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Estratégias de apropriação de valor: conectando a visão baseada em recursos à
teoria de direitos de propriedade

Value appropriation strategies: linking the resource based view to the property rights theory

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Value appropriation strategies: linking the resource based view to the property rights theory

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RESUMO

Sá, C.D. de (2018). *Estratégias de apropriação de valor: conectando a visão baseada em recursos à teoria de direitos de propriedade*. (Tese de doutorado). Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo. São Paulo.

Esta tese de doutorado examina as estratégias de apropriação de direitos de propriedade intelectual (DPIs), desenvolvidas e adotadas pelas firmas. O estudo argumenta que a abordagem teórica tradicional sobre o assunto, que é baseada no trabalho seminal de Teece (1986) “Lucrando com a inovação tecnológica”, não é adequada para circunstâncias não triviais, fora do setor industrial e manufatureiro, governadas por DPIs *sui generis*. Para entender os esforços de apropriação de DPIs realizados pelas firmas inseridas nesses ambientes peculiares, este estudo sugere a integração da Teoria de Direitos de Propriedade com a abordagem estratégica da Visão Baseada em Recursos. Baseia-se na perspectiva da Economia dos Direitos de Propriedade, especialmente no trabalho de Barzel (1997), que conceituou os recursos como uma cesta de atributos para os quais individualmente podem ser atribuídos direitos de propriedade. Partindo dessa definição, que foi estendida por Foss e Foss (2005, 2006), com o argumento de que a habilidade do detentor do recurso em extrair e sustentar valor depende se o mesmo detém direitos de propriedade garantidos sobre o atributo relevante, propõe-se o desmembramento dos atributos dos recursos, como estratégia para apropriação de valor. Com o intuito de testar as proposições teóricas eu desenvolvi um estudo de caso duplo que compreende o melhoramento vegetal de soja e algodão no Brasil. Para situar o leitor neste contexto empírico, um dos capítulos da tese explica as dimensões organizacionais, institucionais e competitivas do setor de melhoramento de sementes. O estudo de caso foi conduzido por meio de entrevistas semiestruturadas com obtentores de plantas e complementado com estatísticas descritivas sobre o tema, a partir de dados oficiais. O principal achado da pesquisa refere-se à ideia de que o acesso aos direitos econômicos de um recurso pode ser desmembrado por meio do acesso à alguns atributos relevantes, para os quais podem ser atribuídos direitos de propriedade individuais. Por sua vez um indivíduo ou firma pode se beneficiar da proteção superior conferida por apenas um único atributo relevante do recurso. A tese se encerra com reflexões gerais sobre as implicações deste achado e particularmente em relação ao futuro do melhoramento de plantas no Brasil.

Palavras-chaves: estratégias, direitos de propriedade, apropriação, sementes, melhoramento genético.

ABSTRACT

Sá, C.D. de (2018). *Value appropriation strategies: linking the resource based view to the property rights theory*. (Doctoral dissertation). Faculdade de Economia, Administração e Contabilidade, Universidade de São Paulo. São Paulo.

This doctoral dissertation examines alternative appropriation strategies of intellectual property rights (IPRs), developed and adopted by firms. The study argues that the traditional theoretical approach used to address this issue, based on Teece's (1986) seminal paper "Profiting from technological innovation", is not suitable for non-trivial circumstances, outside the industrial and manufacturing sector and which are ruled by *sui generis* IPRs. To understand the IPRs appropriation efforts undertaken by firms within these peculiar environments, this study suggests the integration of the Property Rights Theory with the Resource Based View approach to Strategy. It is based on the perspective of Property Rights Economics, particularly on the work of Barzel (1997), who conceptualizes resource as a bundle of attributes for which property rights may be granted. Resting on this definition, which was extended by Foss and Foss (2005, 2006), who argue that the resource owner's ability to extract and sustain value depends on whether he holds secure property rights over the relevant attribute, I propose the unbundling of the resource attributes, as a strategy to appropriate value. To test the theoretical propositions, I developed a double case study on the soybean and cotton seed breeding in Brazil. To place the reader in this empirical setting, a chapter explains the organizational, institutional and competitive dimensions of the seed-breeding sector. I carried out the double case study through semi-structured interviews with breeding firms, complemented by some descriptive statistics of official data. The main finding of this dissertation refers to the idea of accessing economic rights to a resource that can be dismembered in few attributes, to which individual property rights are assigned, and then benefit from the superior protection offered by one single relevant attribute. The dissertation ends with some reflections on the implications of this finding, on a general basis and particularly regarding the future of seed breeding in Brazil.

Keywords: strategy, property rights, appropriation, seed, plant breeding

TABLE OF CONTENTS

1	INTRODUCTION.....	17
1.1	Relevance.....	18
1.2	Method and research structure.....	20
2	BRAZILIAN SEED SECTOR: ORGANIZATION, STRUCTURE AND PROPERTY RIGHTS.....	23
2.1	The Brazilian seed sector.....	24
2.2	Organization and competitive structure in the seed industry	29
2.3	IPRs of plant varieties	41
3	VALUE APPROPRIATION: LINKING RESOURCE-BASED VIEW TO PROPERTY RIGHTS THEORY	49
3.1	Traditional theoretical approach to the issue of IPRs appropriability	49
3.2	Property rights theory for expanding RBV's strategic dynamism	54
4	SOYBEAN AND COTTON BREEDING: AN EMBEDDED DOUBLE CASE STUDY. 69	
4.1	Research Method	70
4.2	Research Design	71
4.3	Data Collection.....	73
4.4	Data Analysis.....	78
4.5	The soybean and cotton seed breeding clinical cases.....	79
5	DISCUSSION AND CONCLUSIONS	103
5.1	Results and discussion.....	103
5.2	Conclusions	107
5.3	Final remarks	108
6	REFERENCES.....	115
	APPENDIX A – Interview script	129

LIST OF ACRONYMS AND ABBREVIATIONS

ABRASEM: Associação Brasileira de Sementes
BRASPOV: Associação Brasileira de Obtentores Vegetais
BF: breeding firm
CADE: Conselho Administrativo de Defesa Econômica
COODETEC: Cooperativa Central de Pesquisa Agrícola
CR4: four-firm concentration ratio
CRISPR-Cas9: kind of genome editing technology
DNA: deoxyribonucleic acid
EMBRAPA: Empresa Brasileira de Pesquisa Agropecuária
GM: genetically modified
GMOs: genetically modified organisms
GPT: General Purpose Technologies
HHI: Herfindahl-Hirschman Index
IMAMT: Instituto Mato-grossense do Algodão
INPI: Instituto Nacional de Propriedade Industrial
IPP: intellectual property protection
IPRO: Intacta RR2PRO
IPRs: intellectual property rights
ISF: International Seed Federation
KBV: Knowledge Based View
LL: Liberty Link
LPC: Lei de Proteção de Cultivares
MAPA: Ministério da Agricultura Pecuária e Abastecimento
MNCs: multinational Companies
M&A: mergers and acquisitions
NBTs: new breeding technologies
OECD: Organization for Economic Co-operation and Development
PBI: precision breeding innovation
PBRs: plant breeder's rights
PFI: profiting from technological innovation
PVP: plant variety protection
RNC: Registro Nacional de Cultivares
RBV: Research Based View
R&D: research and development
RNA: ribonucleic acid
RR: Roundup Ready
SISZARC: Sistema de Zoneamento Agrícola de Risco Climático
SMEs: small and medium-sized enterprises
TMG: Tropical Melhoramento & Genética
SNPC: Serviço Nacional de Proteção de Cultivares
TRIPs: Agreement on Trade-Related Aspects of Intellectual Property Rights
UPOV: International Union for the Protection of New Varieties of Plants
WIPO: World Intellectual Property Organization
WTO: World Trade Organization

LIST OF FIGURES

Figure 1 - Generic chain of commercial seed production in Brazil.....	25
Figure 2 - Cotton and soybean GM seeds adoption in Brazil.....	26
Figure 3 – Market share of the commercial soybean seed sector in the crop season 2017/18.	33
Figure 4 – Market share of the commercial cotton seed sector in the crop season 2017/18	36
Figure 5 – Brazilian utilization rate of informal seeds in soybean and cotton	44
Figure 6 – Illustration of the theoretical model	68
Figure 7 – Description of alternative IPRs appropriation strategies	87
Figure 8 – Participation of soybean seed technologies in the seed commercial production area in the crop season 2017/18	95
Figure 9 – Historical series of soybean protection certificates issued since the enactment of the Brazilian PVP Law	96
Figure 10 – Share of the IPRO varieties in the protected portfolio of breeding firms	97

LIST OF TABLES

Table 1 - Models of producing agreements between breeders and seed producers	28
Table 2 – Economic importance of the agricultural crops chosen for the case studies	71
Table 3 - Overview of the organizations interviewed and summary of data collection strategy...	75
Table 4 - Soybean breeding firms and their competitors.....	79
Table 5 - P&D partnerships and alliances	80
Table 6 - Comparison between number of varieties protected and registered (soybean).....	81
Table 7 – Modes of royalty collection.....	82
Table 8 – Breeding firms involvement against IPRs infringement	85
Table 9 – Alternative IPRs appropriation strategies adopted by soybean breeders in Brazil ..	88
Table 10 – Comparison between number of varieties protected and registered (cotton).....	99
Table 11 – Alternative IPRs appropriation strategies adopted by cotton breeders in Brazil..	100

1 INTRODUCTION

In 1972, in his book chapter on economic welfare and the allocation of resources for invention, Kenneth Arrow was the first to express concern about the appropriation of rents from invention and research. As he highlighted, leakage of knowledge from the organization that produced it could threaten the appropriation. At that time, Arrow mentioned “suitable legal measures” – like legally imposed property rights - as a tool to foster rent appropriation, but not sufficient to provide a thorough appropriation.

A proper depiction of Arrow's (1972) concern is the case of the seed industry, where the ease of plants' replication limits the markets for commercial seeds, as it enables farmers to reproduce seeds themselves, thus rewarding breeders' inventions only partially.

Dixit (2009) claims that when the government does not properly safeguard private property rights, alternative arrangements arise. In other words, individuals and firms often find ways of changing the terms of their formal and informal contracts, in order to avoid the adverse effects of weak institutions (Acemoglu & Johnson, 2005).

Therefore, to protect the results of their innovations firms may invest in alternative appropriation mechanisms. Through this dissertation I sought to understand the efforts of plant breeding firms targeted to farmers, aiming to ensure value appropriation generated by the improvement of new varieties of plants. Thus, I tried to answer the following question *What are the strategies adopted by breeding firms to appropriate rent from their intellectual property rights?*

Some authors distinguish appropriation mechanisms within two categories: legal and strategic (Arbussà & Coenders, 2007; Delerue & Lejeune, 2011; Milesi, Petelski, & Verre, 2013), while others like Leiponen and Byma (2009) refer to them as formal and informal mechanisms. Among the group of legal or formal mechanisms are patents, trademarks, copyrights and other forms of protecting intellectual property rights (IPRs). Strategic, informal or alternative mechanisms comprise investments in complementary assets, such as marketing, sales effort and customer service, secrecy, lead time, the relative complexity of products and quickly moving down the learning curve (Arbussà & Coenders, 2007; Cohen & Levinthal, 1989; Leiponen & Byma, 2009; López & Roberts, 2002; Teece, 1986; Winter, 1998).

1.1 Relevance

Despite the existence of a substantial amount of empirical work that discusses and compares the different labels that refer to the firms' efforts to protect the returns from innovation - in other words, different means to protect IPRs -, there is still room to further extend the understanding of this phenomenon, since conditions of appropriability vary across industries, and so does the efficiency of the appropriation instruments. In some circumstances, legal protection is effective, while in others strategic mechanisms are more suitable (Levin, Klevorick, Nelson, & Winter, 1987; Mansfield, 1986). Also the effectiveness of these strategies varies according the sector in which the firm operates and the nature of the protected innovations (Arundel, 2001; Cohen, Nelson, & Walsh, 2000; Gallié & Legros, 2012)

As noted by Lopez (2009) and Milesi *et al.* (2013), in the particular case of non-manufacturing sectors, as well as in developing countries, very few studies address this subject. Lopez (2009) especially emphasizes the case of services and agriculture, where specific IPRs protection mechanisms are in place but very little is known.

Most scholars explore the use and effectiveness of different appropriability strategies at the firm and industry levels, supported by the Knowledge Based View (KBV) approach. David Teece's 1986 paper on profiting from technological innovation, and his subsequent studies on the issue (Sherry & Teece, 2004; Teece, 1996, 1998a, 1998b, 2000, 2002; Teece, Rumelt, Dosi, & Winter, 1994) form the basis of this approach. Roughly speaking, this literature prescribes that the firm should develop appropriate vertical integration and complementary asset positions, given the existing appropriability regime and the nature of the technology to be protected (Pisano, 2006).

This approach is very useful and much used to explain three kinds of appropriability circumstances, namely: (i) competition – when firms make efforts to protect product innovations from imitation by (potential) competitors (Hurmelinna-Laukkanen & Puumalainen, 2007; Laursen & Salter, 2014; Teece, 1986), (ii) business to business situations, like interactions between providers of knowledge intensive business services and their client firms or strict outsourcing situation (Arora & Ceccagnoli, 2006; Leiponen, 2008; Miozzo, Desyllas, Lee, & Miles, 2016; Pisano, 1990; Verwaal, Commandeur, & Verbeke, 2009; Ziedonis, 2004) and (iii) Research and Development (R&D) strategic alliances and networks – when firms

engage in collaboration to perform R&D activities (Baldwin & Henkel, 2014; Laursen & Salter, 2014; Leiponen & Byma, 2009; Manzini & Lazzarotti, 2015; Oxley, 1997, 1999; Ritala & Hurmelinna-Laukkanen, 2009; Stefan & Bengtsson, 2017; Teece, 1986; Veer, Lorenz, & Blind, 2016).

However, despite the relevance of these contributions, I argue that this phenomenon – appropriability strategies – can be addressed in a different way, for two reasons. The first reason is that the existing literature lacks of a perspective on appropriability mechanisms to address weak institutional conditions in regard to the firm’s consumer’s compliance. Actually, this perspective has received little attention in the existing body of strategy theories¹.

