in a question of logistics and supply that, could turn inefficient (that is, transportation and supply costs could surpass the savings by the generation of energy at their own plant)[72]. In the last case we have to add -what should be taken into consideration in the previous one- the agro-ecological sustainability of the initiative[73].

104. The interviews show that the priority from the feasibility studies conducted from the State was to determine the real availability of residual biomass to be used per year. It is from these studies that they do not believe in the viability of the use of the mountains of sawdust being generated, and that no great innovations are expected in terms of machinery in this area from the interior of the country -"whatever is necessary will end up being imported"-[74].

105. In 2005 the promotion of the use of renewable energies began, with the target of reaching 200 megawatts of alternate sources (more than two calls for project proposals were made for that purpose). For this, the government defined the decrees that entrusted the state-owned company[75] (UTE) to make solicitation of tenders, competitive in prices -public tenders to private generators[76]-.

106. There are 8 plants today generating electric power with biomass. The paper mill in operation; the two biggest sawmills[77], plus a small sawmill[78], the only pure generator -that is not associated to any industrial enterprise, produces only electric energy, no vapor[79]- a

[70] In this area, some important industries have joined the issue of energy. Large sawmills (Urufor, Weyerhaeuser, Valerio, Ponla), that already had installed capacity, and knew the business, because they could sell to the network and also, UPM and Montes de Plata -when it becomes operational- that uses basically black liquor and are exploring the use of other types of residual biomass.

[71] In the framework of the government's energy policy aimed at modifying the energy matrix, two companies moved forward to be buyers of raw material, Fenirol, inTacuarembó, and the complex in Azucarlito, in Paysandú (uses energy part of the year to refine the sugar it buys as raw material and sells the rest).

[72] In fact, those companies that attempted to be supplied with wood, since they did not have their own raw material, had great difficulties to obtain it (contracts, seasonality, whatever they bought came all mixed, etc.).

[73] It became clear from the interviews that before promoting energy forestry they want to conduct more studies to see if it is really sustainable, especially in terms of soil exhaustion.

[74] Fixed chippers or portable equipment.

[75] The generation of electric energy is free; the distribution and transmission are within the monopoly of the State.

[76] Based on the interviews, a company of Brazilian capital of 40mv, which is going to be installed in Chamberlain is the only one with which it was possible to concretize the last decree of fixed prices. Of the 12-15 company groups that presented offers of more than 350 mv, almost all of them were pure generators. Three or four of these groups that were left out may still be interested.

[77] Weyerhaeuser in Tacuarembó and Bioener, which is in the Urufor sawmill, which are cogeneration of electric and thermal energy.

[78] Ponlar, which is in Rivera.

[79] Fenirol, which is in Tacuarembó.

cogeneration plant, from rice husks[80], another one from sugar cane bagasse, and finally, a plant based on forest biomass, which is also of cogeneration, however not associated to the processing of wood, but is related to a business venture for processing raw sugar[81], with the particularity that it does not have a PPP with UTE, so it sells its surplus of energy to the spot market.

107. In Uruguay, there are three invention patents to generate energy based on residues (requested by local applicants). Additionally, an application for a patent in the USA was presented for a patent in the USA for a drying device and a process for the use of wood as fuel (for more information see annex 3).

108. With respect to ***boilers***[82], there is indeed technology developed at a national level[83] and emphasis was made in the tender on the national component -they had to have certain percentage of local component, or they would not be considered, which resulted in a strong obstacle at the moment of implementing the tenders[84]-. Uruguay, in the '80s developed boiler technology, but on the other hand it does not have a developed heavy industry, consequently the necessary machinery is imported -with the exception of one detected case (see annex 3), the existence of registration or patents of this technology could not be determined-.

109. As was previously mentioned, another area where local innovative efforts may be found is in boiler technology. Uruguay has local companies that have acquired productive and technological capacities in their development. At the same time, and hoping to strengthen the sector, Uruguay sought to support the sector by means of including favorable clauses for the "buy national" in its tenders.

