Escola Superior de Agricultura "Luiz de Queiroz", Universidade de SãoPaulo[1]

Alex da Silva Alves
Núcleo de Estudos e Pesquisas, Instituto Gênesis para Inovação e Ação Empreendedora
Pontifícia Universidade Católica do Rio de Janeiro

1. Introduction

This case study is focused on the analysis of a University-Industry dynamics, fundamentally concentrated on the of role of two different units of a research-university within the premise of a large university-industry consortia. The object of analysis in this study is the interplay between these research units and four big players in the Eucalyptus industry, under the auspices of a large collaborative R&D project. The consolidated research position obtained by these units in the study of the genetic improvement of plants with commercialization potential – of which tobacco, sugar-cane and the eucalyptus – has paved the way for an extensive network of joint R&D collaboration agreements with important Brazilian universities and private firms operating in the Eucalyptus market. Up until the year 2001, such initiatives were being carried out in isolation from one another. In that same year, though, the Max Feffer Laboratory of Genetics of the Department of Genetics, the Centre for Agricultural Biology (CEBTEC) of the Department of Biological Sciences and later on the Fitopathology Unit of the Department of Entomology, Fitopathology and Agricultural Zoology, all of them from Esalq/USP, have been put together with the support of FAPESP in a joint initiative with other four important Brazilian players in the Eucalyptus business (Suzano Bahia Sul Papel e Celulose, Votorantim Celulose e Papel, Duratex S/A and Ripasa S/A). Another Brazilian university, the Paulista State University at Botucatu was also involved. The objective of this ambitious project, named FORESTS-Eucalyptus Genome Sequencing Project Consortim (hereafter FORESTS), was to sequence the DNA of the Eucalyptus plant, so that to subsequently identify and exploit genes with economic relevance for the firms operating in that market (in particular timber, wood and cellulose industries). The complex and pioneering nature of a project of such a magnitude in Brazil, that is still under way, produced important externalities – not anticipated by its participants – that went far beyond the control of the partners involved. As a consequence, the Project's scientific relevance was maintained, though its expected economic prospects were undermined. The main shortcomings arising out of the interaction among the four firms and the Esalq/USP departments involved in the FORESTS project will be herein analyzed. The understanding of the dynamics, strategies and institutional lessons learned in this long-term project, still under way, is the main objective of this case study.

2. Project Description

The Genesis: The Economics of Eucalyptus and the Brazilian Scientific Prominence in the Field of Applied Genomics

Eucalyptus species mainly originate from Australia and are widely propagated all over the world because they adapt easily to a wide range of differing environmental conditions. In Brazil, eucalyptus species were introduced by Edmundo Navarro de Andrade for use by the Paulista Railroad Company in the State of São Paulo at the beginning of the XIX Century, and by the time of his death, in 1941, he had established more than 75 species in orchards. Today, according to the United Nations Food and Agriculture Organization (FAO), Brazil has the largest area of

[1] Esse trabalho contou com o auxílio (apoio para marcação e realização de entrevistas; levantamento e análise preliminar de dados) de Yuri Arrais, M.Sc, assistente de pesquisa do projeto no Brasil e Pesquisador Associado Junior do NEP Gênesis, PUC Rio. Adicionalmente, sem o apoio dos entrevistados nas instituições objeto de estudo, certamente a realização deste trabalho não teria sido possível. No entanto, eventuais erros ou omissões que persistirem ao longo do texto são da inteira responsabilidade do autor.

commercially reforested eucalyptus in the world with around 3 million hectares, representing 60% of domestically planted forest. Eucalyptus has become a very commercially important tree, especially for timber, wood and pulp and paper industries. The eucalypts-based forestry industry in Brazil represents around 4% of Brazilian GDP and 10% of world exports.

Once importer of cellulose, Brazil has consolidated a position of a leading exporter of the product and the world's largest producer of the fiber obtained from the eucalyptus plants. A considerable part of this success can be attributed to the favorable environmental conditions that significantly influenced the productivity of the plant, as Table 1 indicates. Additionally, major R&D efforts have been carried out by cellulose producers, with Suzano and Votorantim as private leaders in the segment. These private conglomerates, together with the Brazilian public R&D firm EMBRAPA, have long established collaborative networking records with Universities throughout the country.

That is to say, the combination of favorable production factors such as a fertile ground and cheap labor, with scientific efforts geared at improving the efficiency (resistance to diseases, quality improvement, longer life cycles etc.) of the plant have been fundamental in making the Brazilian economics of eucalyptus so competitive in the international markets. The eucalyptus gender, of the Myrtaceae family, constitutes more than 700 species. Brazil has accumulated in the last decades a vast and diversified genetic material of such species, in particular those with economic interest, being the most developed country – after Australia and New Zealand where such species originated – in genomic research on eucalyptus, contributing to making the plant more resistant and easily adaptive to the vast and environmentally different regions of the country.

Table 1: Characteristics of World Eucalyptus Production

Country	Harvesting time (years)	Productivity (m^3/ha/year)
Brazil	7	45-50
Argentina	7-12	25
Chile	10-12	20
Indonesia	7	20-25
Australia	7	20-25
Spain	12-15	10-12
Switzerland	35-40	5,5
Finland	35-40	4
United States	25	10
Canada	45	7

Source: Votorantim.

The international market of eucalyptus is very competitive, increasingly pushed by a growing world demand for quality products with lower prices. As a commodity, the market price of the cellulose obtained from the eucalyptus cannot be controlled by a single producer and the fragmentation in the world cellulose industry imposes significant barriers for the formation of cartels or oligopolies. That means the influence exerted by producers for price control does not determine the international price of cellulose. In this direction, the remaining competitive strategy available for firms is to reduce their production costs by increasing *productivity* (reducing production cycles, which in Brazil is already quite low in respect to other countries) and *quality* (making it more resistant to plagues and easily adaptive to changing environments), thus sustaining the justification for intensive R&D efforts carried out *in-house* by companies or in joint programs with research universities.

In this competitive context some influencing components were at play: the existence of a product with a significant economic value; the presence of Brazilian companies with international market share and a R&D history in the field; research universities strongly dedicated to the theme; and established and mature public R&D support agencies like the São Paulo State R&D Support Agency (hereafter FAPESP). The interplay with these institutions has contributed to creating a critical mass behind the idea of a long-term joint research project putting together government, universities and industry.

The FOREST project was proposed to act right in this direction, filling a gap that – up until the time of its launching in 2001 – no other similar Latin American scientific institutions have pursued. The project fundamentally consisted in putting together competing (and competitive) private companies, research universities and a public R&D support agency in a long-term scientific project whose main goal was to consolidate the knowledge required to exploit the economic benefits of the genomic of the eucalyptus plant.