Some kinds of creative goods, like luxury apparel and accessories, are often difficult to create but easy to copy. It is well known that in the luxury fashion industry copiers typically free ride on creators’ efforts. This is also the case of the Brazilian seed industry, which is the empirical context that I chose to address in this dissertation.

The second reason why I argue that appropriability strategies deserve a different theoretical approach relates to this peculiar empirical context. It embraces a situation of analysis, where the appropriability conditions, as well as the nature of the technology, are non-trivial compared to the traditional IPRs’ systems at the industrial and manufacturing sectors. Brazilian seed industry offers an experimental setting that appears to be fruitful in addressing an important topic laid aside by the Research Based View (RBV).

As I discuss in detail in Chapter 3 of this dissertation, RBV, although one of the most important theories concerning the strategic choices of the firm, is criticized in a specific aspect. According to Foss and Foss (2005) and Kim and Mahoney (2002, 2007), there is an improper implicit assumption in RBV, which is that once firms’ resources are valuable, rare, imperfectly-imitable and non-substitutable, the property rights of these resources are safeguarded. These authors argue that created value must be protected, due to the possibility of its dissipation.

In other words, RBV allows the examination of potential value creation, but leaves open the issue of creating real value. In order to analyze the ability of resource owners to create real

¹ Except for the papers by Conner & Rumelt (1991) and Shy & Thisse (1999).

value, one should be aware of the economic property rights that agents have control of, and how well these rights are outlined (Monteiro & Zylbersztajn, 2012).

There is an interface between the three lines that lead this dissertation - RBV's gap in explaining the real value appropriation; the chosen empirical context; and the unfitness of the existing literature to explore specific appropriability contexts.

As I show along Chapter 3, although plant breeders are able to achieve competitive advantage by improving an existing plant variety, value created in this process is not protected against the possibility of economic misappropriation by farmers, due to weak appropriability conditions (institutional environment and ease of replication). Hence, they need alternative mechanisms. Such mechanisms, as I present throughout this dissertation, relate to the discovery of new attributes to resources in the relationship between breeders and the end users of their product, the farmers.

Therefore, the purpose of this research was to understand the efforts carried out by breeding firms to appropriate economic rent, concerning the farmers' compliance with IPRs. Putting in a very objective way, I sought to explore the governance modes of property rights in the Brazilian seed industry, by distinguishing different types of IPRs' appropriation strategies. Theoretically, the ultimate intention of this dissertation was to contribute to advance RBV on the issue of protecting firms' value creation through integration with Property Rights Theory.

In summary, this study is original in three ways. First, I examine appropriability arrangements in a perspective that has been neglected by Strategy scholars – costumer's compliance to IPRs. Second, I build the reasoning that supports IPRs appropriation strategies through the unbundling of the resources' attributes, while most studies do not even consider the partition of resources into attributes. Finally, it approaches an empirical context that has been little studied, namely the agricultural sector in a developing country².

1.2 Method and research structure

This dissertation is composed of five chapters, including this introduction. Chapter 2 presents the institutional and structural context of the Brazilian seed industry, which comprises the

² I found only two papers approaching the same empirical context – Endres and Goldsmith (2007), and Monteiro and Zylbersztajn (2015).

organization of the seed chain, an outlook of its local competitive structure, as well as the global. Regarding the competitive environment, I traced the recent merger and acquisition (M&A) wave in the biotech, agrochemical and seed sector in Brazil. I also present the institutional environment enfolding the seed sector, with attention to the legal framework that rules the business environment, and to the problem of rent appropriation experienced by the breeders, together with a description of alternative appropriation strategies reported in the literature.

In Chapter 3, I carry out a brief RBV literature review concerning value creation, followed by a RBV scrutiny on the value appropriation issue, followed by the analysis of literature insights on how property rights economics could complement RBV, regarding appropriation. Finally, I present some propositions related to appropriability in the seed sector, through attributes of resource unbundling along with property rights protection.

In Chapter 4, I respond to the propositions by undertaking an empirical research using the case study method, more specifically, a double case study comprising soybean and cotton breeding firms. In the first part of Chapter 4, I describe the research preparation and organization, with a detailed explanation about the research method, the research design, sampling, data collection procedures and data analysis. In the second part, I analyze all the information gathered through semi-structured interviews and available databases.

The empirical setting of thi study consisted of a double case study, comprising soybean and cotton breeding firms. Nine breeding firms were interviewed. These firms were individually analyzed and collectively compared. I also relied on triangulation of data from others sources to help validating my findings.

Chapter 5 addresses the discussion and conclusions of the double case study findings, and their contribution to the literature. I also present a section on concluding remarks that comprises considerations about the interrelationship between IPRs and market consolidation, theoretical and practical implications of the findings, limitations of the research and suggestions for further studies.

2 BRAZILIAN SEED SECTOR: ORGANIZATION, STRUCTURE AND PROPERTY RIGHTS

Intellectual property protection (IPP) enables people to earn recognition or financial benefit from what they invent or create (WIPO, 2018). Despite some controversies about its effectiveness in promoting innovation, productivity, international trade and economic development, the impact of strengthening IPRs was proved to be sector and technology specific (Dosi, Marengo, & Pasquali, 2006; Teece, 1986). Plant breeding is a source of scientific and technological innovation in the seed industry; therefore, it is object of IPP.

The institutional environment concerning IPRs that apply to the seed sector in Brazil is cause for debate, since it entails the possibility of legal reproduction of seeds by farmers, without the appropriate compensation to breeders. The result is that the rate of informal seed utilization in the Brazilian soybean and cotton crops – which form the chosen empirical setting - accounts for 29% and 43% of each seed market, respectively. Some experts claim that weak IPP may hinder the recovery of R&D investments, leading to the reduction of innovation in the sector (Clancy & Moschini, 2017).

Given this context, this thesis sought to understand the efforts of breeding firms targeted to farmers, with the aim to ensure value appropriation generated by the development of new plant varieties.

In the last 35 years or so, plant breeding and the commercialization of seeds have grown dramatically at the global level. The International Seed Federation (ISF) estimates an increase in international seed trade from less than one billion dollars, in 1970, to approximately 11.4 billion in 2016 (ISF, 2016). Campi and Nuvolari (2015) observe that the value of domestic seed markets has also been growing at a similar pace.

The total size of the world seed market is not well known, due to the difficulty of assessing the value of the informal market. The commercial seed market was estimated around USD 39 billion in 2013 (ETC Group, 2015), and approximately USD 48.5 billion in 2015 (Bonny, 2017)³. Market

³ Bonny (2017) presents a compilation from more than ten sources on the size of the global seed market, ranging from USD 26.2 to 64.1 billion.

study companies, in general, forecast a rapid growth of the seed industry in the next few years, with a compound annual growth rate that varies from 6.8% to 13.3% (Bonny, 2017).

I organized this chapter in order to present the institutional and structural context in which this dissertation develops. In the first section, I approach the productive and commercial dynamics of the Brazilian seed sector, highlighting the specific features of soybean and cotton seed crops. The evolution of genetically modified organisms (GMOs) is also described in this first part. The second section includes an outlook on the competitive structure of the seed industry, both domestic and global, since the second half of the years 2010 has experienced an intense consolidation process. The third section briefly presents the institutional environment of the seed sector. I give special attention to the legal framework that rules the business environment, and to the problem of rent appropriation experienced by breeders, which is crucial for the development of this thesis. Chapter 2 closes with a description of breeders' alternative appropriation strategies reported in the existing literature.

2.1 The Brazilian seed sector

The Brazilian seed sector annually negotiates around BRL 10 billion, and is the third largest in the world – behind USA and China. Between the crop season 2004/05 and 2015/16 it grew from 1.8 million tons to 4 million tons. Soybean seeds' share corresponds to 37%, while cotton represents 1% of the total, according to the Brazilian Seed Association [Abrasem] (2016)⁴. I illustrate a generic seed chain and its main transactions and relationships.

2.1.1 Characterization of the seed industry and its main transactions

Figure 1 shows a generic seed production chain including the main links, its transactions (T_n), and business flows.

⁴ Associação Brasileira de Sementes (Abrasem).

Figure 1 - Generic chain of commercial seed production in Brazil

Source: Based on Sá and Marino (2011) and Aviani and Machado (2015)

This dissertation explores the relationship between breeders and farmers in seeds' trading. As shown in Figure 1, the relationship in question is not straightforward. I gradually describe the main transactions carried out, in order to complete the seed flow from breeder to farmer:

2.1.1.1 Transaction 1

In 2013, the Brazilian government, together with higher education organizations and nonprofit agencies, spent BRL 2.7 billion on agricultural R&D (Flaherty et al., 2016)⁵. Seed R&D refers primarily to the conventional breeding activity performed by breeders. Conventional plant breeding is the foundation of the seed industry (Aviani & Machado, 2015). The authors explain that this activity merges the genetics of plants already in use by farmers with seed collections stored in seed banks, with the purpose of improving specific plants' attributes to better adapt them to different production challenges – like soil and climate conditions - that farmers face all over the world. In general, it comprises useful characteristics such as pest and disease resistance, drought tolerance and better yields.

Conventional plant breeding started with crop domestication, about 10,000 years ago. Since then, farmers and breeders have been developing and improving crops. Over time, plant

⁵ Research conducted by the private for-profit sector is not included, due to the lack of available data.

breeding advanced with the use of modern and sophisticated techniques. In the last 150 years, plant scientists and breeders have improved plant breeding on a scientific basis (ISF, 2017).

In the Brazilian context, R&D on soybean, cotton, corn, sugarcane and eucalyptus also involves the use of genetic engineering to produce GMOs. The use of genetic modified (GM) technology for the development of GMOs occurs through the inclusion of a foreign gene of interest in a particular species, which will express, in the end, the desired trait (feature) - (see T1 in Figure 1).

The use of genetic engineering in agricultural crops meets one of the following objectives: herbicide tolerance, resistance to pests and diseases, drought resistance and changes in the metabolism of plants, while including different nutritional attributes. The varieties improved through conventional breeding are vehicles for the GM technology. The year 1994 marks the arrival of this technological paradigm, with USA's launching of the first commercial GM variety.

According to the consulting firm Céleres (personal communication, January 3, 2018), in the 2016/17 crop season the adoption of GM seeds by soybean and cotton farmers reached respectively 96.5% and 78.3% of the whole planted area. Figure 2 shows the evolution of adoption.

Figure 2 - Cotton and soybean GM seeds adoption in Brazil

Source: based on Céleres' data (2018)

Both activities, conventional plant breeding and genetic engineering, can be performed, or not, within the same organization. Genetic engineering of seeds is an activity carried out by firms called biotechnology firms. These companies are, in general, Multinational Agrochemical Companies (Biotech Agrochemical MNCs), such as Bayer and Corteva, whose core business is the provision of agrochemical inputs, together with seeds⁶.

Usually Biotech Agrochemical MNCs have as business branches units that perform conventional breeding. Therefore, T1 may occur as a process within the same organization or as a licensing agreement - related to the use of the GM technology - between the biotech firm and the breeding firm. Ultimately, my empirical research focus is the relationship between the breeding apparatus and the farmer. Since the former are an independent, legal and accountable business unit, I will use the terms “breeder” or “breeding firm”, even in cases when the firm is part of a Biotech Agrochemical MNC.

2.1.1.2 Transaction 2

Seed producers are farmers who specialize in the production of seeds. Normally they establish a legal company and adopt a commercial brand to trade the seeds⁷.

Seed producers receive the basic seed from the breeders (T2) and carry out the reproduction into commercial seeds⁸. They represent an important link in this chain, and are responsible for strictly following the production guidelines received from the breeders to obtain a seed with the best possible quality. Moreover, frequently seed producers are the known face of the breeder’s product to the farmers.

Table 1 describes the types of production agreements between breeding firms and seed producers.

⁶ These business organizations receive different names: agrochemical/seed companies; pesticide and seed companies; agricultural chemical companies; agricultural R&D companies; agrochemical corporations; and so on.

⁷ It is possible for a farmer to perform different production activities simultaneously, that is, he can allocate part of his resources for grain production and part for the production of seeds, being considered both farmer and seed producer (Aviani & Machado, 2015).

⁸ The basic seed corresponds to the seed produced from the pre-basic seed - which carries the genetic identity and varietal purity - under the responsibility and direct control of the breeder, and kept within its characteristics of genetic identity (Brazil, 2001).

Table 1 - Models of seed production agreements between breeders and seed producers

Models of production agreements	Features	Level of exclusivity	Variety identification	Royalties' collection	Market development
Open licensing agreement	Most common type. The breeder licenses its varieties to several seed producers (see T2).	Low: same variety or group of varieties can be licensed to different seed producers, which means that several seed brands may offer the same variety.	The variety name is defined by the breeding firm, even though each seed producer uses its own trademark.	The licensee makes the collection of royalties for the breeder, based on the number of bags sold to the farmer.	It is done together by the breeder and the seed producer (see T3 and T5).
Exclusive licensing agreement	Breeders develop a closer relationship with a small group of seed producers - one to three of them – (see T2). The breeder has the exclusive right to trade specific varieties with his own brand, even though the production is outsourced to a seed producer (see T2 and T4).	High*	The seed producer chooses the variety name.	Same	It is the seed producer assignment (see T3).
Vertical integration		High*	The variety name is defined by the breeder.	It is enclosed in the price of the seed to the farmer.	Breeder assignment (see T5)

Source: the author based on the research interviews.

Note: * the variety is associated with only one brand.

In the soybean case, approximately 85% of the commercial seeds traded in Brazil are produced in the form of open or exclusive licensing agreements between breeders and seed producers. The production and commercialization of the remaining 15% is vertically integrated. In the cotton case, 60% is vertically integrated (Peske, 2016).

2.1.1.3 Transactions 3 to 6:

T3 and T5 refer to transactions in which breeders directly or indirectly access the distribution channels, who might be, in general, agro dealers or cooperatives. In the case of strict T3, this access is indirect. T3 is in charge of the seed producer, regarding the exclusive licensing agreement settled by the parts. T5 occurs in two situations. The first is when the breeding firm accesses the distribution channel together with the seed producer, in a context of open licensing agreement (T3 and T5). The second refers to a situation of vertical integration, when seed production is outsourced to a seed producer (T4), and the breeder directly accesses the distribution channel. I do not give details about T3, T4 and T5 operationalization, since they are irrelevant for this dissertation core issue.