[80] In Treinta y Tres Orientales.
[81] In Paysandú.
[82] The boiler works with steam, and the term co-generation is used because part of the steam goes to the industrial process and part for the generation of electricity.
[83] In the case of Weyerhaeuser, when the expansion to a second line of production is decided, at the end of 2008 beginning of 2009, the second line is added to an energy production boiler of 10 mv/hour to supply the plant and leave a surplus of 20 to 40% to sell to the local energy network. This boiler was made with national technology, designed by a national company based on its technology but with a strong involvement of technicians of the company in Uruguay – with less involvement from the US.
[84] The tender calls made were found to be insufficient as to the local capacity to respond to their needs, important engineering problems arose in some of the works; according to the interviews, the national capacity in this sector was not prepared to respond to this demand in time and form.

Final comments

Uruguay is a country that has had a relatively recent entry into the forestry complex thanks to public policies of incentives that have been pursued from the State for the last decades. While the chain has been growing in relative importance for Uruguay (up to the point that today it is, among the activities regarding renewable natural resources, of the greatest importance as to dollars per exported hectare), the contribution at a global level continuous to be negligible; which indicates that Uruguay is an insignificant participant in the global chain of forestry value and that there is still an ample space for growth without great obstacles (duplicating the current export values, and assuming that international trade remained stable, Uruguay would not represent more than 1% of the total).

At the same time, the distribution of the Uruguayan export pattern indicates a bias towards those products of less complexity, or that are less differentiated –commodities- with smaller relative participation in the more elaborate ones. Paradoxically, being able to make a leap toward those sectors, today, would seem to be more a problem of scale -the internal Uruguayan market does not allow these types of initiatives to settle, to later make the exporter leap- than a problem of access to knowledge -and therefore, of intellectual property rights-.

On the other hand, another of Uruguay's particular characteristics is its productive/exporter profile. World patterns show that forest exploitation is divided in half between energy and industrial processing -with a slight bias towards the first item- and equally divided into the interior of the industry, between paper and processing of hard woods. At the same time, the international trend indicates that the less industrialized countries present a much more biased profile towards production of energy based on wood, whereas the most developed ones lean towards industrial production (particularly in hard wood). Uruguay, in this case, has been modifying its productive structure relative to the forestry chain, placing itself today in the paper-production sector, especially in what refers to the production of pulp -first links of the specialization of the chain-.

Consequently, today, the chain presents a forest patrimony that is quite concentrated -with a shift towards the exclusive exploitation/plantation of eucalyptus in different varieties-, and an industrial phase strongly committed to fiber -specifically cellulose-. In contrast, there are attempts of the country, through specific policies -like the Tripartite Forest Sector Council of the Productive Cabinet-, to try to provide incentives for the area going to the solid-wood industry -of a higher value added, with greater participation of local labor- to grow in participation -or at least avoid a fall as a consequence of a rebound of the international crisis[85]-. In this sense, the growth of this area depends more on world demand -still declining- than Uruguay internal policies.

Therefore -and recognizing the efforts made to this day-, it would seem that in the paper sub-chain -given that the final paper production stage is made close to the final destination- as well as

[85] The solid wood package -everything that is not fiber-, which had certain perspectives of expansion, today remains quite limited basically due to the decrease in investments in Europe and the US, with whom an important exchange was maintained in the real estate market.

in the production chain of solid wood -which depends on the demand of developed countries, today in crisis- no favorable horizons are visible in the medium term to move forwards toward the more complex links into the interior of the chain. In this sense, the expected expansion lies in a growth in the forestry stage -in volume as well as quality-, turning the nurseries and forestry services into key links for the development of new knowledge -and, therefore, into sectors to be considered in relation to IPRs-.

In any case, given the structural composition of the current forestry chain in Uruguay, industrialization downstream is heavily conditioned by the existing companies today -global giants that seem to have much more interference to define the future of the sector from their corporate policies, than what is defined within the sovereign policy in Uruguay- that have assigned to the country, based on their global strategies, a role of supplier of semi-processed raw material. This opens the question if it is possible to occupy another place in the forestry world and if so, which is the way to achieve it.