The Consolidation of Industry-University Collaboration towards Sustainable Development under the framework of a Large R&D Consortia

FORESTS is the first tree transcriptome database produced in Brazil. It was created by researchers from Universities and Research Institutes that belong to the Agronomical and Environmental Genomes Project (AEG), a part of the ONSA (Organization of Nucleotides Sequencing and Analysis) network created by FAPESP and also included the active participation of four private competing wood and paper companies based in the State of São Paulo. Included in this consortium are Suzano Bahia Sul Papel e Celulose, Votorantim Celulose e Papel, Duratex S/A and Ripasa S/A. As the project partners state, it was a challenging and a very productive learning process for scientists and specialists from the private sector to work together, for the first time, on a large genomic project, exchanging experiences towards reaching a common goal.

In the genesis of this project lie the joint efforts of a consortium of universities in the state of São Paulo made possible by the establishment of ONSA network, that also involved – in varying degrees of participation – researchers from the University of Campinas (Unicamp) and from the Paulista State University (Unesp) at Botucatu. The first result of this joint R&D initiative came about in 1998 with the complete genomic sequencing of the DNA of Xylella Fastidiosa – a bactery that resulted in more than R$ 150 million of losses per year to orange producers in the State of São Paulo. This event started Brazil in the Genomic era, followed by the establishment of several networks for genomic research throughout the country, among which the above mentioned AEG. The consortium of Brazilian universities and research centers put together by AEG network has subsequently mapped and sequenced the DNA of other variations of Xylella, of the Expressed Sequence Tags (ESTs) genomes of plants and animals (coffee, sugar-cane and bovine animals), being thus targeted at the core of one of the engines of the countryside São Paulo State economy: the agribusiness industry.

As a consequence of these actions, the experience accumulated by AEG network paved the way for the further sequencing of the eucalyptus plant, carried out by FORESTS in its first three years of existence. The Eucalyptus plant is formed by approximately 120,000 genes. Although presenting challenging research efforts, the sole sequencing of this plant would be of limited economic value. The identification of genes with market potential would increase the success motivations behind its idea so that a fundamental pillar of the project architecture – also strongly encouraged by FAPESP – was to promote the articulation with private firms interested in the identification and further development of these genes obtained from the previous sequencing and mapping.

The main motivation behind FORESTS was to identify 17,000 genes with economic value by means of the sequencing of 100,000 ESTs obtained from libraries of different tissues of the plant, including wood, stem, roots, leaves, and plantule (the embryo part of the plant). All genomic

sequences obtained were compared with those available in other national – like Genoma/FAPESP – and international databases so to avoiding redundancies and errors. The methodology used for the mapping and analysis of sequences was supported by sophisticated bioinformatics computational algorithms. The whole sequencing phase was carried out by 22 university laboratories spread in the State of São Paulo, who are active members of the FAPESP ONSA-AEG network. These phases have been carried out under the scientific coordination of professors Helaine Carrer and Carlos Labate of Luiz de Queiroz School of Agriculture of the University of São Paulo (USP). The cost of this project phase was estimated in R$ 2 million, being half of this sum invested by FAPESP and the remaining split by the four private companies participating in the project.

Table 2: FORESTS Development Stages

FORESTS Phase	Time Length	Description	Main outcomes
Phase I	2001 – 2003	the genoma of the eucalyptus plant was sequenced and mapped throughout this phase.	In the course of this phase there were obtained 112.152 sequences of the Eucalyptus plant, made available for consultation of external scientists on a free-access database.
Phase II	Started in 2003, still in execution	Performing a functional analysis of the sequences in order to identifying genes with potential economic interest	There were analyzed 28,000 genes previously mapped in Phase I, which were compared with other genes already mapped and readily available in other national and international databases. Consequently, 17,000 genes of potential business development interest, were made public for consultation (not for exploitation) by FAPESP to researchers of universities not participating to FORESTS.
Phase III	In execution	Exploitation of these genes and the definition of the commercialization strategies, whether by means of property rights licensing or internal utilization of the genes by the participating institutions	

Source: Elaborated by the author.

The whole sequencing process took about three years to be concluded. Given the pressure made by the private firms involved, as they were active investors as well as the most benefited by the results expected to be achieved, the project was subsequently divided into three phases, as indicated in Table 2. Even though not officially concluded, the last two phases are being simultaneously carried out, giving signs that no substantial *collective* economic results to the participating partners have been achieved since the conclusion of Phase I: apart from a myriad of scientific publications, no licensing, patents filled or issued have come about; three spin-offs indirectly arising out of the Project have been created with financing obtained by the corporate venture capital arm of one the competing companies participating in the Project. Both Phases II and III are being expected to consume another R$ 2 million throughout their courses of development.

The Project counted, along the course of Phase I, with the participation of tree renowned Esalq laboratories, with their respective FORESTS coordinators: the Max Feffer Laboratory of Genetics at the Department of Genetics - prof. Carlos Alberto Labate; the Centre for Agricultural Biology (CEBTEC) at the Department of Biological Sciences – prof. Helaine Carrer; and the Department of Animal Production - prof. Luiz Coutinho Lehmann. At the Unesp/Botucatu the unit and the local

Project coordinator were the Institute of Biosciences, whose coordinator was prof. Celso Luiz Marino. In 2003, Both Department of Genetics and the Department of Biological Sciences withdrew the Project after concluding Phase I. As the project kept its way through, the Department of Animal Production continued participating in the Project, although with a reduced participation, and the Fitopathology Unit of the Department of Entomology, Fitopathology and Agricultural Zoology, with prof. Luis Eduardo Aranha, was subsequently included, being today the FORESTS scientific coordinator for Phases II and III. The withdrawal of these important research units from the Project, together with other events that took place throughout Phase I, have paved the way for a subsequent dynamics that undermined the prior expectations built around this university-government-industry cooperation initiative.[i] For the sake of space and scope of this case study, there will be analyzed the interplay with only two departmental units of Esalq in this Project, the Max Feffer Laboratory and CEBTEC, given their scientific roles in the Project along its critical design, definition and development phases as well as the different characteristics of their cooperation with industry.

The idea behind the FOREST project would be of a significant value for Brazilian companies so that it was not difficult for FAPESP to put together the major players in the Brazilian cellulose industry and to prove these companies there was enough scientific critical mass in the State of São Paulo to carry out joint collaborative research projects of the magnitude proposed. The genetics of eucalyptus is very important for this industry, given the costs faced by Brazilian companies extracting cellulose from the eucalyptus plants, translated in royalties paid for the utilization of international patents of genes identified abroad. In this sense there was, on the one hand, an industry demand for scientific skills required to solve relevant industry problems in genetic engineering and microbiology of plants that calls for important science-based efforts in applied genomics. On the other, there was an established research-university that has accumulated a significant hold in these areas, thereby carrying out independent and, in most cases, sporadic research contracts with the major players in this industry. The lacking element was though introduced by FAPESP, which put all these players together so that to structure a single and long-term collaborative research effort that culminated in the launching of FORESTS.