Transaction 6 refers to the transaction between the distribution channel and the farmer. Although this relationship develops in different ways and involves a rich body of study, it is out of this dissertation scope.

2.2 Organization and competitive structure in the seed industry

This section presents an overview of the global competitive structure of the seed industry, pointing out the main players, as well as examining the domestic soybean and cotton seed market structure and organization.

2.2.1 Global economic consolidation of the seed industry

Most of the big companies in the seed sector come from the biotech agrochemical industry, where they were known as the “Big Six” - Syngenta, Bayer, Basf, Dow, Dupont and Monsanto. Monsanto and DuPont had a high share of seeds and biotechnology in their total agricultural sales, while Syngenta, Bayer, Dow and Basf mainly sold pesticides. According to Bonny (2017), in 2016 Monsanto owned the highest seed market share, of 23%, followed by DuPont with 15% and Syngenta with 9%. Limagrain – the fourth global seed company - and KWS – the sixth – have focused only on seeds (Lianos, 2017). However, the recent wave of consolidation – which reached its peak between 2014 and 2018 – has established true platforms in both seed and plant protection.

Since the beginning of the 21st century, the global consolidation of the seed and biotechnology industry, as well as of other agricultural inputs, has been the focus of economic research (Harl, 2000; King, 2001; Fernandez-Cornejo, 2004). In 2011, Fuglie, Heisey, King and Schimmelpfennig shed light on the topic by reporting that for the global seed and biotechnology industry the CR4 index jumped from 21%, in 1994, to 54% in 2009. ETC Group (2015) estimated the CR4 index around 60% in the year 2013.

Fuglie et al. (2011) observed that the emergence of biotechnology was a major driver for consolidation. Companies sought to acquire relevant technological capacities and serve larger markets in order to share the large fixed costs associated with getting regulatory approval for new biotechnology innovations⁹. In other words, the factors that drove the concentration in the seed industry were the acquisition of complementary technology and market assets, and economies of scale in crop biotechnology R&D. Furthermore, research on genetic modification of crops only produces revenues if it is incorporated into seeds that can be sold commercially¹⁰.

According to Fuglie et al. (2011), in the late 1990s and early 2000s the so-called “Big 6” relied on small and medium-sized enterprises (SMEs) as sources of new innovation, often spinoffs from university biotechnology R&D. Of 27 crop biotechnology SMEs acquired between 1985 and 2009, 20 were purchased directly by one of the Big 6 or by a company that was eventually acquired by one of them.

In the second half of the years 2010, an unprecedented wave of consolidation took place in the global seed industry. It started in July 2014, when Monsanto made a number of acquisition offers to Syngenta. Despite rejection, the Monsanto bid triggered a number of other M&A in the global industry. In August 2017, Dow Chemical and DuPont officially merged to become

⁹ McDougall (2011) revealed that the total average costs associated with the introduction of a new biotech trait, between 2008 and 2012, were USD 136 million; and 25% of the total costs regarded regulatory procedures.

¹⁰ While a GMO trait holder can, in principle, license it to breeding firms, such licensing is typically less profitable than the direct application to the relevant seed. In practice, this means that GMO research is facilitated by having a large variety of seeds for conducting experiments, and eventually applying to them the GMO technology. This seems, indeed, to be a major driver of recent M&A transactions. As long as each potential GMO innovator still has access to a critical mass of seeds, we would expect such mergers to improve welfare, as they allow the internalization of complements. However, as the share of the (proprietary) seed markets controlled by some companies grows, additional mergers between these firms and seed companies would eventually limit the availability of seeds to rival GMO innovators, until they would negatively affect their ability to innovate at the same pace. To assess the likelihood of such an “innovation foreclosure”, it is useful to look at the share of the proprietary seed market controlled by the main companies (Lianos, 2017).

DowDuPont. Only two months earlier, in June 2017, Syngenta was formally acquired by the Chinese state-owned enterprise ChemChina.

In May 2018, Bayer's acquisition of Monsanto was approved in US - as occurred in other countries – forming the world's biggest seed and agrochemical supplier. The approval was conditioned to a divestiture package in order to keep market competition. The agreement includes the transfer of Bayer's seed assets - vegetables, soybean and cotton seed, seed-trait, breeding facilities - to Basf.

Therefore, these mergers further consolidated a highly concentrated industry. According to ETC Group (2015), at the time mergers happened, there were estimates that the "Big 6" collectively controlled 63% of the commercial seed market, and almost three quarters of private R&D expenses in the seeds and pesticides sector. After all, the "Big 6" has become the "Big 4".

2.2.2 Economic seed consolidation in Brazil

From 1996 to 2005, seed legal regulation in Brazil undertook important changes, concerning the enactment of a new regulatory framework that comprised biosafety, industrial property (patenting), plant variety protection (PVP) and the establishment of the National Seeds and Seedlings System (see more in 2.3). The intent was to create an attractive institutional environment for public and private investments, aimed at increasing and accelerating programs of plant genetic improvement, as well as stimulating the admission of new seed and biotech firms in the market.

Hence, a very intense process of public and private investments in the domestic seed sector, especially by the Biotech Agrochemical MNCs, started. These organizations, who had already realized the Brazilian agricultural potential, received legal support concerning IPRs to bring new technologies to Brazil (Fuck & Bonacelli, 2006a; Santos, 2013; Wilkinson & Castelli, 2000). Thus, there was the strengthening of Biotech Agrochemical MNCs, which, mostly through the acquisition of domestic breeding programs, began to operate more strongly in the local seed market, by bringing new technologies, high investments and aggressive strategies of market penetration.

Those acquisitions were determined by the need to gain access to the germplasm adapted to Brazilian soil and climate conditions; otherwise, they would have to spend a considerable

amount of time and money to study and develop appropriate varieties, while this research had already been done locally (Azevedo et al., 2016)¹¹.

2.2.2.1 Soybean and cotton seed competitive structure

Based on Santos (2013), and more recently on information retrieved from the Administrative Council for Economic Defense [Cade]¹² (2018a), it is possible to state that between 1995 and July 2018 about 40 concentration acts were carried out in the Brazilian biotechnology and seed industry. Most of them were considered as horizontal mergers.¹³

2.2.2.1.1 Domestic soybean seed market

The Organization for Economic Co-operation and Development [OECD] (2018) compared market concentration in the soybean seed market between some important crop producing countries in the year 2016¹⁴, based on measures of the Herfindahl-Hirschman Index (HHI) and the four-firm concentration ratio (CR4)¹⁵. Market concentration in value was lowest in the Ukrainian soybean seed market – HHI: 736; CR4: 42% - and highest in Uruguay – HHI: 3.690; CR4: 91% - and South Africa – HHI: 3.822; CR4: 96%.

There is evidence of a negative correlation, with larger markets having a lower degree of market concentration, being Ukraine a clear outlier due to the presence of several public research institutes. In the OECD (2018) analysis, Brazil appears with a HHI of 2.173 and a CR4 of 82%, a concentration index just higher than Ukraine and US – HHI: 1.556; CR4: 65%.

According to the Ministry of Agriculture, Livestock and Food Supply [Mapa] (personal communication, April 25, 2018), in the 2017/2018 crop season soybean commercial seed

¹¹ Germplasm is the raw material used by breeders. It is a living tissue, from which new plants can be grown. It can be a seed or another part of a plant – a leaf, a piece of stem, pollen or even just a few cells, which can turn into a whole plant. Germplasm contains the information for a species' genetic makeup, a valuable natural resource of plant diversity (Seed Biotechnology Center, 2018).

¹² Conselho Administrativo de Defesa Econômica (Cade).

¹³ The consolidation of the seed industry has been very dynamic, especially during the development of this thesis. For this reason, the following discussion presents the observed trend according to the operations that took place until July 2018.

¹⁴ The analysis used the Kleffmann Amis®AgriGlobe® database. Data was available for Argentina, Brazil, Paraguay, South Africa, Ukraine, Uruguay and the United States. These countries jointly account for an estimated 86% of the global soybean seed market by value. All calculations refer to shares in the overall seed market (including farm-saved seed).

¹⁵ Herfindahl-Hirschman Index ("HHI") of market concentration is calculated by adding the squares of the individual firms' market shares, which gives proportionately greater weight to the larger market shares.

production area occupied approximately two million hectares in Brazil. I calculated the concentration indexes based on the soybean seed planted area and found out the following results: HHI of 2.149 and CR4 of 83%. These results are very similar to those of OECD for the year 2016. The Horizontal Merger Guidelines, published by the U.S. Department of Justice and Federal Trade Commission (2010), classify markets whose HHI falls between 1.500 and 2.500 as moderately concentrated, as is the case of the Brazilian soybean seed market.

Using data from Mapa, I found 31 legal breeding entities operating in the soybean seed market. Some of these organizations participate only in joint breeding efforts, some are legal variations of the same business group, and some were targets in previous merger transactions. Hence, I organized them in 22 breeding firms, of which 11 reached more than 1% of the soybean seed production area, as Figure 3 shows.

Figure 3 – Market share of the commercial soybean seed sector in the crop season 2017/18¹⁶

Source: based on Mapa data (personal communication, April 25, 2018).

¹⁶ For the calculation of the market share I have considered only the Dow DuPont merger, whose approval in 2017 was obtained prior to the beginning of the 2017/18 crop season.

In the crop season 2017/18, Monsoy reached 34.7% of the commercial soybean seed production area. It is Monsanto's breeding company and operates in the market with two trademarks - Monsoy and Agroeste. Monsoy operates through the open licensing agreement model, with varieties of broad spectrum, which means that the varieties are suitable for soybean producing areas from North to South of the country. Agroeste accesses the market through the vertically integrated model.

GDM Seeds reached approximately 25% of the Brazilian soybean seed market, including DonMario Seeds and Brasmax trademarks. Both brands operate through a licensing agreement model. By using DonMario brand, GDM works with a smaller volume of seeds, focusing on a more customized service to farmers, which includes transfer of information on better production techniques, so they can achieve the best possible results. By using Brasmax brand, it seeks a greater capillarity to meet all farmers' profiles in the different soybean producing regions.

Nidera accounted for 12.6% of market share in the 2017/18 crop season. Although it operates with both models of production agreements - licensing and vertical integration – it uses the same brand. Nidera's market penetration is particularly noteworthy in the South and Southeast regions, and lower in other producing regions. In February 2018, the acquisition of Nidera by Syngenta was formally concluded (see more on 2.2.2.2).

Differently from the first three breeding companies, which have foreign control, Tropical Melhoramento & Genética (TMG) is a Brazilian breeding firm and fourth in market participation, reaching 10.8% of the soybean seed planted area. TMG has access to the market only through licensing agreements.

Far behind the first four breeding firms comes DowDuPont – formally merged in Brazil on May 2017, and renamed since February 2018 as Corteva Agriscience– with a share of 4.2% of the soybean seed market. Data collected refers to the soybean seeds from Coodetec (acquired by Dow in 2015), Dow and Pioneer, the seed division of DuPont¹⁷. The Pioneer brand is used to access the market through the vertical integration model, while the other brands refer to the licensing agreements model. As from February 2018, the company announced the unification

¹⁷ Codetec, a former agricultural research cooperative, which brought together 38 farmers' cooperatives in Brazil. Dow acquired Coodetec's seed and breeding units in 2015.

of those brands under the new seed brand Brevant. The Pioneer brand continues to be used to directly access the market (Dow AgroSciences, 2018).

The Brazilian Agricultural Research Corporation (Embrapa) was once the largest soybean seed breeder, with a share of 56% in 1997 (Almeida, Wetzel, & Ávila, 1999). This share fell to about 15% in the 2000s (Fuck & Bonacelli, 2006b), and now represents 2.5% of the market, together with its partners¹⁸. Embrapa, in the crop season 2017/18, was closely followed by Syngenta and Bayer (both with a share of 2.2%). These, in turn, acquired Nidera and Monsanto, respectively, as I briefly discuss in section 2.2.2.2. FTS, AgroNorte and the others are all domestic breeding firms, with less expression in the soybean seed market.

When using HHI, antitrust agencies consider both the post-merger level of HHI and the increase that results from the merger. When simulating the increase in HHI resulting from the mergers that occurred after the beginning of the 2017/18 crop season (Syngenta – Nidera and Bayer – Monsanto), I found that it increased from 2.149 to 2.356, a difference of 207 points, being 156 points due to Bayer's acquisition of Monsanto. Following the U.S. Department of Justice & Federal Trade Commission (2010), mergers resulting in moderately concentrated markets, which involve an increase in HHI of more than 100 points, potentially raise significant competitive concerns and often warrant scrutiny. This is what happened in the Bayer and Monsanto case, as is detailed in section 2.2.2.2. The CR4 index from the soybean seed market increased from 83% to 87.5%.

2.2.2.1.2 Domestic cotton seed market

In the OECD (2018) report, there are numbers of the concentration indexes in the cotton seed market for Mexico - HHI: 5.308; CR4: 100% -, Brazil – HHI: 4.348; CR4: 100% -, and USA – HHI: 2.786; CR4: 91% -, for the year 2016. As can be seen, all of them have a highly concentrated market.

Based on data provided by Mapa (personal communication, April 25, 2018), in the crop season of 2017/2018 the commercial cotton seed production area accounted for 3.06 thousand

¹⁸ The partnerships include other public research organizations from the States of Minas Gerais, Goiás and Mato Grosso.

hectares¹⁹. Only four breeding firms participate in the Brazilian cotton seed market. As will be seen in section 2.3.1, the utilization rate of informal cotton seeds is high, around 45%. Based on information collected during the interviews, I calculated the concentration indexes: HHI of 4.986 and CR4 of 100%. The value is close to that attained by OECD (2018).

Figure 4 shows the market share of the cotton-breeding firms, based on information collected from market experts.

Figure 4 – Market share of the commercial cotton seed sector in the crop season 2017/18

Source: based on data collected from market experts in 2017.