In contrast, in the stage of generation of energy based on biomass there is a whole universe to be explored, since this should be developed for local application, with the possibility of generating business opportunities if a new and competitive technology at a global level were to develop. In the stage of heavy machinery and equipment, limitations would exist to consider opportunities -given the problems of scale previously mentioned-, but this is not so in the development of process technologies (like in the case of blast furnaces based on firewood that are indicated in annex 3). There, without a doubt, the already existing traditional mechanisms -and to everybody's reach- at both local and global levels, would seem sufficient -in any case, the only thing to do would be to continue with training courses and facilitation for their management-.

In any case, in the design of policies, the companies providing forestry services must be taken into account as strategic agents for any initiative to be carried out. They are of Uruguayan capitals, they are based in the country, they are the agents that make incremental improvements and have relation with the large plantations of the transnational companies, as well as with the smaller companies of Uruguayan capitals, which also turns them into drivers of dissemination of knowledge.

At the same time, there is another level that has not been fully explored -also under development globally- which is the one related to the exploitation of non-wood forest products. In this sense we must point out that, today, as a first step, The Forestry Department (DGF) is conducting a survey of all native forests in Uruguay, which will serve not only to preserve the native species of the country, -this way guaranteeing the certificate of origin of all native species- but also to know what we have in the national territory and start to explore which possible products can be obtained from the forests. In parallel, it is also possible to work to advance in this type of industry by exploiting planted forests, knowing in advance the type of product to be obtained.

To the natural conditions, a couple of decades ago, a mechanism of incentives that originated, first, a mass of artificial forests and more recently, a substantive industrial capacity (in the local industrial context) was added; just as the present is, to a large extent, the result of such past

measures, the future (a possible supplementary second stage and of replacement of forests that are beginning to enter the industrial phase) depends on public measures and current private strategies.

In the current scenario, it would seem there is not much to do on the issue of IPRs on the first links of the chain; for the future, the scenario is open. Reality shows there are several critical points in matters of IPRs; one of them refers to what occurred in the access to genetics.

What do we know about what happened?

a) That genetics is controlled by the integrated companies;

b) That these companies have the best techniques and, as such, make of this a competitive asset.

b) INIA is the public counterweight -and also for the smaller producers-, but a counterweight that is increasingly lighter.

c) Downstream, most of the developments come from abroad, almost turnkey.

d) Local adaptation has almost no relevance… But its future development could be promising.

Precisely, in the future (that is, the repopulation of future forests and possible replantations), we could expect:

a) Biotechnology to keep growing in its determinant role;

b) The development of varieties to continue to be relevant, because the gene-patenting model also implies variety;

c) Fingerprints and other techniques to be relevant in the supply contracts with third parties – if they are not resolved via public or decentralized agencies, they will be made through private agreements-;

d) The local legal framework to be out of step between patents and plant breeders; the same thing with institutional strengthening.

In terms of intellectual property and its impact on the forestry chain in Uruguay, we should highlight the strategic value of forest management. The development of what is planted upstream will condition the development of the activity downstream. In this sense, as mentioned in the text, 75% of forested terrain is in the hands of a few companies. Those owning more land are transnationals, and while they have mounted the most advanced nurseries, along with laboratories, the bulk of the investment in research is made at their headquarters, so we can infer

that the problems of intellectual property they might face -or the strategies defined on the subject- will come dictated from abroad.

On the other hand, if Uruguay plans to diversify its forestry chain, and advance towards more complex links, it would be desirable to study which IPRs instruments could be developed to accompany and stimulate the growth in these areas (mainly biomass and non-wood derived products).