3. The School of Higher- Education in Agriculture of the University of São Paulo

Brief History

The University of São Paulo's Luiz de Queiroz School of Higher Education in Agriculture (hereafter Esalq) formally began its activities in 1901. As many Brazilian schools of higher education, its evolution was the result of a long process of local entrepreneurship, tenacity and leadership. The name of the school is a respectful deference to Luiz de Queiroz, son of the Baron of Limeira, who received his education in the second half of the 1800s at the School of Agriculture of Grignon, France, and in Zurich, in the German Switzerland. After the death of his father, Luiz de Queiroz bought, in a public auction in 1889, the 319-hectares' Fazenda São João da Montanha, located 3km away from downtown Piracicaba. By acquiring the farm, Luiz de Queiroz basic intent was to establishing a pioneering school of agriculture, following the models of renowned schools of higher education in agriculture in Europe and in the United States. After traveling to England and to the U.S. to seek qualified people and ideas to support him in such a risky venture for the time, Luiz de Queiroz put together, in 1892, 200 technicians and workers fully engaged in the building and designing of the new school.

Given the size of the venture, relying on public support would be fundamental for the success of the project. After many attempts, all of them rejected by government officials, Luiz de Queiroz did not miss his enthusiasm. Mr. Queiroz donated the farm to the Government of the State of São Paulo for the purpose of building the school, establishing 1901 as a deadline for the state's government to

make the school operational, otherwise the property would be given back to the Queiroz family. Luiz de Queiroz died in 1898 without fulfilling his dream. Nevertheless, after many drawbacks and shortcomings, the school finally became operational in 1901. After being managed by the Secretary of Agriculture of the State of São Paulo for nearly three decades, the school was integrated to the University of São Paulo (USP) in 1934.

The Esalq's total territorial area corresponds to 3.825,4 hectares, totaling 50% of the whole USP system area. The campus is in an area covering a 914,5 hectare extension, with 11 departments and 148 laboratories, employing 228 full-time professors and researchers, and 528 administrative personnel.

The institution also collaborates with industry in joint research projects, involving a substantial part of its faculties and researchers, full-time engaged in teaching and in carrying out basic and applied research. Most university-industry projects are undertaken in co-partnership with public state and federal research support agencies – like FAPESP and CNPq – as well as with private firms.

Esalq Undergraduate and Graduate Courses

Every year Esalq receives 390 new undergraduate students on a competitive basis along its seven courses. Table 3 depicts the distribution of undergraduate students according to each course offered by the institution.

Table 3: Distribution of Esalq's undergraduate students.

Undergraduate Courses	Students enrolled as of Sep 06'	Total Students[a]
Agronomical Engineering	1.030	9.652
Forest Engineering	205	703
Agroindustrial Economics [b]	114	82
Home Economics[c]	-	338
Food Sciences[d]	197	62
Environmental Management [e]	152	21
Biology [e]	139	-
Total	1.837	10.858

(a) Number of Bachelor degrees awarded; does not include current students.
(b) Created in 1998
(c) No longer available since 1991
(d) Created in 2001
(e) Created in 2002

Source: Elaborated by the author upon data provided by Esalq.

The emphasis in practical problems of industry in the fields of agriculture and forestry, combined with the emphasis in the production and utilization of solid scientific instruments and methodologies, attracts firms who seek Esalq students at both undergraduate and graduate levels. Most of the students are hired by firms established in Piracicaba and surrounding regions. The city of Piracicaba, where Esalq is located, is in the heart of the Brazilian agroindustrial value chain, hosting local, national and multinational groups of firms exploiting the tobacco, sugar-cane and eucalyptus plantations, used as raw-materials in cigarettes, beverages, food, fuel and cellulose industries, many of them also located therein.

The School was the pioneering institution within the University of São Paulo (USP) system to offer, in the beginning of the 1960s, graduate courses at Masters (MSc) degree level. In the 1970s, Esalq offered the first PhD courses in Agriculture and Forestry-related areas in the country. Table 4 presents the distribution of Masters (MSc) and Doctoral (PhD) courses in the institution.

Table 4: Esalq's Master and Doctoral students

Current MSc and PhD Students*	975
MSc titles awarded	4.303
PhD titles awarded	1.741
Total MSc and PhD titles awarded	6.044

* As of Sep 06.

Source: Elaborated by the author upon data provided by Esalq.

Esalq's 975 graduate students represent more than half the School's undergraduate students. In combination, the number of graduate degrees awarded corresponds to more than 60% of the total, elucidating the position of Esalq as a research university. This position can be confirmed by taking into account the annual evaluations carried out by CAPES, the Brazilian Ministry of Education's commission in charge of performing annual evaluations of the country's graduate courses.

Table 5: Esalq Graduate Courses relate to the fields of Genetics, Fitophatology and Biological Sciences

Graduate Course	Type of curse	Year		
		96/97	98/99/00	01/02/03
Fitopathology	MSc/PhD	6	6	6
Fitotechnics	MSc/PhD	6	6	6
Genetics and Plant Improvement	MSc/PhD	7	7	7
Land and Nutrition of Plants	MSc/PhD	6	6	6

Source: CAPES.

CAPES created a complex scale, ranging from 1 to 7, to classify Masters and Doctoral courses offered by Brazilian state and private universities, as well as by independent research centers. Among the criteria utilized, there are variables measuring the amount of publications in internationally renowned magazines and journals in the area object of evaluation, the quality of faculty employed as well as the infrastructure available for carrying out basic and/or applied research. A graduate course is given 7, considered as excellent, only when it offers PhD courses and meets all of the criteria required for students to take on quality research leading to the awarding of their PhDs. Courses below 3 are not given the legal status to award their graduate degree certifications.

As Table 5 shows, graduate courses in Fitopathology, Fitotechnics and in Land and Nutrition of Plants have received the grade 6 since 1996. That result means these courses have acquired – and managed to keep – a level of quality considered as very good. The graduate course in Genetics and Plant Improvement, graded 7 at every year since 1996, is coordinated by Esalq's Department of Genetics and is considered as a one of kind graduate course in the area, with significant contributions to basic and applied research in the field of genetic improvement of plants, most of which exploring the regions' main competitive advantage: the agroindustrial business formed around tobacco, sugar-cane and eucalyptus commodities.