Bayer, by far, dominates cotton breeding in Brazil, accounting for about 65% of the seed market. TMG appears in the second place with 27%, followed by Instituto Mato-grossense do Algodão (IMAMT), with 4%, and Monsanto's D&PL, with also 4%.

2.2.2.2 The latest M&A wave in the Brazilian seed industry and some concerns

¹⁹ MAPA's data for the 2017/18 cotton seed crop were very different from the information collected from the interviews with market players. In calculating the concentration indexes based on MAPA data and on information from agents in the market, the last were much closer to that presented by OECD (2018). When questioning my MAPA source about this difference, he claimed that MAPA's data tool was undergoing changes and there could actually be some inconsistencies, which he would check; but until finishing the thesis, I got no return. Hence, I decided to use the market share of the cotton-breeding firms, based on the information from the market agents. It is worth mentioning that for soybean seeds, market and MAPA information were aligned.

In this section, I briefly describe the main concerns raised by Cade, while analyzing the recent M&A operations in the biotech, agrochemical and seed sector in Brazil. In this description, I focus specifically on the cotton and soybean's seed markets. I also address some additional issues that should be of concern to studies on the topic.

In Brazil, Syngenta and ChemChina merger was approved in February 2017. Cade undertook an extensive analysis of all relevant markets, but given the small importance for the domestic seed market, I chose not to comment on the merger details²⁰. Later, in November 2017, Syngenta notified Cade about its intention to acquire Nidera Seeds in South America.

Cade examined the possibilities of horizontal overlap in the market for soybean seeds, and vertical integration between insecticides and fungicides for treatment of soybean seeds. The analysis revealed that the increase in concentration was not significant, and there was sufficient competition. Therefore, in January 2018 Cade approved the operation without restrictions (Cade, 2018b)²¹.

In August 2016, Cade was notified about the Dow and DuPont's intention to merge²². Given the complexity of the case, it reached the in-depth second phase of analysis on merger control. Both companies have substantive activities in Brazil, and Cade undertook an extensive analysis of all the relevant markets. In the specific case of the seed market, the authority did a more careful analysis and developed jurisdiction-specific solutions. Among others, it analyzed the following alternative scenarios for the relevant markets of local interest: domestic market of soybean seeds in general (conventional and GM); world market for R&D in GM soybean seeds; and national market for licensing GM soybean seeds. Regarding the vertical integration between licensing, development and production of seeds, Cade did not raise any concerns: a market foreclosure strategy, either upstream or downstream, would be ineffective. Given that the merger was between foreign companies, the decision reported that solutions would be coordinated with other jurisdictions. In Brazil, remedies were mostly structural and referred to

²⁰ In the Syngenta and ChemChina merger, Cade evaluated horizontal concentration in each of the relevant markets. The resulting concentration in most of them was below 30%, and despite that, Cade considered the extensive entry barriers, so that competition was sufficient to avoid concerns. Vertical integration between inputs and pesticides, and between pesticides and seeds, produced by Syngenta was not a problem: some of them already existed, and there would be no incentive for market foreclosure. Cade's Superintendence approved the operation without restrictions.

²¹ Concentration Act nº 08700.007412/2017-41 (Cade, 2018b)

²² Concentration Act nº 08700.005937/2016-61 (Cade, 2017).

corn seeds, not involving the assets related to soybean or cotton seed, as in this dissertation (Cade, 2017). The merger was approved in May 2017²³.

Upon notification of Bayer's acquisition of Monsanto in February 2017, Cade decided that the merger was complex and started an extensive analysis of all relevant markets²⁴. Both Bayer and Monsanto have substantial activities in Brazil. In October 2017, Cade's Superintendence issued a report and objected to the transaction. Based on market shares and HHI variation, of local interest, the following relevant markets were further investigated: soybean and cotton biotechnology (R&D of GMO varieties in the world and licensing of GMO varieties to Brazil), and breeding, production and commercialization of soybean and cotton seeds in Brazil.

Barriers to entry were high in all relevant markets, due to the cost and time involved to engage in R&D, the need for specialized work, and the presence of strict regulatory requirements. Particularly, Cade's Superintendence considered that both companies had activities in other parts of the chain, such as the development of seeds, genomics and pesticides, and extensive R&D capabilities in pesticides. This indicated that the admission of competitors was quite difficult, given the strong portfolio of the new entity and its extensive ties with distributors.

In markets related to cotton and soybean seeds, competition was not considered sufficient to counterbalance market power. Among the reasons, we can mention that (i) the parties are the only players capable of operating in an integrated way with biotechnology, production and commercialization of seeds; (ii) all the other players depend on other parties' technology; (iii) the parties have stronger brands and capacity to invest in marketing, compared to their rivals (Cade, 2018c).

As illustrated in the previous section for the soybean seeds' market, although HHI variation was not so substantial – 156 according to data retrieved from Mapa (2018) - and Bayer had not attained a relevant market share – 2.2% -, the resulting market share is high - approximately 37%. While Monsanto is the largest player in both GMO technology and soybean seeds in Brazil, there were signs that Bayer would increase its focus on the country. In the cotton seed market, although Monsanto had not achieved an expressive market share, it is the third player,

²³ Cade concluded that the merger could lead to horizontal concentration in the markets of pesticides, and prescribed specific remedies.

²⁴ Concentration Act nº 08700.001097/2017-49 (Cade, 2018c).

and the resulting participation would be around 70%. In any case, both parties had significant R&D pipelines for improvement of cotton and soybean.

Regarding the non-horizontal effects, Cade's Superintendence identified a variety of vertical relationships. Among them, the cross-integration between the development of GM soybean and cotton, whose breeding, production and sale was considered harmful. Both companies had the incentive to limit the access of competitors to its technology, given Monsanto's mastery of the soybean technology and the resulting high market shares, upstream and downstream, in both cotton technology and seeds.

Cade also analyzed the conglomerate effects. The need to enter the sector in two or more markets at the same time, and the possibility of offering bundles of complementary products by the merged company raised concerns. The Superintendent's opinion was that the efficiencies generated by the transaction were not sufficient to balance the resulting market power. Thus, Cade's Superintendence objected to the transaction and sent the case to its Tribunal for a final decision (Cade, 2017).

In February 2018, the majority of Cade's Tribunal finally approved the merger. Following the remedies employed in other jurisdictions, Bayer must comply with a divestiture agreement to sell off its whole seed business of soybean, cotton and herbicides to Basf²⁵. In addition to structural solutions, Bayer and Monsanto also proposed behavioral commitments. They involve transparency on sales practices, prohibition to impose exclusivity of sales channels, ban of product bundling, and broad and non-discriminatory licensing. A Trustee should support the monitoring of all commitments (Cade, 2018c; Cade, 2018e).

During the instruction of the Concentration Act, Cade's Superintendence received complaints that applicants would be taking an unilateral conduct with anti-competition effects in the markets for soybean and cotton seed. Cade understood that these accusations had no causal link with the operation; however, part of the information brought to the proceedings could eventually constitute violations of the economic order. Therefore, it decided to establish an autonomous investigation procedure²⁶. In a technical report issued in July 2018, Cade stated

²⁵ In total, 29 national jurisdictions were notified on the merger.

²⁶ Administrative inquiry n° 08700.000270/2018-72 (Cade, 2018d).

that a large volume of highly complex information had been added to the files, which required further analysis, and no conclusion had been reached until then (Cade, 2018d).

It was assumed (ETC Group, 2015; Lianos, 2017; Murray, 2016) that the firms involved in this M&A wave were trying to develop an integrated offer of inputs and services to farmers, which would enable them to gradually build a compelling one-stop solution, or, in other words, that these firms would become a one-stop shop for agricultural inputs²⁷.

Worldwide divergent views are expressed on the impact of these recent M&A transactions in the agri-food chain. While certain stakeholders worry about the risk of market power by the biggest companies, which in turn may result in a reduction in the farmer's profitability, others expect useful innovations, since these players are able to bring critical innovations for agriculture, food, and the bio-economy, due to their high R&D capacity.

It is imperative to notice that besides the huge market power held by these companies they also control IPRs. There is some causal link between the rise of IPRs protection in this industry and the higher level of economic concentration observed (Ferrari 2015; Lianos, 2017).

Domestic breeding firms have not only local market expertise, but also their own innovation, IPRs and products focus on local needs. Therefore, it is crucial to determine why certain acquisitions are taking place. If the main driver is to access the name, local reputation and distribution channels of the domestic firm, then one may fear that its focus on local needs will quickly erode, once it becomes part of a large group. If, on the other hand, the reason for the acquisition is to gain access to the firm's IPRs, its research expertise or its stock of locally adapted seeds, then one can expect that the acquisition will lead to an increase in innovation targeted at some local needs.

As I discuss in the next sections, IPRs appropriation by plant breeding firms is not trivial, and it is important to keep in mind that there is some sort of interaction between IPRs and competition law.

²⁷ In terms of antitrust concerns, the fact that Biotech Agrochemical MNCs have been offering a package of genetic engineered traits, seeds and chemicals raises questions related to determining the relevant markets affected by M&A operations. Should research, breeding and market development of the various kinds of seeds be considered as part of the same or of different relevant markets? See Lianos (2017) for a deeper discussion on the issue.

2.3 IPRs of plant varieties

IPRs debate on a wide range of issues has taken place over the past decades, since the enactment of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), in 1994. It addresses issues such as: the reasons for the growing use of IPRs; the impact of strengthening IPRs for innovation; the role of IPRs in developing countries; the need for international harmonization of the laws that regulate the matter; and the consequences of IPRs' legislative reforms in poor communities, in areas such as health or traditional knowledge, among others (Lopez, 2009).

TRIPS establishes minimum standards for many forms of intellectual property regulation that World Trade Organization (WTO) members must obey. TRIPS agreement, in its article 27, section V, paragraph 3, item b, determines that:

Members may also exclude from patentability: plants and animals other than microorganisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, Members shall provide for the protection of plant varieties, either by patents or by an effective *sui generis* system, or by any combination thereof (TRIPS, 1994, p. 331).

The Latin term *sui generis*, meaning “of its own kind”, is applied to something that is unique or peculiar. The *sui generis* rights is a legal adaptation to provide IPP in unique cases as that of plants, which, as living organisms, are subject to inherent, individual variability and do not fit the classical models of IPRs - industrial property or copyright (Wilkinson & Castelli, 2000).

In compliance with TRIPS, between 1996 and 2005 the regulatory framework regarding IPRs on agriculture biotechnology was settled in Brazil. This framework comprises laws concerning biosafety, industrial property (patenting), plant variety protection (PVP) and the National Seed and Seedlings System²⁸.

In practice, there are two statutory mechanisms related to plants' IPRs in Brazil. The first is the PVP System, also called Plant Breeder's Rights (PBRs), which recognizes IPRs of new plant varieties, through a certificate issued to the breeders by the national authority. The purpose of this instrument is to ensure the appropriation of economic outcomes as compensation for the

²⁸ In 2015, the Brazilian Biodiversity Law was approved by the National Congress. The new regulation determines access to genetic heritage, protection and access to traditional knowledge and the sharing of benefits for the conservation and sustainable use of biodiversity. This legislation may bring new implications for biotech firms; however, it should not affect their relationship with farmers, which is the focus of this dissertation.

resources invested and risks assumed in the breeding of new varieties of plants, and to foster innovation. Although patenting of plants is formally prohibited in Brazil, IPP of the process of genetic modification is provided by the Brazilian Patent Law. Therefore, a GM seed is exposed to two types of legal mechanisms: PVP and patenting.

2.3.1 IPRs appropriability concern in the seed industry

National legislations on PBRs derive from the TRIPs agreement and the rules of the International Union for the Protection of New Varieties of Plants (UPOV)²⁹. They take into account the concern with food safety and economic sustainability of family-scale farming, as well as the preservation of landrace varieties; therefore, they provide permission to the farmer's privilege, which is the consent to the practice of saving seeds. It should be noted that the latest act of UPOV Convention – the 1991 Act - considers the farmer's privilege an exception that can be adopted by member countries, as long as they apply certain “reasonable limits subject to the safeguarding of the legitimate interests of the breeder” (UPOV, 1991).

Seed saving is defined as the practice of retaining the best seeds or other reproductive material from the harvest, for seeding or propagating the next crop. This is the traditional way farms worked, before plants' IPP became a legal right.

Brazilian PVP Act³⁰ states, in its Article 10, Paragraph II, that “one who does the following shall not be considered to have trespassed on property rights: sets aside and plants seeds for his or her own use, in his or her own facilities, or in facilities in his or her possession, although owned by third parties” (Lei n. 9.456, 1997)³¹.

As settled, the provision of saved seed became a common justification for the storage of any volume of seeds or seedlings with no purpose. Legislators failed to establish an upper limit to

²⁹ The UPOV mission statement is to provide and promote an effective system of PVP, with the aim of encouraging the development of new varieties of plants, for the benefit of society. It emerged with the adoption of the International Convention for the Protection of New Varieties of Plants by a Diplomatic Conference in Paris, in 1961. This marks the recognition of the rights of plant breeders internationally. The Convention acts were revised in 1972, 1978 and 1991 (UPOV, 2018).

³⁰ Lei de Proteção de Cultivares. Act n. 9.456 of April 25, 1997.

³¹ The act of saving seeds must comply with the instructions of Attachment XXXIII of MAPA Normative Instruction no. 9, of June, 9, 2005, which refers to the Declaration of registration of area for production of seeds for own use.

the farmer's scale of production or income, creating an opportunity for farmers to retain amounts larger than necessary for their own use, and to trade the surplus in illegal transactions³².

For this reason, several Brazilian experts (Aviani & Machado, 2015; Sá & Saes, 2015; Yokoyama, 2014; Fuck, 2009; Van Rooijen, 2006; Nogueira, 2006) observe that the Brazilian established regime on IPRs regarding plants does not secure the effective protection of IPRs related to certain species of agricultural interest.

It is important to distinguish the saved seed from the pirated seed. The first is not illegal, since the right to save is provided by the legislation. On the other hand, pirated seed is illegal. Seed piracy can be done by (i) saving seeds without the proper declaration of origin; (ii) trading or exchanging saved or discarded seeds; and (iii) smuggling seeds³³. In Brazil, both saved and pirated seeds are considered informal seeds.