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ANNEX 1 – Export statistics by company

Uruguayan forestry sector exports by company. 2011 (millions of $US)

Product	Description NCM10	Company	2011	%/Subtotal	%/Total
Wood	Eucalyptus	Cñia Forestal Oriental S.A. (UPM)	179.09	70.7%	34.2%
		Cñia Forestal Uruguaya	25.62	10.1%	4.9%
		Forestal Atlantico Sur Soc. Arg	8.32	3.3%	1.6%
		Foresur G.I.E.	6.27	2.5%	1.2%
		IDALEN S.A	3.78	1.5%	0.7%
		PIKE y Cia Comercial Ltda	2.91	1.1%	0.6%
	the others of coniferous	Rio Tumbes S.A	2.13	0.8%	0.4%
		Los Piques S.A	2.41	1.0%	0.5%
	Others	Others	22.74	9.0%	4.3%
Subtotal Wood			**253.27**	**100.0%**	**48.4%**
Chips	Different coniferous	Forestal Atlantico Sur Soc. Arg	49.92	30.1%	9.5%
		Sierras Calmas S.A	38.17	23.0%	7.3%
		Foresur G.I.E.	24.63	14.9%	4.7%
		Comercializadora Grupo Foresta	23.34	14.1%	4.5%
		Eufores S.A. (Montes del Plata)	21.38	12.9%	4.1%
		Asoc. Agrag de Resp. Ltda de Pro	3.64	2.2%	0.7%
		Urufor S.A	3.17	1.9%	0.6%
		Others	1.45	0.9%	0.3%
Subtotal Chips			**165.69**	**100.0%**	**31.6%**
Sawn Wood	Eucalyptus	Urufor S.A	25.26	50.8%	4.8%
		Caja de Jubilaciones Bancarias	3.14	6.3%	0.6%
		Maderas Aserradas del Litoral	3.66	7.4%	0.7%
	Others	Dank S.A	11.56	23.2%	2.2%
	elioti pine	Caja de Jubilaciones Bancarias	3.22	6.5%	0.6%
		Others	2.93	5.9%	0.6%
Subtotal Sawn Wood			49.76	100.0%	9.5%
Playwood	others with some external leaf of different coniferous wood	Los Piques S.A. (Weyerhaeuser)	22.79	51.6%	4.4%
		Urupanel S.A	1.1	2.5%	0.2%
	Others	Los Piques S.A. (Weyerhaeuser)	13.18	29.8%	2.5%
		Urupanel S.A	6.63	15.0%	1.3%
		Others	0.48	1.1%	0.1%
Subtotal plywood			44.18	100.0%	8.4%
Other products			10.79	100.0%	2.1%
Total			523.7	100.0%	100.0%

Source: Own preparation based on data from URUGUAY XXI

Paper and cardboard exports – $US 80 million -2010-

Company	%
Fabrica Nacional de Papel S.A.	49.9%
Industria Papelera Uruguaya S.A. 32.267	40.2%
Pamer S.A.	5.8%
SAGRIN S.A. 1.984	2.5%
Compañia Industrial Comercial del Sur S.A (CICSSA)	1.6%
Total papers and cardboard	100.0%

Source: Prepared by Uruguay Forestal, 2011

Exporting companies

(Part. % annual – 2010)

Exporting company	% of total
Compañia Forestal Oriental S.A	33.2%
Forestal Atlantico Sur S.A	10.3%
Fabrica Nacional de Papel S.A.	7.1%
Sierras Calmas S.A.	6.3%
Industria Papelera Uruguaya S.A.	5.7%
Los Piques S.A	4.9%
Urupanel S.A	4.7%
Compañia Forestal Uruguaya S.A	4.1%
Eufores S.A	3.6%
Urufor S.A	3.5%
Comercializadora Grupo Foresta	3.3%
Foresur G.I.E.	3.2%
Dank S.A	2.0%
Cas.A.Bo S.A	1.1%
Caja de Jubilaciones Bancarias	0.9%
Pamer S.A	0.8%
Maderas Aserradas del Litoral	0.6%
Sagrin S.A	0.4%
Rio Tumbes S.A	0.3%
Imnsur Ltda.	0.3%
Asoc. Agrag de Resp Ltda. De Pro	0.3%
Pike y Cia Comercial Ltda.	0.3%
Others	3.2%
Total	**100.0%**

Source: Prepared based on information from DNA

ANNEX 2

List of interviewed persons in Uruguay during the visits performed between the 22nd and 26th of July, and between the 10th and 13th of December 2012.