The excellence and interdisciplinary essence of graduate courses like the MSc and PhDs in Genetics and Improvement of Plants that also cuts across different Esalq units, attracts several qualified students from all over the country, together with private firms interested in the human capital and the scientific knowledge with economic potential developed and accumulated therein. This graduate course (MSc and PhD) counts with 20 professors, 215 students and is divided into six thematic areas. The graduate courses in Fitopathology, graded 6, is coordinated by the Department of Entomology, Fitopatology and Agricultural Zoology and counts with 12 full-time professors distributed in 11 thematic areas. An interesting feature of both graduate programs in Genetics and in

Fitopathology, both participating in the FORESTS, is the dedication of their professors in research activities related to the thematic areas of these graduate research programs. According to CAPES, these full-time researchers dedicate from 30 to 60% of their time to activities pertaining to research related to the program and to supervising graduate students. It is no different in the graduate program in Land and Nutrition of Plants, whose scientific coordination is in the Department of Biological Sciences.

Table 6: The Departments of Genetics, Biological Sciences and Fitopathology

Department	Number of professors (only full-time)	Number of Patents (filled and granted)†	Average Year Publications/Researcher ratio in selected top Journals
Genetics	21	29	2,80
Biological Sciences	18	9	N.A.
Fitopathology	22	10	3,31

Notes:

N.A. – Data not available.

† These patents are associated with the the respective full-time professors and they have not necessarily been obtained during the time these researcher were into Esalq.

Source: Elaborated by the author upon data available in Esalq, CNPq, CAPES.

The Department of Genetics, the Department of Entomology, Fitopatology and Agricultural Zoology, and the Department of Biological Sciences, all of them collaborating in basic and applied research in genetics, and in quality and health improvement of plants, has significantly contributed for the high-level Brazilian entry into the genomic era. It is thus important herein to shed some light into the role of two researchers in the Departments of Genetics and of Biological Sciences who played an important role in the coordination of FORESTS in its first development phase, together with their respective research units, thereby contributing to depicting an important feature of their participation with joint industry-research projects.

Scientific Excellence for the Benefit of Industry: the different industry cooperation character of two important scientific units within a R&D consortia

The Department of Genetics of Esalq officially began its activities in 1936, with the arrival in Brazil of the German scientist Friedrich Gustav Brieger, who is considered one of the founding fathers of the Brazilian Genetics. In 1958 there was created the Institute of Genetics, followed by the Chair of Cytology and Genetics, officially incorporated to the University of São Paulo in 1964. Today, the Department of Genetics of Esalq carries out undergraduate teaching activities within the courses of Agronomical Engineering, Forestry Engineering, Food Sciences, Environmental Management and Biological Sciences. At masters and doctoral level, the Department coordinates the multidisciplinary graduate course in Genetics and Plant Improvement, created in 1964. The Department presents today the following infrastructure:

- 19 Research laboratories – of which Max Feffer's –, teaching and experimentation facilities, all of them spread throughout a 25 hectares area.
- 1 experimental station in the district of Anhumas, in the city of Piracicaba.
- The "Professor Paulo Sodero Martins" Orchids House, hosting 800 species of different orchids organised in populations throughout 20,000 vases and 27,000 plants.
- A sectoral library consisting in 7,000 books and 300 periodicals specialised in Celular Biology, Genetics, Vegetal & Animal Evolution and Improvement, and Microorganisms.

The Department of Biological Sciences of Esalq was established in late 1998 after merging of the former Botany Department and the Biochemistry Sector of the former Chemistry Department. This merge was part of the general process of consolidation of various departments within the University of São Paulo. The Department mission is carry out research and teaching activities in Biochemistry, Molecular Biology, Botany, and Vertebrate Biology. The department has a suitable physical structure and a staff constituted by 18 full-time faculties and 22 support staff distributed in various sectors. Teaching, research and extension activities are developed in 14 laboratories, including a herbarium with 90,000 exsiccates, being considered a Brazilian reference of Experimental Garden of Medicinal and Aromatic Plants. In these laboratories some 60 undergraduate students participate in research activities. Some of them widely recognized for their excellent work.

Today the Department of Biological Sciences administrates and coordinates the undergraduate program in Biological Sciences. The faculty also participates in other undergraduate courses, including Agronomic Engineering, Forest Engineering, Environmental Management, and Food Sciences, dealing with about 1,100 students every year.

The department coordinates the Plant Physiology and Biochemistry Graduate Program at both Masters and Doctoral levels. The faculty also collaborate in other graduate programs of Esalq as well as other units of USP, and other universities as well (UNICAMP, UNESP-Botucatu, Universidade Federal de Mato Grosso). The extension activities of this Department tend to primarily focus on taylored training programs, environmental adequacy of rural properties, riparian forest restoration, plant taxonomy, plant micro propagation, and laboratorial training.

By combining the information obtained in Table 6 and Table 7, the understanding of the motivations behind the structuring of FORESTS around units from these Departments seems to be quite plain. The ratio of scientific publications per researcher in Genetics and in Fitopathology is, according to CAPES, higher than in other Brazilian universities offering similar graduate courses in these areas. Moreover, these department units, together with the Department of Biological Sciences, have developed closer ties with industry by means of the exchange of students who carry out their research in the premises of private and public firms and organizations. In that sense, on the one hand, these students contribute to solving typical industry problems that require solid scientific skills to be addressed and, on the other hand, firms support these students on carrying out more applied research leading to the awarding of their university degrees. The departmental unit that seems to have further advanced in the direction of establishing a solid cooperation tie with industry is the Max Feffer Laboratory of Genetics, headed by Professor Carlos Alberto Labate, whose cooperation with Suzano – one of the firms that joined FORESTS – has produced significant contributions in both scientific and business aspects.

The relationship between Suzano and the Department of Genetics has been established in 1997 and seems to be the most fruitful in terms of the long-term prospects for the relationship of an Esalq unit with industry. Suzano contributes with scholarships paid to graduate students carrying out basic and applied research in the Max Feffer Laboratory at the Department of Genetics. The Max Feffer laboratory itself was financed by Suzano who donated R$ 585.000,00 for the building up of the laboratory. There have been so far – apart from the FORESTS Project – carried out two mid-term projects under the auspices of FAPESP's PITE research-innovation financing schemes. The first one was carried out in 1998 and the second in 2001, being these two projects fundamentally related to basic and applied research aimed at changing the metabolism of wood (eucalyptus) so that to increasing its quality and productivity. Both research projects were co-sponsored by FAPESP and Suzano. As a result of the first PITE project with Suzano and the Department of Genetics, there was signed a genetic transfer protocol giving rise to the subsequent issuing of a patent in 2000 in the U.S. and in South Africa. The proprietary rights related to this patent belong to the University of São Paulo and Suzano on a 50-50% basis. Today, a total of three patents have been filled (one issued) as a result of the interaction between Suzano and the Max Feffer Laboratory. The differing character of the Department of Genetics, which is less autonomous than other departments with

their own undergraduate and graduate programs, makes its units more inclined to cooperating with other university departments and industry so that to guarantee a sustainable flow of resources to keep their scientific facilities operational, without sacrificing its quality. Professor Carlos Labate, for instance, who manages the Max Feffer Laboratory, has a long established history of cooperation with industry.