Figure 5 shows the Brazilian utilization rate of informal seeds between crop seasons 2006/07 and 2015/16, in soybean and cotton production.

³² Sugar cane received a special treatment in the Brazilian PVP Act, concerning the farmer's privilege. In this unique case, farmers cannot save seed without the breeder's prior authorization. This exception was granted basically due to a successfully lobby of the sugar cane sector, which was able to persuade legislators about the technical importance of granting this exception for the sugar cane crop (Cardozo, 2015).

³³ Seeds that do not comply with quality requirements of the seed producer or legal phytosanitary requirements are discarded.

Figure 5 – Brazilian utilization rate of informal seeds in soybean and cotton

Source: Based on data retrieved from Abrasem (2018).

The figure shows that despite the decrease in the rate of informal seed utilization, it still has an expressive value. According to I. M. Carraro (personal communication, June, 19, 2017)³⁴, in the soybean seed market saved seeds account for almost 35% of the informal seeds, while pirated seeds represent the remaining 65%³⁵. In the cotton seed market, saved seeds account for 90% of the informal market, while the pirated ones reach 10% of that market.

Although the market for pirated seeds is more representative than that of saved seeds, indiscriminate permission to save facilitates seed piracy. Aviani and Machado (2015) claims that the way the topic is settled in the Brazilian PVP has led to the organization of a parallel and illegal seed industry, which trades the harvest product as propagating material, under the pretext of farmer's privilege.

One could argue that breeding firms' misappropriation problem could be solved simply by including the value of losses into the seed price. Market experts argue that this is not feasible,

³⁴ Ivo Marcos Carraro, Vice President of the Administrative Council of the Brazilian Seed Association (2016-2019), and President of the Brazilian Breeders Association (Braspov).

³⁵ See Aviani and Machado (2015), on cases of Brazilian breeders who quit the market by selling out their firms, due to seed piracy.

because firms already work with a narrow margin that would not bear increases, due to the competitive configuration of the market. For them, this kind of reaction could result in an even greater rise of informality. Although this is a sector with some concentration level, the informal market is quite representative, according to Figure 5.

From the breeders' point of view, it is important to know the different methods of plants' propagation, in order to better understand the need for an effective PVP system. These methods are associated to the ease of replicability of the plant's reproduction material (seed and seedlings, among others), which, in turn, affects the appropriability of IPRs by breeders. Three kinds of propagation methods or reproduction techniques exist: hybridization, self-pollination, and vegetative (asexual) propagation.

In the case of hybrids, there is a biological protection against imitation inherent to crops, in which the second generation of plants loses its vigor, forcing farmers to constantly renovate the seeds to grow their crops. The case of firms dealing with hybrids is very similar to the case of manufacturing companies that possess an industrial secret. This is the situation where breeding firms are able to recover their investments more easily. Corn is the main crop that represents the hybrids.

In the self-pollinated (open pollinated) crops, like soybean and cotton, due to the biological attribute of self-reproducibility, the genetic traits are transmitted between generations. This makes an effective PVP system very important, because farmers can save the seed, thus making it more difficult for firms to recover their investments.

The vegetative propagated plants are the easiest for reproduction. It is not necessary to join a male and a female individual; any part of the plant can be used. Roughly speaking, any layman is able to propagate this kind of plants. Potatoes and cut flowers are good examples of asexual reproduced crops. Easy replication implies the fast dissipation of rents. Therefore, an effective PVP system is very important to guarantee value appropriability to breeding firms (Eaton & van Tongeren, 2004).

The outlined case, in which R&D expenditures of breeding firms are not adequately recovered, gives rise to alternative mechanisms of property rights protection (Dixit, 2009; Acemoglu & Johnson, 2005).

2.3.2 Alternative IPRs appropriation strategies

Endres and Goldsmith (2007) argue that when doing business in weak institutional environments, companies should adopt second-best alternatives to appropriate property rights and maximize profits. I present alternative business strategies developed by firms in Argentina and USA, as described by Endres and Goldsmith (2007) and Goldsmith, Ramos and Steiger (2006):

- a) pricing: refers to a “pump-priming” scenario, where the breeder and the farmer know that monopolistic power is sustainable for only a single period. The breeder would maximize prices in the first year and forego profits in the second year. The farmer would accept a lower benefit in year one, because he knows that yield drag would be minimal in year two, and he could exploit the technology by saving the seed not only in year two, but possibly beyond. In the Argentinean seed market, commercial soybean seed prices actually rose over time in response to aggressive seed saving, as breeders realized that their seed served only as foundation seed “to prime the pump” of the extensive brown-bag industry. The feasibility of the pricing strategy depends on the breeders’ underlying R&D costs, the farmers’ utility perspectives, and credit availability for the farmers;
- b) rapid innovation: an active innovation strategy, by which seed genetics get outdated after two periods, and a new variety is rapidly launched by the breeding firm, in order to re-establish the firm’s monopolistic position, by increasing yield drag and significantly changing the seed-saving calculus, that farmers would prefer to purchase new seeds in the second year. As the previous one, the rapid innovation strategy also depends on the breeders’ R&D costs, farmers’ utility perspectives, and credit availability;
- c) product bundling: this strategy is feasible only for companies that offer multiple inputs to the agricultural system, and can occur in two ways. In the first case, the biotech company exempts farmers from collecting royalties, in order to attract them to purchase its full range of agricultural inputs and services. The alternative option takes place when the company refuses to sell other inputs and services, unless the farmer collects royalties

for the seeds. The adoption of product bundling mechanisms is subject to the antitrust regulations of each country. Brazil does not allow product bundling³⁶.

- d) monitoring strategy: adopted mainly to reduce information asymmetry. In US, where seed saving is illegal, Monsanto actively investigates allegations of the practice, by employing personnel to monitor and aggressively prosecute unauthorized seed saving in the local market. It includes a toll-free number to receive confidential reports on the issue. These well-publicized legal actions undoubtedly serve as a deterrent and may reduce the firm's overall cost of monitoring. In Brazil, where Monsanto holds the patent over the most widespread GM technology, the company devised a way of monitoring farmers based on GM technology detection tests, carried out at the time of grain delivery. This scheme enables royalty's collection on the GM technology, owed even by farmers who sowed informal soybean seeds. Based on Intacta RR2 Pro (2018), Monteiro and Zylbersztajn (2012, 2015) and Rodrigues (2016), I describe this scheme:
- Royalty's collection on the GM soybean technology may occur in three moments. The first is at the time of a commercial seed purchase by the farmer, who pays the established fee per hectare for that crop season. The second moment occurs when a farmer decides to use saved seeds of trait-bearing varieties; to do this, he must legalize the procedure with the responsible authority and present the proof to a licensed firm³⁷; which then surcharges the established biotech fee per hectare, by approximately 10%³⁸. And the third moment is at the time the farmer delivers the harvested crop, when the trait owner reserves the right to conduct tests to confirm the absence or presence of his trait in the grain. If the farmer used saved seeds of trait-bearing varieties without doing the legal procedure, the trait owner charges 7.5% on the volume of grains delivered³⁹.

The orchestrating of such a royalty collection scheme by the biotech firm, owner of the soybean GM technology, was enabled by the fact that the protection of this technology is provided by

³⁶ Despite not being allowed, there is an administrative inquiry under way at Cade to investigate complaints of anticompetitive practices by the company resulting from the merger between Bayer and Monsanto, which may possibly include product bundling. See footnote 26.

³⁷ *Op. cit.* 31

³⁸ In fact, the firm who holds the GM technology establishes a fixed price per crop season, for charging the farmers who plant the saved seed. In the last years, the difference to the normal price – when the farmer uses a commercial seed – has been of approximately 10%.

³⁹ In the crop season 2016/2017, that would mean approximately 2.2 times the initial biotech fee. This value was estimated based on some variable assumptions.

the Brazilian Patent Law, whose enforcement is better than the one provided by the PVP System. However, what about the Brazilian breeders, who operate under the fragile framework provided by the Brazilian PVP System? The following question arose: *Does any of the strategies described in the literature apply to the Brazilian case?* As presented in this chapter, Brazil has its own idiosyncrasies; hence, *how do Brazilian breeding firms organize their resources to appropriate value, regarding IPRs?*

Aviani and Machado (2015) present only anecdotal evidence that Brazilian breeding firms usually try to embody a patented GM gene within their varieties, as a means of effectively securing their IPRs appropriability. In fact, the above described royalty collection scheme seems to work as an incentive for the farmer not to save the seed and to acquire a commercial seed. Since it provides the possibility for breeding firms to improve their value appropriation, another question arose: *Do breeding firms in Brazil try to benefit from this scheme?*

This dissertation aimed to address these questions regarding value appropriation. I did this by applying the theoretical reasoning of the RBV, along with its integration to the Property Rights Theory. Since the theme of value appropriation has received little attention in the existing body of RBV, I believed that examining the seed appropriability problem might offer insights to turn RBV into a really strategic stream of theory.

3 VALUE APPROPRIATION: LINKING RESOURCE-BASED VIEW TO PROPERTY RIGHTS THEORY

Value creation and value appropriation are components of the firm's strategy. The former refers to the net rent-earning capacity of the firm through resources configuration, and the latter refers to its ability to appropriate these rents. According to Coff (1999), firm performance is an outcome of a two-stage game, where rent generation is the first stage, and rent appropriation is the second. Even though it seems logic that both deserve attention, since neglecting one of them will certainly cause firm performance failure, Verwaal et al. (2009) argue that strategy doctrines tend to focus on one of them. Grimpe and Hussinger (2014) observe that research on value appropriation has remained a relatively understudied area in RBV.

In this dissertation I was interested in building some contribution to the issue of appropriability, regarding economic rent that results from intellectual efforts. In the first part of this chapter (Section 3.1), I discuss the more traditional doctrine on rent appropriation adopted by the literature on strategy – which derives from David Teece's (1986) work on profiting from technological innovation – and why I believe it is not suitable for the case of seeds.

Next, considering that rent appropriation has received little attention in the specific context of the resource-based view (RBV), I carry out a very brief RBV's literature review concerning value creation, followed by a RBV scrutiny on the value appropriation issue, followed by the analysis of literature insights on how property rights economics could complement RBV towards appropriation. Finally, I present some propositions regarding appropriability in the seed sector, through attributes of resource unbundling, along with property rights' protection.

3.1 Traditional theoretical approach to the issue of IPRs appropriability

As Scotchmer (2004) asserted, several discussions on appropriability begin with the assumption that IPP is the solution to the problem. However, as she pointed out, it is better to start from the problem, that is, the difficulty to capture the economic rent produced by an innovation, and the disincentive that such difficulty can create, rather than starting from the solution⁴⁰.

⁴⁰ Authors such as Grimpe and Hussinger (2014), Pisano (1990), Pisano and Teece (2007), and Scotchmer (2004) use the term "capture" to express appropriation or mechanisms used with the objective of protecting property rights. The same is true for the companies that operate in the plant-breeding sector. As I will show later in this dissertation, Foss and Foss (2005, 2006) and Monteiro and Zylbersztajn (2012) use the term to describe resource consuming activities to appropriate value from others, without compensating them. I chose to use the same logic as these authors.

Levin et al. (1987) and Cohen et al. (2000) show that firms improve the conditions for appropriating the returns on their innovations through different strategies, such as patenting, lead-time advantage, and secrecy, among others. Most scholars explore the use and effectiveness of distinct appropriability strategies, at the firm and industry level, supported by the KBV approach. David Teece's (1986) work on profiting from technological innovation (hence the acronym "PFI") and his subsequent works on the issue (Sherry & Teece, 2004; Teece, , 1996, 1998a, 1998b, 2000, 2002; Teece et al., 1994) form the basis of this approach.

According to Teece (1986), PFI depends upon the interaction of three fundamental building blocks: the **appropriability regime** faced by firms, their position regarding the **dominant design paradigm** of the sector where they operate, and the possession of **complementary assets**.

Appropriability regime – the property rights environment where a firm operates – is characterized by the nature of the technology and the effectiveness of the available legal mechanisms to assign and protect intellectual property. Technology's nature, as described by Teece, relates to the protection of processes or products, and to the kind of knowledge - tacit or codified. As legal mechanisms, Teece considers patents, copyrights and trade secrets. In a very simplified way, the author explains the dichotomy between "tight" and "weak" appropriability regimes; in the first, technology is relatively easy to protect, and in the second it is almost impossible to protect.

Thanks to the complex technological nature of GM seeds, the appropriability regime for our empirical object is not trivial. A seed is protectable by a *sui generis* right (PBRs), but when it comes to a GM seed, it is also subject to patent protection. Thus, the PFI's appropriability regime framework does not cover all contingencies that exist in the institutional environment where breeding firms operate.

Teece (1986) develops his second building block, relating **the dominant design paradigm** in a given industry to the accomplishment of value appropriation. The author builds on a design competition between firms' basis, while my interest is to understand the efforts done by firms

to appropriate economic rent concerning farmers' compliance with IPRs. Farmers, in a strict sense, do not compete with breeders⁴¹.

In his third building block, Teece (1986) addresses the importance of **complementary assets** to PFI. In almost all cases, the successful commercialization of an innovation requires that knowledge be used together with other capabilities or assets. Services such as marketing, competitive manufacturing, and after-sales support are usually needed. These services are often achieved from complementary assets, which are specialized. This could be an important insight for the analysis of the breeding firm's efforts to appropriate rent, regarding the farmer's adhesion to IPRs.

In Teece's PFI model, an imitator may profit more than an innovator, because he adapts the original design, protects it, and secures the resources he needs to achieve commercial success. To make sure that an entrepreneur – not an imitator - succeeds with his innovation, he needs to consider the following three aspects: protect the idea, find/achieve the dominant design, and reach scale quickly. When all these three elements are in place, organizations can develop innovative designs, protect their products, and secure the resources they need to profit from those innovations.

In short , the PFI literature prescribes that the firm should develop appropriate vertical integration and complementary asset positions, according to the existing appropriability regime and the nature of the technology to be protected (Pisano, 2006).