- Julio Bartol (President – MNIRUX SA) jbartol@adinet.com.uy
- ZhoraBennadji, (INIA) (Principal Researcher – National Program on Forest Research, National Institute of Agricultural Research, INIA): zbennadji@tb.inia.org.uy
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- Gerardo Camps, (Manager of evaluation and registry of cultivars, INASE); gcamps@inase.org.uy
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- Verónica Durán Fernández, (Office of Programming and Agricultural Policies, Ministry of Livestock, Agriculture and Fisheries); vduran@mgap.gub.uy
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- Carlos Hartwich; (Metalúrgica Julio Hartwich); carlos.hartwich@jhartwich.com
- Mónica Heberling, (Responsible for Research and Development of Montes del Plata)
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- Carlos Mantero (Director of the Experimental Station Prof. Bernardo Rosengurtt, Faculty of Agronomy, UdelaR); cmantero@fagro.edu.uy
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- Juan Pedro Posse (Manager of Forestry Technology for South America – Weyerhaeuser Productos SA) juanpedro.posse@weyerhaeuser.com
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- Luis Sancho, (Forestry Specialist – PROBIO/Production of Electricity from Biomass); probio@dinama.gub.uy
- Roberto Scoz (Director of the National Program on Forestry Research, National Institute of Agricultural Research, INIA); rscoz@inia.org.uy

- Pedro Soust (articulator of the Forestry/Wood Sectorial Council and Forest General Director of the Ministry of Livestock, Agriculture and Fisheries): psoust@mgap.gub.uy
- Adriana Tambler, (Office of Programming and Agricultural Policies, Ministry of Livestock, Agriculture and Fisheries); atambler@mgap.gub.uy

ANNEX 3

Industrialization of Iron Ore and Generation of Electric Energy using Wood as Fuel

(By Julio R. Bartoljbartol@adinet.com.uy– Montevideo, Uruguay - Dec. 21, 2012)

Pig Iron production using Charcoal as fuel

Charcoal is used in blast furnaces to produce Pig Iron – an alloy of iron and 4.3% carbon. Pig iron is used directly in foundries or as the raw material for the production of steel products. Charcoal supplies the heat to reduce and melt the iron and other elements contained in the mineral. Fluxes are added to form a fluid slag that traps the impurities contained in the ore.

State of the art technology produces Charcoal by drying and carbonizing wood in a discontinuous (batch) process that lasts some 12 days. The process is highly contaminant and the water and energy contained in the wood volatiles are lost to the atmosphere.

Liven® Wood – A new development that substitutes traditional Charcoal production

We have developed and patented "a continuous drying apparatus and method", registered under the trademark "Liven®" (LIVeENergy). Extensive controlled tests have proven that Liven® wood can be continuously carbonized in a matter of tens of minutes. Therefore, Liven® wood can be rapidly carbonized inside the blast furnace and substitute traditional charcoal as fuel. The thermal energy contained in the wood volatiles can now be managed and a part of it can be transformed into electric energy to supply plant needs and/or sell it to the grid.

The use of Liven® wood eliminates: a) the need for a separate and independent charcoal producing plant, b) the solid and gas pollution associated with charcoal production, c) the loss of the water and energy contained in the wood and d) the need to purchase electric energy.

We have recently presented patent applications in several countries under the title: "A sustainable process for the co-generation of pig iron and electric energy using wood as fuel".