Table 7: The Max Feffer Laboraty and CEBTEC

	Patents filled	Researchers	Most important non-academic Partners	Main Cooperation Characteristics	Main Project Financiers
Max Feffer Laboratory (Department of Genetics)	3	21‡	Suzano Papel e Celulose S.A.	Mostly about applied research on the genetics of plants.	Suzano and FAPESP. There are also projects 100% backed by Suzano.
CEBTEC (Department of Biological Sciences)	0†	3	Suzano, Votorantim, small producers of sugar cane, and CTC (Technological Centre for Sugar Cane Research)	Mostly basic research in *plant resistance to parasites and bacteries* in contracts where CEBTEC provides firms with MSc and PhD students to carry out the field research required for their thesis within firm's forests or plantations.	FAPESP and Ministry of Science and Technology (MCT)

Notes:

† Professor Helaine Carrer, who was the FORESTS scientific coordinator during PHASE I, holds two patents related to her doctoral research, before entering CEBTEC.

‡ 4 out of these 21 researchers are PhDs; 12 are are undergraduate and masters students with part-time collaboration contracts; 8 are PhD candidatesand MSc researchers with full-time contracts.

Source: Elaborated by the author upon CNPq, CAPES and Esalq data.

In addition, although different than the Max Feffer's, the role of CEBTEC in FORESTS has also been determinant, even though its scientific coordinator, prof. Helaine Carrer, admitted to have had no prior cooperation with industry before joining this Project. Professor Carrer – and the CEBTEC's facility – joined FORESTS in its very beginning and withdrew it in 2003, almost together with the Max Feffer Laboratory of Genetics.

The Center for Agricultural Research (CEBTEC, Laboratório de Biotecnologia Agrícola), bound to the Department of Biological Sciences, was created in 1981, although the experience of most of the its scientific personnel engaged on plant tissue culture started in 1971, when Prof. Otto J. Crocomo and Dr. William R. Sharp (USA) introduced that technique in Brazil in the premises of Esalq. CEBTEC develops R&D either in collaboration with private companies or with financial support from official entities, as stated in Table 8.

So far, the students who passed through CEBTEC have produced 25 MSc dissertations and 15 PhD thesis. Most of the projects in which CEBTEC is engaged in are financed by FAPESP, by the Brazilian Ministry for Science and Technology-MCT and by CTC (Centro Tecnológico Canavieiro, once Copersucar). As Table 8 shows, CEBTEC also counted with significant contributions from private enterprises, though not in the same extent as the Max Feffer Laboratory,as discussed in the Section that follows.

Today, among other scientific duties, Prof. Carrer coordinates research projects with cooperatives and small firms for the identification of more resistant seeds of plants, as indicated in Table 7. She is also collaborating with a Dutch medium-sized firm acting in the woods business. The cooperation with private actors is provided on a contractual basis, mostly targeted at the provision of researchers (graduate and undergraduate students) who take on their *in-company* research aiming at identifying

sicknesses in plants and determining new methods for increasing their resistance and health, with a financial aid as well as the right to publish the results of their findings provided as a counterpart. Although professor Carrer holds 4 patents (3 produced during her PhD in the United States and 1 filled in cooperation with an German scientist and Esalq) she sees no future prospects for intellectual property rights exploitation of these patents.

Table 8: Main Sources of Financing for CEBTEC

Public	Private
• European Community (TS 1/TS 2 Programs) (1984-1992) • Financiadora de Estudos e Projetos (FINEP) (1981-1998) • Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) (1981-1997) • US-Brazil Initiatives in Science and Technology Program (Blue Ribbon) (1989-1992) • Deutscher Akademischer Austaauschdienst (DAAD)(Germany) (1988-1992) • Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ) (1981-1996)	• Johnson & Johnson (1982-1984): Eucalyptus: callus production • Duratex Florestal and CAFMA Agrícola (1984-1990): Eucalyptus (clonal micropropagation and in vitro selection) and Pinus (micropropagation and rooting) • Brazilian Venture Capital (1986-1991): a) pineapple micropropagation; b) strawberry micropropagation and mother plants production c) banana micropropagation for virus free mother plants d) Aloe vera micropropagation (Fazenda California) (2006) • Citrovita Agrícola (Votorantim Group) (1989-1992) citrus micrografting • Citoplanta (1991-1992): strawberry micropropagation; mother plants and fruit production • Cia Suzano de Papel e Celulose (1993-1997): isoenzymes for characterization of in vitro propagated forest trees. • Agricultural Producers (1995-1998): fruit (banana) micropropagation

Source: Department of Biological Sciences, Esalq.

Even though presenting similar roles in terms of scientific duties, the complementary nature of these units has not induced competition among the scientists involved in each of these areas, given the complementary character of their roles within FORESTS. Nevertheless, the characteristics of these units have been determinant for the further events that took place as the Project advanced. The Max Feffer Laboratory of Genetics holds three patents, two of them related to joint long-term R&D projects carried out with Suzano. The Department of Genetics itself is Esalq's Department that holds the highest number of patents associated to their full-time faculties, according to CNPq's database of Brazilian researchers, known as *Plataforma Lattes*. On the other hand, the faculties of the Department of Biological Sciences have very few patents associated to them, as well as low cooperation ties with industry. Professor Carrer is among the few professors holding patents in that Department. She holds 4 out of the 9 patents associated to the Department's full-time professors. Nevertheless, as mentioned before, these patents are associated to findings of Prof. Carrer's related to her PhD thesis in the U.S., having no connections with her current research activities at CEBTEC or at the Department of Biological Sciences.

The Max Feffer Laboratory has played a pivotal role together with Suzano in the seminal stages of the Project, given that both of them have previously cooperated in the same areas as that explored by the FORESTS' network, being thereby much advanced than the other partners in terms of knowledge with economic potential to be developed in the applied genomics area. Before, during and even after FORESTS' Phase I, they have cooperated, patented and further developed genes with economic importance for the industry, most of which internalized by Suzano by means the licensing of patents issued by the Department of Genetics through the Laboratory headed by Prof. Labate.