This approach is very useful to explain three kinds of appropriability circumstances, namely: (i) competition – when firms make efforts to protect product innovations from imitation by (potential) competitors (Hurmelinna-Laukkanen & Puumalainen, 2007; Laursen & Salter, 2014; Teece, 1986); (ii) business to business situations, like interactions between providers of knowledge intensive business services and their client firms, or simply strict outsourcing situations (Arora & Ceccagnoli, 2006; Leiponen, 2008; Miozzo et al., 2016; Pisano, 1990; Verwaal et al., 2009; Ziedonis, 2004); and (iii) R&D strategic alliances and networks – when

⁴¹ It is worth noting that the farmer can become a breeder's competitor if he decides to save seeds. I look at the relationship in which the farmer is a breeder's client who has the potential to do harmful actions concerning the breeder's IPRs. The tension of appropriating innovation outcomes between competitors is well discussed in the literature.

firms engage in collaboration to perform R&D activities (Baldwin & Henkel, 2014; Laursen & Salter, 2014; Leiponen & Byma, 2009; Manzini & Lazzarotti, 2015; Oxley, 1997, 1999; Ritala & Hurmelinna-Laukkanen, 2009; Stefan & Bengtsson, 2017; Teece, 1986; Veer et al., 2016).

However, Pisano (2006) states that even though PFI had a profound impact on the innovation field, and its relevance in global competition, open source, and other forces is greater than ever, many issues remain to be explored. For instance, the fact that firms proactively shape an appropriability regime in their favor, which includes the engagement in alternative institutional arrangements.

Therefore, despite the pertinence of PFI contributions, I believe that this phenomenon – appropriability strategies – can be addressed in an alternative, broad manner, for two reasons.

The first reason is that the existing literature lacks a perspective on appropriability mechanisms to address situations of weak institutional environment, regarding the firm's costumers' potential actions. For instance, the perspective of IPRs infringement has received scarce attention in the existing body of strategy theories, except for few studies on the software industry (Conner & Rumelt, 1991; Shy & Thisse, 1999). The theme is fairly recent, and more often addressed - above the label of piracy, IPRs infringement and counterfeiting - in the research fields of marketing, information technology, and business ethics (Zhang et al., 2012)⁴².

Some kinds of creative goods, like luxury apparel and accessories, are often difficult to create but easy to copy. It is well known that in the luxury fashion industry, copiers typically free ride on the creators' efforts. Copying is also particularly easy in computer software, print, and recorded media, and most literature focuses on these industries. As seen in section 2.3.1, the plant propagation method of some economically important crops makes the seed industry very similar to the above-mentioned industries in one aspect, which is the ease of imitation.

In the seed industry, although the farmer is not the final costumer, if we consider the whole agricultural chain, he is the end user of the breeder's product - or the costumer, when strictly considering the seed chain. That is, in this industry, like in the software industry, the potential

⁴² Besides mainly dedicated to the field of digital goods, which comprises software, music and media copyright infringement, the literature does not address the issue on an appropriability strategic basis; instead, it elaborates around protective measures and a structure that leads to a whole prevention strategy.

imitator is the breeder's client. In other words, unlike a wide set of industries, the possible infringement practitioner (offender) is the client himself, and not the competitor⁴³.

It is worth noting that farmers cannot copy a seed without first purchasing it. According to Burton, Love, Ozertan, and Taylor (2005), in general, the literature on copyright protection has utilized single-period models in which costumers can copy a durable good without first purchasing it.

The second reason why appropriability strategies deserve an alternative and broad theoretical approach relates to the fact that, even though useful, the PFI framework confines appropriation strategy studies to the models of very traditional industrial and manufacturing sectors. In other words, Teece's PFI model reduces the role of innovators and imitators and their business environment to contexts that do not always match with uncommon/singular business sectors.

Empirical evidence on the use of appropriation mechanisms focuses almost entirely on developed countries and manufacturing and industrial sectors. Milesi et al. (2013) reviewed more than fifteen researches on the theme, since Levin et al. (1987) seminal paper, and found only two references to Latin America, which addressed manufacturing and industrial fields. Sectoral heterogeneity in the use of appropriation mechanisms is a clear result of many of these papers, indicating the existence of sectoral patterns of appropriation.

The seed sector consists of a peculiar situation for analysis, where the appropriability conditions, as well as the nature of the technology, are non-trivial compared to the traditional IPRs systems at the industrial and manufacturing sectors⁴⁴. Burton et al. (2005) state that IPP embedded in self-replicating biological innovations, such as some species of seeds, presents two problems for the innovator: the need for protection of intellectual property against copy, and price competition between new seeds and reproduced seeds.

The above discussion suggests that Teece's (1986) model offers a very useful guide to PFI, but a caveat should be made - one size does not fit all. To appropriate rent from IPRs, when the

⁴³ Just to remember, seed saving is not an infringement in Brazil, but the indiscriminate permission of this practice facilitates seed piracy.

⁴⁴ Just to remember, in this rare empirical context two IPRs statutory mechanisms coexist, the PVP System and the GMO patenting, as is the case of 96.5% of the soybean and 78.3% of the cotton planted in Brazil.

nature of technology and appropriability conditions are not trivial and therefore the dominant design is easily imitable by the innovator's costumer it is not sufficient for the breeding firms to trust on the "PFI recipe" for protecting the idea, achieving the dominant design and reaching scale. There is the need for a broader theoretical framework.

As previously examined by Endres and Goldsmith (2007) and Goldsmith et al. (2006), breeding firms employ several arrangements to improve their IPRs rent appropriation, given the institutional environment. Regarding the unconventional setting that this thesis addresses, I suggest that the integration of RBV with property rights theory acquires great importance for the understanding of this phenomenon. So, in order to understand the existing plurality of forms concerning IPRs appropriation strategies, I asked the following question: *What are the strategies adopted by breeding firms to appropriate rent from their intellectual property rights?* To answer this question, I examined RBV theoretical knowledge and property rights theory.

3.2 Property rights theory for expanding RBV's strategic dynamism

RBV has become one of the most influential theories in the strategic management literature. Inspired by Penrose (1959), RBV scholars developed a conceptualization of sustainable economic result, mostly inner to the firm, where the firm's resource is the leading element and taken as the unity of analysis.

Rumelt (1984) and Wernerfelt (1984) are the precursors of the idea that the internal development of resources, their nature, and the different methods of employing them are related to profitability. Hence, firms should develop isolating mechanisms or resource-position barriers to secure economic rents⁴⁵. Barney (1991, 2001) enhanced RBV framework by defining that once firm's resources are valuable, rare, imperfectly imitable and non-substitutable, and the firm is organized to take advantage of them, a competitive advantage is created. The competitive advantage of the firm can be understood as a function of the combined value and rarity of all firm resources and resource interactions.

Peteraf (1993), in turn, advanced on the link between resources and economic rents by suggesting that resources enable the generation of Ricardian rents and quasi-rents. Therefore,

⁴⁵ Isolating mechanisms: causal ambiguity, firm-specific specialized assets, patents, trademarks, and other forms of legal and technological mechanisms designed to protect proprietary resources (Rumelt, 1984).

firms must pursue four conditions to achieve sustained competitive advantage. These include superior resources (heterogeneity within an industry), *ex-post* limits to competition, imperfect resource mobility, and *ex-ante* limits to competition.

3.2.1 RBV's scrutiny

Although RBV has been widely employed, it also received considerable criticism. From the beginning of the years 2000, many authors like Coff (1999), Foss and Foss (2004, 2005, 2006), Kim and Mahoney (2002, 2006, 2007), Kraaijenbrink, Spender, and Groen (2010), and Lavie (2006), among others, have attempted to lead RBV to a more dynamic direction.

By stating that firm's possession of specific capabilities distinguishes successful from unsuccessful firms, RBV is implicitly assuming that property rights of resources are secure, suggesting that the ownership of certain resources automatically leads to economic rents.

Authors like Foss and Foss (2005, 2006), Kim and Mahoney (2002, 2006, 2007), Kraaijenbrink et al. (2010), and Monteiro and Zylbersztajn (2012) claim that traditional RBV literature neglects the ownership issue, suggesting that it is complete and unconstrained. One criticism is that RBV brings the "illusion of total control", by trivializing property rights issues and exaggerating the extent to which managers can control resources or predict their future value (McGuinness & Morgan, 2000). According to Lavie (2006), RBV pioneering studies do not focus on appropriability issues, and assume that the appropriability of rents requires ownership, or at least the complete control of the rent-generating resources.

By assuming that firms have a complete and undifferentiated control over resources, RBV fails to recognize the various types of rights that can be associated with a particular resource - rights to consume, to obtain income from, and to alienate resource attributes (Alchian & Demsetz, 1973). Moreover, fails to recognize also the implications regarding the extent to which the potential capacity of a resource can be attained (Kim & Mahoney, 2006).

Makadok (2001) observes that the possession of resources is not sufficient, and only by being able to deploy them a sustainable competitive advantage can be reached. Lavie (2006) goes further, by arguing that ownership or control of resources is not a necessary condition for competitive advantage; instead, he claims that a weaker condition of resource accessibility,

which establishes the right to utilize and employ resources, or enjoy their associated benefits, may suffice. This idea is similar to Penrose's (1959) suggestion, that what creates value for the firm are the services that resources provide, not the resources themselves. Putting it differently, resource configurations or combinations are more likely to explain performance than single resources.

In short, what I argue is that RBV has somewhat neglected the Property Rights theory. Kim and Mahoney (2002, 2007) warn that RBV, inaccurately, assumes that property rights of resources are secure. Accordingly, one must protect the value created, due to the possibility of dissipation. Property rights theory explains why the actual value created can be disappointingly below the potential value creation.

According to Foss and Foss (2005), the value that a resource owner can create and appropriate depends not only on the use, scarcity and outside options of the resource, but also on the transaction costs of trading and protecting the property rights of the attributes that make up the resource.

The soybean and cotton seed industry cases are examples of business contexts where there are struggles for establishing property rights to enhance the economic value of resources, contradicting the RBV's control fallacy. The cases show a relevant economic gap between potential and realized value. The size of the informal seed market in Brazil, 29% in the soybean case and 43% in the cotton case, gives an idea about this economic gap.

Before proceeding with the analysis of how the cases can contribute to enhancing the validity of RBV as a strategic management theory, I present a brief overview on Property Rights Economics, and how its incorporation into RBV has evolved.

3.2.2 Theory on Property Rights

Property rights are vital for interactions between parties in a transaction, as well as for the economic outcome of this transaction. Coase (1960), who introduced property rights into mainstream economics, states that property rights frameworks evolve in response to the

economic problem of allocating scarce resources, and the prevailing specification of property rights affects economic behavior⁴⁶.

Demsetz (1967) observed that individuals are prone to establish ownership, as the value of common property increases; that is, provided that potential economic gains are expected, there will be a change in the system of property rights that leads to the attainment of these potential economic gains. Adjustments in property rights will respond to changes in technology (production possibilities) and in relative prices, which old institutional arrangements poorly address.

In tune, North (1990) asserts that potential profits that cannot be appropriated within the existing framework lead to the development of new institutional arrangements, in which institutions evolve toward more efficient economic solutions. However, in a world of positive transaction costs, this is a gradual process, at best (Williamson, 2000), and may lead to cases where systems of property rights are not efficient (North, 1990). Property rights outcomes may be ambiguous, and once they are embedded in formal and informal rules the costs of enforcement will reflect the institutional environment.

Eggertsson (1990) contributes to the economics of property rights. He adds the component of political processes in dealing with property rights and free-rider problems in groups' decision-making. The political dynamics, third-party enforcement, efficiency of government mechanisms, and the overall institutional framework affect property right's effectiveness. The formation of the property right's system also reflects the distribution of power within a society (Eggertsson, 1996).

The economic relevance of property rights depends on their recognition by society (Barzel 1994, 1997; Coleman, 1990; Eggertsson, 1990). According to Barzel (1994, 1997), there is a fundamental difference between legal rights and economic rights; the former refers to rights

⁴⁶ In this dissertation, I build my arguments based on the earlier set of studies on property rights, commonly referred as "classical property rights theory". Seminal works include those by Coase (1960), Alchian (1965), Demsetz (1967), Cheung (1970, 1983), Alchian and Demsetz (1973), Libecap (1989), North (1990) and Barzel (1989). Eggertsson (1990) presents a good review of this literature. Another stream of work in property rights is the "modern property rights theory", of the formal models of Grossman and Hart (1986) and Hart and Moore (1990). The so-called "GHM model" main argument consists of assigning ownership (residual control) to the economic party that has more to gain or lose from the performance of a particular resource, so that economic incentives of the owner are aligned with the maximization of economic performance of that resource.

recognized and enforced by the government, and the latter regards the capacity of an individual to appropriate it, by excluding third agents. The author observes that “the economic rights over assets are not constant, they are a function of individual’s direct efforts at protection” (Barzel, 1997, p. 4), and are “related notably to what they believe they control *de facto*” (Barzel 1994, p. 34).

The division of rights over assets is a source of conflict and dispute. When the use of an asset, whose rights are owned by an individual, creates externalities to others applications of the same asset, whose rights, in turn, are held by others, we can say that what is being traded is the right to take some actions, instead of the right over the physical asset (Coase, 1960).

Coase’s (1960) assertion is confirmed by Barzel’s (1997) important argument, that an asset is composed of multiple attributes, and property rights linked to each attribute may be shared by different individuals⁴⁷. This scenario is a permanent source of externalities. Demsetz (1967) developed the following arguments concerning the problem of externality. Every cost or beneficial effect in a relationship between parties is a potential externality, and the primary function of property rights is to guide incentives to achieve a greater internalization of externalities.

Therefore, property rights develop to internalize externalities, when the gains of internalization become larger than their costs. Property rights’ theorists discuss the institutional constraints that inhibit the evolution of property rights toward internalizing externalities. In doing this, they are concerned about the realized value over assets. “The fundamental insight of the property rights theory is that new ways to bundle property rights are (imperfectly) adaptive responses to internaliz externalities in new contractual situations, in order to allocate resources more efficiently” (Kim & Mahoney, 2002, p. 235).