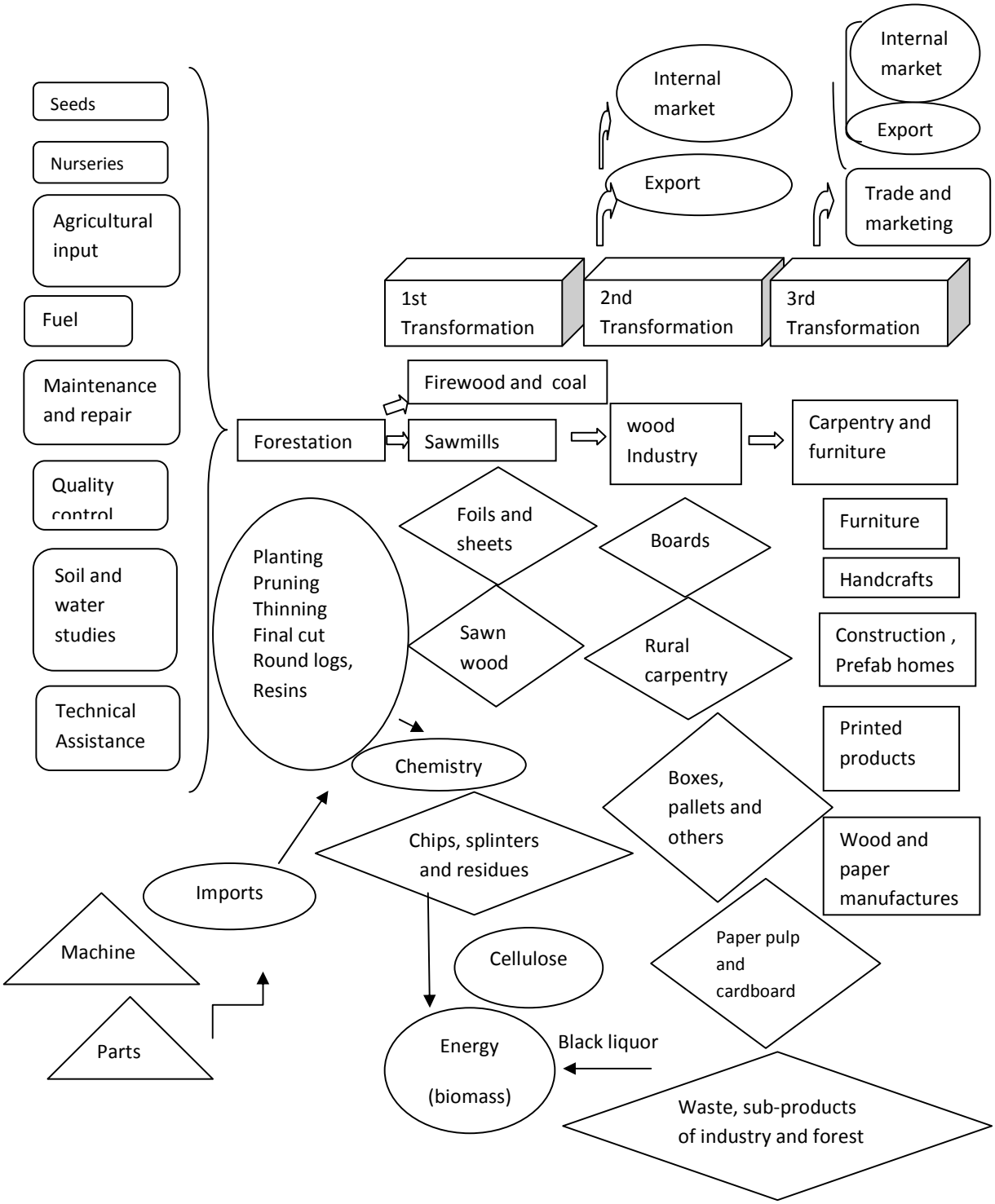
Benefits of using Liven® Wood as Fuel

1. - It makes "a green and sustainable steel industry" a true possibility through the co-generation of pig iron and electric energy.
2. - It fosters skilled employees and increases the quality of life of society.
3. - It creates "energy self-sufficiency" allowing countries to attract investments and to decentralize industries.
4. - It minimizes pollution and fossil energy consumption, and increases materials efficiency.
5. - It generates valuable Certified Emission Reduction credits.
6. - It administers a non-renewable resource – iron ore - in a rational way by producing high added value products that extend the life of the mining projects.

ANNEX 4

The forestry value chain

Table 3. Diagram of Forestry Chain



Source: Own preparation based on Morales, V. 2012 and the study 002/07 of the Mercosur Secretariat.