The role of CEBTEC, on the other hand, has been more oriented – apart from the coordination role of Prof. Carrer – to the application of the basic research inputs required by the team of scientists headed by Prof. Carrer so that to proceed with the sequencing phase of the DNA of the Eucalyptus

plant required in the first stage of FORESTS. CEBTEC has though had a primary role, contributing to knowledge inputs required for achieving the desired final outcomes of the Project. The Max Feffer Laboratory was thence more related to the outcome sought by the Project network, although a series of events have determined its exit from FORESTS. CEBTEC has followed suit as RORESTS Phase I reached its end.

4. The Evolution of the Project

FORESTS' governance structure was divided into two main bodies: Technical and Deliberative. The prior is subjected to the latter. The University labs are members of the prior, without veto decisions in the latter. The Deliberative body is controlled by FAPESP and is significantly influenced by the participating companies, in particular by Suzano and by Votorantim.

Having as a main objective the improvement of the efficiency and production conditions of wood and other products derived from the Eucalyptus plant, the information and knowledge created throughout Phase I was not readily available to the scientific community and to industry segments. Neither participating university research units nor the industry partners could have made individual utilization of the information obtained without formal consent of FAPESP. The main objective of this decision regards the need to understand the most suitable means for the collective appropriation of the knowledge obtained, together with the strategy needed to exploit this knowledge in economic terms (patents filling, licensing etc.).

As the result of Phase I, there were obtained 112.152 sequences of DNA of the Eucaliptus *grandis* species (the most important for economic exploitation). At the end of this Phase, the Project was ready to proceed with Phase II that started in 2003, whose aim was to identify the genes with an economic development potential.[ii] An intellectual property agreement was signed with the participating companies and the two universities involved, with R$ 1,2 million dedicated to this second Phase, in a co-investment agreement set up by FAPESP and the participating companies. In Phase II there were analyzed 28,000 genes previously mapped in Phase I, which were compared with other genes already mapped and readily available in other databases.[iii]

External scientists, by means of signing up a "confidentiality agreement", can freely browse the database developed as a result of the Eucalyptus DNA sequenced in Phase I so that to identifying matters of potential interest to be further exploited. There is a current discussion, not yet resolved, on who will detain the ownership of this database. Evidences indicate that FAPESP is claiming the ownership and the firms in the consortium are resisting to it.

As concluding evidences for this Section, given the indications brought about so far by the interviews carried out and the extensive review of media information, both printed and online, the project achievements can be divided on two groups. The first group is the one more politically engaged in the project, with a strong science-based profile and a consolidated vision that FORESTS was designed as a scientific project, whose achievements have been fully met up until now. The main aspects related to this view are summarized as follows:

- The Project was successful and is in line with the objectives previously established.
- The main FORESTS objective was to stimulate a sort of pre-competitive debate, being such the *raison d'etre* of a consortium of this nature.
- FORESTS is a long-term project. Its main characteristic is that it was a sort of "starter" in terms of making more mature in the country the university-industry relationship rooted in scientific skills.
- FORESTS main goal is to build a critical mass around the theme, very much necessary to put forward future projects of this magnitude.

The second group has a more critical vision of the Project. Its motivations are related to the fact that FORESTS should have been an initiative capable of transforming the nature of University-Industry relations in the country. In this account, the Project presents significant market development potential in all directions ranging from intellectual property rights management to other technology transfer issues, such as start-up development, as well as the fact that it should have been a "best practice" example to other Universities (and even other units within Esalq) who have a more traditional vision of the nature of the relationship of the university with its surrounding environment – industry included. That is to say, this view sustains the belief that FORESTS should have contributed to building up a more entrepreneurial (and responsive) university as well as a more targeted research agenda for universities, including in it a less stereotyped view of academics within industry segments. The elements pointed out to sustain this view are described as follows:

- There has not been prior discussions on what comes before and after competition among the partners. This aspect has a strong influence in subsequent issues such as: intellectual property rights and information and knowledge management. These issues are among the aspects that undermined the continuum of the high-caliber network established in Phase I and no longer available in the Projects' succeeding Phases.
- No patents have been filled or issued throughout phases II and III.
- As a spin-off of the Database utilization, there was developed a software for the optimization of genomic expression on eucalyptus. This software was developed by professor Marcelo Menozzi from the University of Campinas (Unicamp). None of the previous FORESTS members detain any proprietary rights (or equity) in the product developed by this researcher. This software was developed upon knowledge obtained for free in the FORESTS database.
- The Database developed is being used by external researchers to identify regions for the promotions of genes in the DNA of the Eucalyptus plant. This represents some indications of future economic benefits, although none of the external scientists carrying out their research with information obtained from the database have paid for it. Moreover, no contractual terms have been established to secure ownership for FORESTS partners as well as the consequent economic exploitation strategies for the knowledge produced.

5. Main Results

The year 2003 seems to have been critical in the further evolution of FORESTS. Two key players in the Project, the participating units of the Department of Genetics and of the Department of Biological Sciences left it in that year, stating their scientific role in the Project has been fulfilled as Phase I was concluded. The Department of Genetics, by means of prof. Labate's Max Feffer Laboratory – has stable collaboration ties with Suzano, since 1997, and keeps collaborating with it in joint basic and applied research projects. This Department has no prior cooperation records with Votorantim. The Department of Biological Sciences, in particular its Centre for Agricultural Biology (CEBTEC) – as before joining the Project – has no significant R&D ties with any of the firms participating in FORESTS. No partnering firms have yet withdrawn the Project, although after 2007 there will be only three participating firms, given that Suzano and Votorantim acquired Ripasa in 2005.[iv] Between 2002 and 2003 Votorantim announced the launching of three new start-ups exploring business segments considered transversal to the knowledge and experience gained by FORESTS scientific and industrial partners. Additionally, after the withdrawal of the Dept. of Genetics and of CEBTEC, there was included in the Project the Department of Fitopathology, which has closer scientific ties with Votorantim than with the other participating companies.

The evidences obtained so far indicate these complex exit and entry nodes, combined with a lacking governance structure capable of setting up clear roles, objectives and reward-systems for its

scientific and industry partners, paved the way for recurring spill-overs of strategic information which started to increase in value as the Project took its way through. Given there were no established means to secure the protection of intellectual property arising out of the knowledge developed through the R&D processes carried out in the different – and to a certain extent competing – Esalq Departments, the two main participating firms, Votorantim and Suzano, started to control information provision that could have a potential value to one-another. As information is a fundamental input of knowledge, and the achievement of information with potential economic value tends to be mostly tactical – dependent on quality interactions of individuals rather than on technical books and manuals – firms tended to hinder the interaction and communication among the different Departments participating in the Project, mostly driven by lack of trust and moral hazard concerns.[v] In circumstances as such, every one tends to blame on the other for the Project's change of focus, though it seems these limitations in the Project lied more in its inception and design, rather than in its course of development.