Meanwhile, RBV theorists discuss the potential of value creation over resources. Therefore, the way property rights are constrained by law, agreements or norms, affects how much value a resource owner can create and appropriate from that resource, and this is why property rights are important for RBV and strategy (Foss & Foss, 2005).

⁴⁷ Known as the concept of ‘resource as a bundle of attributes’, introduced by Barzel (1989), who advocates that it is more efficient to examine the ownership of attributes, instead of the ownership of the resource itself (Foss & Foss, 2001). I return to it in the next section.

In the soybean and cotton seed industries, breeders employ a range of resources to create new varieties of plants to meet farmers' needs. According to RBV reasoning, when this purpose is reached by following Barney's (1991) or Peteraf's (1993) approach, a sustainable competitive advantage is achieved and value is created. However, RBV theorists do not consider that externalities would emerge through the lack of perfect economic rights. The case is an illustration of such circumstance. The biological characteristics of the plants make it easy for soybean and cotton farmers to self-reproduce the seeds, thus eroding the economic rent of breeding firms.

This example demonstrates that protection of resource value goes beyond preventing imitation by competitors. Firms may still be hindered from appropriating value. Resources are not fully protected from value erosion unless they are protected from all possibilities of capture⁴⁸. In other words, "the competitive advantage is just sustainable if the firm has perfect economics rights to every potential use (attribute) of the resource" (Monteiro & Zylbersztajn, 2012, p. 371).

The ability of breeding firms to prevent capture depends on the legal IPRs protection offered by the State, on third parties capture attempts – soybean and cotton farmers, in this case – and on the appropriation efforts of individual breeding firms (Monteiro & Zylbersztajn, 2012). As this dissertation purpose was to understand this latter issue, in the next section I review the key elements regarding how the application of the property rights theory to the problem of value appropriation has been interacting with RBV.

3.2.3 Property rights and RBV

Property rights are social institutions that define the range of privileges granted to individuals regarding specific resources. Hence, from the property rights perspective, firms' resources are not the physical resources, but rather the property rights.

Penrose (1959) defined that an asset consists of different available attributes or services to be provided. Barzel (1997) extended the idea by stating that property rights are held to such

⁴⁸ Foss and Foss (2005) define capture as resource consuming activities to appropriate value from others, without compensating them.

attributes, and not to the asset as a whole. Barzel's conceptualization is relevant to RBV, because since a resource is composed by several attributes to which a bundle of rights can be assigned - the so-called concept of 'resource as a bundle of attributes' - RBV's understanding of resources can be improved.

The refining of the RBV resource concept is proposed by Foss and Foss (2005). The authors claim that "resources are better thought of as molecules that are composed of bundles of property rights to attributes". Accordingly, property rights theory holds the potential to enriches the Strategic Management study of value creation and appropriation.

RBV indicates that resource deployment is a managerial function; if one incorporates the property rights conceptualization of resources – a bundle of property rights for attributes - then property rights bundling is a managerial function, and the services offered by the resources are determined by their property rights. Thus, according to Kim and Mahoney (2002), to clearly define property rights of potentially valuable resources can be a source of competitive advantage.

Foss and Foss (2005) add the transaction costs component to the above logic. They argue that strategic realization and appropriation of value from resources depend on transaction costs. Rent differentials that resources create are partly a function of the differential costs of protecting resource attributes from capture; or, in other words, value creation is a function of transaction costs.

Thus, they state that the firm can appropriate more economic value created by resource utilization, by defining more clearly the property rights of these resources. Theoretically, the authors advance further, developing a relevant point: value creation is an outcome of the savings obtained in transaction costs, in a transaction involving a certain resource.

Indeed, Foss and Foss (2005) made a key contribution regarding a business context of positive transaction costs, that is, the real world. Property rights theory must be considered in an analysis of realized economic value creation, because the resource value that a firm can create and appropriate depends on the bundle of property rights that it holds for that resource, the constraints imposed on these property rights, and the costs of trading them.

Kim and Mahoney (2006), in an attempt to lead RBV into a more dynamic direction, claim that there is a need for a theory that fully accounts for the endogenous adaptive function of the firm. They build their argument around Foss and Foss' (2005) idea, that applying property rights theory to explain value creation needs to be expanded, by including not only economizing on transaction costs, but also generating 'new combinations', *à la* Schumpeter (1942), and adaptive responses to transaction costs.

Combining the logic of Foss and Foss (2005) with Kim and Mahoney's (2006) attempt to make the process of creating and appropriating value more endogenous, in order to give more dynamism to RBV, the reasoning develops as follows.

Firms might be able to appropriate value in a bargaining situation - even if the value is not added to the whole value chain, but only to the focal firm. Second, firms might be able to save on transaction costs, which is possible through more efficient governance mechanisms or institutions, whether formal or informal. This creates economic value not only to the individual firm, but also to the whole chain. Kim and Mahoney (2006) define economic rents as a combination of the returns that the firm can appropriate from resource utilization, and the returns from entrepreneurial activities. They argue that it is not sufficient to consider only the economic return from appropriation based on resource use, but also the entrepreneurial rent - based on Schumpeterian ideas of new resource combinations and entrepreneurial alertness (Kirzner, 1973). This claiming fits especially into the context of knowledge assets, as is the case addressed in this dissertation.

In short, in the process of defining property rights⁴⁹, organizations find out new solutions to problems, and in doing so they define property rights in ways that were not available before. Hence, Kim and Mahoney's (2006) contribution to the integration of property rights and RBV shows that it is a dynamic evolutionary process of entrepreneurial discovery, for defining and redefining property rights over potential value creating resources.

In a constant effort to change RBV into a more vigorous theory, Foss and Foss (2006, 2008) show their understanding on how transaction costs shape the process of entrepreneurial

⁴⁹ At the macro level, the definition of property rights means the establishment of property rights regimes or institutional settings, while at the micro level it means the choice of governance arrangements and organizational processes' adaptation (Kim & Mahoney, 2006).

discovery. They argue that economizing on transaction costs and entrepreneurship are intertwined⁵⁰. One important implication to RBV is that since firm's ability to earn rents is linked to the establishment and enforcement of property rights over attributes, whose process, in turn, results from the transaction costs involved, this is the reason why the value of resources partly results from the process of discovering and achieving new attributes for them. According to the authors, the other part comes from the transaction costs economizing in exploring those attributes.

To build this logic, Foss and Foss (2006, p. 56, 2008), in line with Nelson and Winter (1982), "stress that most assets have multiple non-specified and not yet discovered attributes [...]. The value to the resource owner of the attribute depends on whether he holds secure property rights to the relevant attribute." Thus, the authors argue that, since the property rights to the resource are secure, the value that the owner can derive from attributes yet to discover are safe and this fact influences the entrepreneurial actions and judgements. Recalling Lavie (2016), I go further by arguing that to protect the value one can derive from a resource, it suffices that access to the resource's attribute is secure.

In other words, the value to the attribute of the resource is a function of the protection – how well it is defined - of property rights to the attributes, that is, it depends on the institutional environment. Hence, IPRs assignment specifications in the seed industry affect the ability of the breeding firm to appropriate and realize value from its resources.

Foss and Foss (2006, 2008) argue that property rights foster entrepreneurial discovery. If the firm is not able to safeguard property rights to the resources' attributes, they might never be discovered or realized, because without appropriation guarantees, the firm would not exploit these resources.

The emergence of GMOs in Brazilian agriculture, backed up by The Brazilian Patent Law, is particularly interesting because it represents a very important transformation in the technological environment of the seed industry. This significantly changed the appropriability

⁵⁰ Foss and Foss (2006) clarifies that the kind of entrepreneurship that was implicitly addressed in Foss and Foss (2005) referred to the engagement in searching ways to reduce transaction costs: "[...] new ways of defining (e.g., better ways of measuring attributes), protecting (e.g., ways of protecting credit card information in virtual exchanges), and exchanging (e.g., internet trade) property rights [...]." (Foss & Foss 2006, p. 57). However, in the 2006 paper they recognized that entrepreneurship also involves discovering new resource attributes.

regime in that industry, and made the exploration of genetic engineering and its use much more attractive. The space for potential discoveries was expanded, as a result of the delimitation and enforcement of property rights for biotech R&D.

More recently, Monteiro and Zylbersztajn (2012), in an attempt to better conceptualize resources as a bundle of attributes to which economic property rights can be assigned, studied royalties' collection on the genetically modified technology of soybean seeds in Brazil. The authors revealed that the IPRs appropriation mechanism undertaken by the firm is based on the unbundling of the attribute (tolerance to glyphosate herbicide) from the resource (seed), outlining a way to negotiate the attribute, regardless how the acquisition of the resource was made – whether in the formal or informal market.

Their contribution to the refinement of the relationship between property rights and RBV goes in two directions. The first is what they call 'unbundling' - strategic actions directed to one attribute of a resource. The second refers to the institutional environment, which plays a key role in the design of the protection strategy. One should consider the institutional environment as a parameter that shifts the strategic balance regarding the protection and capture of economic property rights (Monteiro & Zylbersztajn, 2012).

In the next section, I examine the link between property rights and RBV in order to analyze the business context of seed breeding. I try to extend the understanding of unbundling on property rights assignment to resources' attributes, as a result of the delimitation and enforcement of property rights to biotech R&D. I also address the issue on how IPRs appropriation strategies respond to the institutional environment's influence, regarding the interaction and configuration of resources' attributes, under the insight of entrepreneurial judgement.

3.2.4 Property rights extending RBV in the context of seed breeding

Well-defined property rights' regimes (patent and trademark protection and equity-share arrangements) provide direct mechanisms for economic appropriability (Barzel, 1989; Eggertsson, 1990). On the other hand, poorly or undefined property rights are sources of market frictions that create misleading price signals, and thus reduce efficiency in the allocation of resources (Coase, 1960). The property rights theory provides a comparative economic

efficiency framework and an evolutionary perspective of the processes through which institutional choices are made.

According to Monteiro and Zylbersztajn (2012; 2015), the institutional environment affects IPRs' modes of governance and firms strategy in the seed industry. They compared the soybean seed industry institutional environment between USA, Brazil and Argentina, and identified the adoption of different property rights protection strategies by biotech firms, regarding the distinct institutional contexts.

The soybean seed's royalties' collection scheme, described in Section 2.3.2 - in which declaring the use of saved seed, the farmer is taxed at 10% on the original price or charged at 7.5% on the volume of grains delivered, in case of non-prior declaration - illustrates how difficult it is to get the correct institutional details of the property rights for realized value.

Foss and Foss (2004, 2005) suggested different governance structures to reduce property rights' capture by third parties: use the legal system; establish private orderings (Williamson, 1996); deter entry (Tirole, 1988); write contracts; and adopt sales strategies to hinder adverse sorting (Barzel, 1982). On the other hand, Monteiro and Zylbersztajn (2015) indicate only two alternatives: a strategy centered on the use of the legal system, and private protection efforts. They summarize the elements that determine the effectiveness of the capture: the technical possibilities of imitation/reproduction of the valuable assets, and the quality of the institutional controls.

In analyzing the breeding activity in the light of Barney's (1991) approach to RBV, we notice that the breeding firm, by combining its different resources - exclusive germplasm bank, researchers' technical knowledge, detailed market knowledge, and organizational research routines, among others -, will achieve a new variety that most likely will meet farmers' demands.

The new variety meets the four suggested attributes – valuable, rare, imperfectly imitable and non-substitutable - by Barney (1991), and so offers high potential to create value for the breeding firm. Therefore, following the traditional RBV, the breeding firm, by combining several resources for the conception of such variety, is creating a competitive advantage and, deductively, has already appropriated the value created. However, as we have seen, property

rights theory informs that the realized value creation may be disappointingly lower than the potential value creation.

Since the institutional environment where breeding firms operate does not have a well-defined framework of property rights, the potential value creation in the development of a new variety of seed does not occur. Farmers can easily capture it, once they decide to save the seeds. Therefore, although the breeding firm was able to create value, it could not fully appropriate it.

Using Peteraf's (1993) cornerstones of competitive advantage to examine the development of a new plant variety, the breeding firm could get rent based on the heterogeneity of the genetic raw material kept in a firm's germplasm bank. The stock of a collection of genetic material, together with the researchers' knowledge and market knowledge, comprise skills that are not easily transmitted to a competitor (imperfect mobility). Such competencies are difficult to reproduce, which imposes ex-post limits on competition, since it involves tacit knowledge that prevents imitation and makes substitution impossible, thus providing competitive advantage. Moreover, because of the established research routines, the breeder firm imposes ex-ante limits for competition.

Although, from Peteraf's (1993) perspective, the firm was able to achieve competitive advantage, without a well-designed system of property rights there is no guarantee that farmers will not capture the value.

Actually, if one follows RBV's (Barney, 1991; Peteraf, 1993) reasoning, we might consider that a new plant variety is a source of competitive advantage, whose value is secured by the configuration of the firm's internal resources. This is not true in many business environments, but gains more evidence and a problematic shape in our case, since IPRs regulation for seeds is poorly defined, from the breeder's point of view. The Brazilian PVP System does not provide full value appropriation to breeders.

In the case of soybean and cotton seeds, due to the existence of some intrinsic characteristics, it is easier to reproduce valuable attributes. This is the case when the farmer decides to save the seed. Otherwise, if the farmer chooses to buy a new seed, he preserves the inimitable aspect of the resource, and thus a competitive advantage (value) can be guaranteed.

As already highlighted, appropriability under PVP systems is limited by the farmer's privilege, which erodes the ability of breeders to appropriate rent by selling seeds. On the other hand, patents do not have limits to appropriability, such as the farmer's privilege, and from this perspective, they can be considered more valuable than PBRs, since their enforcement is stronger.

Considering this context, we suggest that, for the breeders, the combination of the new developed variety with a GM technology with a valid patent, works as a kind of appropriability mechanism, which is not available when the patented technology is not present in the seed. I argue that breeding firms should seek to insert a GM gene with a valid patent in their varieties, not only with the purpose of adding a genetic trait useful for the farmer, but also as a means of strengthening IPRs' appropriation over the variety. That is, the combination of the variety with the patented GM gene is considered an IPRs appropriation strategy.