These major shortcomings, which *per se* can undermine the long-term perspectives of such a complex R&D consortia, seemed not to be the sole elements behind the Projects' deviation from its nature and objectives. After these events, the Project's Deliberative Board presided by FAPESP started to reduce investments in acquisition of new equipment and research material required by the scientists involved in the Project. Given all of these circumstances, the Project lost its economic focus and became, even though not formally admitted by its business and scientific partners, a Project with important scientific relevance though limited economic exploitation prospects. As a consequence, FAPESP decided to make the results of the sequences obtained by Phase I in a database open to the general public, in this sense informally declaring the Project's definitive loss of business prospects. Below follows a shortlist of the most important events sustaining this view:

- The pre-project interaction with private companies is determinant for the success of a university-industry initiative. Apart from the Max Feffer Laboratory of Genetics, no other Esalq unit involved has had long-established relations with FORESTS private partners. This allowed the Department of Genetics to withdraw the Project, though without compromising its R&D ties with Suzano. The CEBTEC remained as before, collaborating with industry on an ad-hoc basis for basic research inputs, fundamentally funded by public science foundations. For both Max Feffer Lab and CEBTEC, the nature of involvement of these units was fundamentally science-based, having their participation fulfilled as Phase I reached its end.
- The fact that the project had two very competing companies (Suzano and Votorantim) with differing R&D agendas and market strategies also posed very critical barriers for a more fluid knowledge and information flow among the partners involved. There were identified conflicts of interest between these two companies in the course of the project, with both imposing informal barriers for information sharing, thereby creating lack of trust which also influenced how the partners viewed the Max Feffer Laboratory, given its prior ties with Suzano. The latter then decided to keep collaborating in the Project, though working independently with Max Feffer Laboratory. In the same token, Votorantim supported the creation of start-ups run by former AEG Network researchers, whose knowledge obtained by their participation in FORESTS and AEG seemed important (though not fundamental) inputs driving their decisions to start-up new business so that to explore the economic potential of their innovative ideas.
- The evidences obtained also indicate that the shortcomings presented in this Section were further complicated by the way every actor interprets the nature of University-Industry interactions. The partners interviewed stated that academic culture regarding university-industry research is poor still prevails. In certain circumstances it happens that one sees the other with disregard. The prior for the "triviality" of the problems of industry that do not encourage scientific curiosity, and the latter for the alleged scientists' lack of short-term

vision and understanding of the practical (applied) needs of industry. This can be verified in any circumstance where universities and firms need to put together in joint projects, not only in Esalq. Though, when things go wrong, it is natural that these views tend to be aggravated, undermining trust and long-term collaboration perspectives.

6. Conclusions

The shortcomings with FORESTS regarded neither money nor lack of qualified skills in both university and industry sides. On a scientific merit standpoint, the Project can be taken as successful, given that publications were made in renowned journals, and information and knowledge arisen out by the interaction with these heterogeneous agents is being made available to the scientific community external to the Project. Though, in its inception, the Project was marketed in the media and also designed as a joint collaborative project that could significantly use the inter-disciplinary knowledge embedded in genomics for increasing the competitive advantage of the cellulose and wood industries. In that sense, the Project failed in its societal objective, since its beginning. Clear rules were not established before the Project started; intellectual property rights were not defined. The Project's expected outcomes were not properly set up. The major motivations behind this reasoning, together with important lessons to be learnt, are presented as follows:

- It is important to define "joint" work methodologies so that to making different (and competing) interests converge into a shared long-term optics. There was no convergence of interests, given that the stakeholders involved did not know exactly how they could benefit from the Project. It seems clear that the four companies involved in FORESTS joined it to reduce the possibility for being caught *out of the game* in case something of value could have been developed in the course of the Project (the "take or pay" strategy).
- Nobody knew the benefits they could have by joining the project. Even though they had known such in certain terms, there were no defined methods to explain how they could have been achieved as well as how the outcomes would have been shared.
- Timing was a fundamental constraint, due to the historical university-industry conflicts. The former has a long-term view and the latter is constrained by short-term results. The lack of clear rules paved the way for secrecy and lack of trust as fragments of (potential) knowledge came into sight in the course of the project. Among the scientists engaged in FORESTS, all of them seemed to be conscious on the importance of joint University-Industry R&D for sustainable development. Nevertheless, these players claimed that initiatives of this magnitude need to be founded upon clear rules and a shared long term view. Again, the "raw material" for such a relationship is empathy (trust), which takes time to be built.
- Esalq is not yet institutionally prepared to take on complex projects requiring competencies for dealing with technology transfer issues and the negotiation of intellectual property rights. The USP Innovation Agency has been founded less than one year ago with this purpose. In Piracicaba, where Esalq is situated, the Innovation Agency is still working towards becoming known within Esalq departments, labs and diversified units, explaining their role in the USP system so that to qualifying the existing channels in terms of introducing tech transfer issues, technological entrepreneurship concepts and strategies, as well as on convincing academics on the relevance of research results valorization methodologies. Moreover, there is only one expert (innovation agent) serving the whole Esalq system. Information regarding more complex and legal issues has to be dealt with the other experts located in the USP campus in São Paulo, more than 150km away from Piracibaca.
- Up until now, it is the researcher the one who negotiates with companies. Researchers, by their own nature, lack the business and legal knowledge required to negotiating in balanced terms. The University – and in this case the USP Innovation Agency can help – must build

the foundations to support them in this sense, given that in such a current configuration it is the private firms who obtain most of the value from the object of negotiation.

- There is a growing critical mass being formed in Esalq's scientific R&D structures, though more work will be needed to convince scientists that a more oriented research agenda made possible by joint collaboration with industry is important. Brazilian research-universities like Esalq itself have the required resources, expertise and willingness to carry out more focused research, with more significant societal impacts. The direction (and regular flow of financial resources) provided by the private sector in this account is fundamental.
- The prevailing structure in State Universities in Brazil still imposes the most significant barriers, becoming fundamental the need to define clear rules and to prepare its related administrative staff with intellectual property expertise. Additionally, State Universities' "political" academic boards need to be more concerned on the importance of the subject to society at large and on how they can benefit from it. The USP Innovation Agency seems to be working in this direction. Though, unless best practices arising out of such interaction do not become diffused, it will take a generation shift to see it widespread in Brazilian University structures.
- The public sector needs to change its evaluation criteria underlying the decisions behind R&D support projects, as the European Union has done since 2000. It is important to reduce the sole and dominant presence of academics in R&D public support agencies, by means of the inclusion of non academic experts into the board that evaluates and discusses collaborative proposals submitted for approval. Before a financing decision to collaborative projects take place, it is important to discuss the potential societal implications of the project, in terms of its impacts to firms, markets and people at large, depending on the case. The public sector needs to establish clear rules, defining how (and why) the project will be good for society, for the university and for the private sector. This is the essence of collaborative R&D projects with a potential for contributing to sustainable development.

University-industry cooperation is being acknowledged today as a fundamental pillar of sustainable development, given the externalities arising out of such cooperation in terms of learning opportunities, shared resources and competences put together for achieving common objectives. Before FORESTS, no other similar research consortia have been experimented in the field in Latin America. As a pioneering experience involving heavy-weight actors in industry and in academy in the fields of cellulose and of applied genomics, FORESTS has contributed to important scientific achievements in the area, as well as to increasing the competitiveness of the industry partners involved. The major aspect to be considered, though, was that the economic value generated by this Project has not been collectively appropriated, being thereby split in bits of knowledge used and hindered by each of the partners. The question on whether or not the investments in time and money made by each Project partner has been sufficiently paid off by the results individually obtained is though beyond the scope of this case study.

Complex networks involving universities and firms, as the one created by FORESTS, have the potential to overcome institutional barriers usually found in projects of this magnitude, allowing it to more easily promoting important institutional changes necessary for initiatives like this to take effect. The governance structure of a project like FORESTS is usually above rectors and scientists of universities, bureaucrats of public agencies, and business people alike. In such circumstances, important measures that need to be discussed and them *pushed* from up side down so that to promoting important environmental changes for removing the traditional barriers hampering university-industry cooperation could have been promoted since the Project's seminal phase. In this sense, an interesting opportunity seems to have been lost at the moment of putting together so many heterogeneous actors from university, industry and government.

For large and complex projects, as FORESTS itself, the benefits must be internalized to all the actors involved, otherwise it is worth collaborating on an *individual firm-laboratory(ies)* basis rather than putting large competing firms and heterogeneous researchers together. The cooperation model pursued by the Max Feffer Laboratory of Genetics and Suzano, in which graduate students are encouraged since the beginning of their careers to take on basic and applied research with industry, jointly discussing methodologies, intellectual property rights and prospective rewards, indicates a potentially growing trend for academy in Latin America that needs to be strengthened and properly supported by both university structures and public authorities. As the experience with both Prof. Carrer's CEBTEC of and Prof. Labate's Max Feffer indicate, cooperation with industry is increasingly becoming mature in Brazil, being thereby important for university structures for dealing with industry in balanced terms as well as to understand how every one can benefit in the short and long-term from such a cooperation.

Annex I – Institutions and People Interviewed.

	Name	**Position / Institution**
1.	Carlos Alberto Labate, PhD.	Professor, Department of Genetics, Esalq.
2.	Daniel Dias	Innovation Agency, USP.
3.	Esteban Roberto González, DSc.	Researcher, Biotechnology Division, Suzano Papel e Celulose.
4.	Helaine Carrer, PhD.	Professor, Department of Biology, Esalq.
5.	Luis Eduardo Aranha Camargo, PhD.	Professor, Department of Fitopathology, USP-Esalq.
6.	Mônica Labate, PhD.	Researcher, Department of Genetics, Esalq.
7.	Shinitiro Oda	Manager, Biotechnology Division, Suzano Papel e Celulose.
8.	César Augusto Bonini	Research Manager, Votorantim Celulose e Papel.
9	Jesus Ferro	Director, Alellyx Applied Genomics

[i] The other events – internal to the Project – that took place throughout Phase I will be analyzed in this work. An external event that will not be treated herein regards the launching of an initiative founded on the FORESTS guiding principles and logic, though with a national focus instead of one restricted to São Paulo State institutions and firms. That project, still underway and called Genolyptus, was backed by the Brazilian Ministry of Science and Technology (MCT) and is being carried out by EMBRAPA (the Brazilian Agricultural Research Corporation) with a consortium of seven universities and twelve Brazilian firms (of which Suzano and Votorantim). Moreover, during the course of the FRESTS Project, although not necessarily related to it, three start-ups have been created to explore knowledge gaps in the fields of genetic improvement of plants, or applied genomics. The peculiarity of this event lies in the fact that these enterprises have explored in their seed phases – directly or not – knowledge produced by researchers engaged in the Genoma/FAPESP program, from which FORESTS has been derived. Furthermore, these companies have been backed by Votorantim Ventures (or Votorantim Novos Negócios), which is the investment company controlled by Votorantim, one of the four companies participating in FORESTS. Votorantim Ventures` mission is to seek and to invest in new firms and ideas that contribute to increasing the market share of the Votorantim Group in its many business segments.
The first of these companies was Allelyx Applied Genomics, founded in April 2002. Allelyx, an acronym for Xyllela – the bactery which DNA was fully sequenced and mapped by AEG network partners – is expected to receive R$ 30 million worth of investments in the next four to six years. One month after its foundation, Votorantim Ventures announced the birth of another start-up, Scylla, operating in the bioinformatics sector. One year later, Votorantim Ventures then presented its third firm operating in the biotechnology business, Canavialis. This firm is expected to receive R$ 25 million to consolidate its mission: becoming in the next years a market leader the development and introduction of new varieties of sugar-cane with the support of molecular biology and biotechnologies.

[ii] According to Helaine Carrer, one of the scientific Project coordinators,"dessas 112.152 seqüências, obtidas aleatoriamente, muitas se expressam da mesma forma em diferentes tecidos e, portanto, são decodificadas mais de uma vez. Utilizando alguns parâmetros e a bioinformática, é possível identificar e agrupar essas seqüências semelhantes. O trabalho já foi realizado e as cadeias foram distribuídas em cerca de 27 mil grupos. Comparando nossas seqüências com as disponíveis no banco de dados internacional, descobrimos que aproximadamente 15 mil grupos são parecidos aos já identificados. Então temos 12 mil grupos sem nenhuma correspondência. Esses são de muito interesse, pois devem ser genes específicos da árvore, podendo representar processos metabólicos exclusivos do eucalipto".

[iii] These genes that were considered worth exploring throughout Phase II are related to the genesis of the wood and its resistance to sicknesses and plagues, as professor Carlos Alberto Labate of the Department of Genetics stressed.

[iv] It is important to mention that, on February 2007, Suzano has bought Votorantim's patcipation in Ripasa, being hereby the sole controller of the company.

[v] As a much diffused term in the Economics jargon, *moral hazard* can be understood as the risk that the presence of a contract will affect on the behavior of one or more parties. The risk a money borrower will use the funds obtained to carry out illegal or any other activity that will increase the lender's expected risk in the transaction constitutes moral hazard. In the case object of this study, moral hazard is interpreted as the risk a project partner faces by providing information to the other part which will (would) use it to unclear purposes. The lack of clear rules and loosing governance issues taking place in complex interactions with heterogeneous stakeholders increase the risk of moral hazard.