Two theoretical propositions can be deployed from this. The first goes back to the Barzel's (1997) concept of resource as a bundle of attributes. Considering that an attribute corresponds to any specific feature or possible use of the resource to which property rights can be assigned, in this case, through the insertion of the patented GM gene in the seed, each of the technical and agronomic features, together with the higher possibility of IPRs enforcement carried by the gene, can be entitled as an attribute to the seed as a resource.

Changes in the costs of defining and enforcing property rights – transaction costs - driven by technological or legal changes, aware entrepreneurs about the discovery of new potentially valuable resource attributes. I advocate that the patented GM gene has acquired one more attribute, besides those for which it was designed – to meet a production challenge –, which is the possibility to strengthen IPRs appropriation of plant varieties by the breeders. Hence, I present **proposition 1: the recognition of new resources' attributes, due to the specification of property rights, offers the potential for the creation of sustainable competitive advantage.**

Following RBV's reasoning (Barney, 1991; Peteraf, 1993), a new plant variety is a source of competitive advantage. To change this potential value to realized value, one way is by doing an introgression of a patented GM gene into the new variety. Traditional RBV overlooks the gap between potential and realized value, which can be better understood by bringing property

rights' elements to the discussion. Thus, **proposition 1a is: the adoption of well-defined IPRs appropriation mechanisms promotes the sustainability of competitive advantage.**

Propositions **1** and **1a** are interconnected, since the potential for value creation in the first approach is precisely the possibility of improving value appropriation in the second.

Proposition 2 relates to the value that the patented GM gene inserted in the seed provides to it. This value can be accessed by the breeding firm, and is a function of the established structure of property rights, and ultimately is a function of the macro-institutional environment. According to Foss and Foss (2006) and Lavie (2006), the value to right holder of the resource attribute depends on whether he holds or access secure property rights to the relevant attribute. In other words, the value of the resource attribute depends on how well IPRs are designed. Thus, **proposition 2 is: Holding one single attribute of a resource, with well-defined property rights, increases the possibility of rent appropriation of the resource as a whole, *ceteris paribus*.**

It is crucial to point out that it does not matter for the case if the patented GM gene was developed by the biotech firm itself or has been licensed to the breeder. As noted by Barzel (1994), the key aspect in the definition of economic property rights is the “ability to directly consume services of the asset, or to consume it indirectly through exchange”. Although the biotech firm owns the property of a GM gene, it gave the right of use to the breeder, and this is sufficient, according to Barzel's logic, so that the licensee can get income from the resource.

The licensing of a patented GM gene - not just for its technical attribute but also for its IPRs protective feature - is in line with Lavie (2006). Traditional RBV emphasis on the proprietary internalization of resources is not relevant, since firms are increasingly outsourcing valuable and difficult-to-replicate business functions, and different types of partnerships play a significant role in shaping competitive advantage (Lavie, 2006; Verwaal et al., 2009)⁵¹. Many authors consider access, rather than ownership or control of resources, as central to firms'

⁵¹An interfirm alliance is an arrangement between firms that exchange or share resources and that engage in the joint development or provision of products, services, or technologies (Gulati, 1998). Alliances can take different forms, including joint ventures, franchising, long-term marketing and licensing contracts, reciprocal trade agreements, R&D partnerships, and affiliation in research.

strategies (Coombs & Ketchen, 1999; Das & Teng, 2000). Figure 6 illustrates the theoretical model.

Figure 6 – Illustration of the theoretical model

Source: the author

In the proposed model, the picture on the left shows how breeders generate, through conventional breeding, a flow of innovation that reaches the farmers. However, given the institutional environment framed by the Brazilian PVP System, the reverse flow of value that would reward the breeding firms' R&D is partially lost, because breeders cannot fully appropriate this potential value.

In the picture on the right, the biotech firm is introduced in the seed production chain. The biotech firm, when licensing its GM technology to the breeding firm, besides bringing the desired agronomic characteristics, also provides the support of a better defined property rights environment. This second attribute enhances the breeder's appropriation of IPRs value. I propose that, once breeders recognize this value provided by patent enforcement, they may deliberately employ the insertion of the attribute into the seed as an appropriation strategy. Chapter 4 explores the efforts of soybean seed and cotton seed breeding firms, to improve IPRs appropriation.

4 SOYBEAN AND COTTON BREEDING: AN EMBEDDED DOUBLE CASE STUDY

Authors such as Lopez (2009) and Milesi et al. (2013) state that little is known about the IPRs appropriation strategies employed in the case of non-manufacturing sectors in developing countries. Endres and Goldsmith (2007) described strategies adopted in the Argentinean seed industry, while Monteiro and Zylbersztajn (2015) examined the cases of property rights appropriation concerning GM soybean seeds in Brazil and Argentina.

My purpose was to understand the efforts of Brazilian breeders to appropriate rent concerning farmers' compliance with IPRs, in a weak environment where seed saving is widely permitted. Theoretically the existing body of knowledge does not explain the appropriation challenge brought by the complex context described in the previous chapters.

Baker and Gil (2013) and Eisenhardt (1989a) refer to diverse situations where little is known about a phenomenon to which current perspectives seem inadequate. They then argue in favor of the appropriateness of theory building from case studies for those situations.

Baker and Gil (2013) define clinical studies in organizational economics as stories, in depth-descriptions, that contain qualitative information that is not suitable for statistical analysis, but can be useful as evidence to support theoretical conclusions. "They combine the specific and the general to guide theorists and empiricists in what to model, how to model it, and how to tell whether their results are valid and sensible" (Baker & Gil, 2013, p.195).

There are several authors (Baker & Gil, 2013; Creswell, 2013; Eisenhardt, 1989a; Miles & Huberman, 1994; Miles, Huberman & Saldana, 2014; Yin, 2006; Stake, 1998) who seek to typify case studies according to the researchers' purpose.

Assuming that there are facts that are impossible to identify by just looking at datasets, I adopted in this thesis the Baker and Gil (2013) approach. I did this, together with some contributions of various authors that provide relevant insights for building a case study, in order to achieve this dissertation's objective. That is, to distinguish between the different types of IPRs appropriation strategies employed by breeding firms in Brazil. This is in line with Eisenhardt's (1989b) argument that "the final product of building theory from case studies may be concepts – e.g.

deliberate and emergent strategies -, a conceptual framework, or propositions, or possibly midrange theory” (Eisenhardt, 1989b, p. 545).

This chapter is organized as follows: from sections 4.1 to 4.4, I comment on the research preparation and organization, with a detailed explanation about the research method, the research design, sampling, data collection procedures and data analysis. In section 4.5, I analyze all the information gathered to develop the case study. Chapter 5 addresses the discussion of results.

4.1 Research Method

I was interested in an individual issue, which is the case of breeding firms that struggle to appropriate rent, by considering the farmers’ compliance with IPRs. In other words, my interest rested on two individual cases - one of soybean breeders and the second of cotton breeders. The literature on case studies comprises both single cases and multiple or collective cases studies.

Even if the institutional context of the soybean seed chain and the cotton seed chain is the same, their biological features are different, and so are both crops value chains. Therefore, I chose to conduct a multiple case study, more specifically a double case study.

According to Eisenhardt (1989a), multiple case studies allow replication and extension between individual cases. This means that individual cases can be used for independent corroboration of specific propositions, and multiple cases can be used to develop a more elaborate theory. Different cases highlight complementary aspects of a phenomenon. By putting together the individual patterns, researchers can draw a more complete theoretical picture (Eisenhardt, 1991).

Since settings may have sub-settings, Eisenhardt’s replication and extension logic is also in line with some authors (Miles & Huberman, 1994; Yin, 2006), who consider that both single and multiple case study designs can come up with kinds of derivations. Hence,, I chose to conduct a particular kind of multiple clinical case study, which is the embedded one (Yin, 2006).

It consisted of two cases - soybean and cotton breeders, each one with multiple units of analysis. This subunits were individually analyzed and collectively compared. Thus, the underlying logic

was replication, and the subunits that confirmed emergent relationships enhanced confidence in their validity. Subunits that did not confirm the relationships provided an opportunity for refining and extending theory.

The motivation for the embedded type lay on the fact that dealing with subunits of the same case, although keeping the external context constant, it is possible to collect individual impressions and compare them. For instance, once soybean breeders face the same institutional environment, the same technical and production challenges, and the same phytosanitary treats, having a variety of individual firms, with their own features, and within the same context, becomes a great advantage for the researcher.

4.2 Research Design

In the next sub-sections, I explain the choice of the research setting, which is the soybean and cotton seed industries, and the steps taken to conduct data collection.

4.2.1 Research Setting

The Brazilian seed industry offers an experimental setting that appears to be fruitful in addressing the important topic of appropriability, laid aside by RBV. I chose two agricultural crops of high economic importance as case studies: soybean and cotton. Table 2 presents the importance of these crops to the Brazilian economy.

Table 2 – Economic importance of the agricultural crops chosen for the case studies in Brazil

Commodity	Brazil's position in global production	Brazil's position in global exports	Share of Gross Domestic Product (GDP) 2017
Cotton	4 th	3 rd	0.5%
Soybean	2 nd	1 st	3%

Source: based on data retrieved from USDA (2018) and CEPEA (2018).

I did not choose these crops based only on their economic importance. They also serve the need to analyze crops whose propagation process rises concern about the easy of reproducibility, and consequently makes appropriability a challenge, as is the case of both crops. I must admit that the combined choice was also a matter of convenience, since breeders of the two crops are the same.

In the Brazilian crop season of 2017/18, soybean seed varieties offered for sale originated from 31 different legal breeding entities. Considering the market share and the process of interviews for data collection, I defined the number of 22 soybean-breeding firms, as I explain below.

As some varieties result from Embrapa's joint work with regional partners, for the purposes above-mentioned I gathered all of them under Embrapa's label. There are also cases of breeders whose varieties registries were under different legal entities, but belonged to the same business group; in these cases, I also joined the varieties under one breeding firm's name. Finally, there were cases of firms that passed through M&A processes and whose varieties – at the date of data collection – were still registered under the name of the original breeders. In this last case, varieties were gathered under the name of the breeding company that resulted from the M&A process. The cotton seed industry comprises only four breeding firms. It is worth mentioning that there is an intersection between soybean and cotton breeders.

4.2.2 Sampling and research preparation

According to Creswell (2013), the concept of purposeful sampling is used in qualitative research. The researcher selects individuals and sites for the study because they can appropriately understand the research problem and the central phenomenon under study.

I followed a deliberate theoretical plan for choosing the sample. This purposeful selection is in tune with Eisenhardt (1989a) and Miles and Huberman (1984). The former proposes that, for building theory, cases should be chosen for theoretical, not statistical reasons. She noted that random selection is neither necessary, nor preferable. The latter asserts that “qualitative samples tend to be purposive because the initial definition of the universe is more limited, and partly because social processes have a logic and coherence that random sampling can reduce to uninterpretable sawdust” (Miles & Huberman, 1984, p. 27). I sought to talk with as many soybean and cotton breeders as possible. Deliberately, I prioritized interviews with the market leaders.

Following Creswell's (2013) guidelines, I presented to the study participants a consent form that included the following topics⁵²:

⁵² See Appendix A.

- a) A short biography of mine;
- b) the central purpose of the study and the related procedures;
- c) comments about protecting the confidentiality of respondents and their firms;
- d) the expected returns from the participants;
- e) the signatures of the participants and of the researcher⁵³.

The interview protocol applied to the breeding firms was refined from insights obtained in the first interview, with the president of the Brazilian Plant Breeders Association (Braspov)⁵⁴. This was not a strictly pilot test, as recommended by Yin (2006), since the respondent did not answer as representative of a breeding firm, instead for the organization that represents them all. Considering the small universe of breeding firms, I could not give up any interview on behalf of the refinement of procedures.

I applied some specific questions to organizations with particular features, related, for example, to their public or private nature, origin of capital, and if they were a business unit that belonged to a diversified enterprise. Eisenhardt (1989a) suggests that additional adjustments can be made in data collection instruments, since they allow the researcher to examine emergent issues or to take advantage of special opportunities that are present in a certain situation. She calls this flexibility as ‘controlled opportunism’, and rejects the complaints on the lack of systematization. This flexibility offers researchers the possibility of seizing the uniqueness of a specific case and the emergence of new issues to improve results.

4.3 Data Collection

I relied on several data sources, of which the more relevant were the semi-structured interviews and data retrieved from Mapa. Other sources were breeders’ websites, Abrasem, and some public documents available at the internet. Triangulation of data from different sources provides more accurate information and improves the robustness of results (Eisenhardt, 1989a).

⁵³ Most participants did not want to sign the form, although they agreed to disclose information, in accordance with their confidentiality guidelines.

⁵⁴ Associação Brasileira de Obtentores Vegetais (Braspov), founded in 1997, is a civil society non-profit organization that was created to join, represent, assist and guide public and private plant breeders, who keep their breeding programs with the primary goal of offering to Brazilian farmers’ varieties that are highly productive, stable, disease resistant and adapted to our soil and weather conditions.

4.3.1 Interviews

The study covered 10 organizations - nine breeders and Braspov. Primary data sources were 12 semi-structured interviews, with both open and closed-ended questions, which made up a total of 11 hours of interviews. There were cases in which I interviewed more than one person in the same organization, as well as situations where I made more than one interview with the same person, in order to clear doubts.

I conducted the first interview with Braspov's president, to understand important details of the legislation, as well as to clarify the role of the Association regarding the themes of saved seeds and piracy. In doing this, I became more acquainted with the topics, which prepared me for the interviews with breeders.

Among the nine breeders interviewed, only one agreed to reveal his identity, in association with the interview's content. Four of them agreed to disclose their identity, without associating it to the content of the answers. The other four requested secrecy of their identity. Taken together, none of the breeders had the identity revealed; we chose to identify them by codes (BF1 to BF9).

I conducted the interviews from June to December 2017. Since the majority of breeders are located in Brazil's countryside, few interviews were made in person; in most of them, I used IT tools that allow distance communication.

Table 3 summarizes the characteristics of the breeding firms and BRASPOV, together with data collection. Appendix A presents the interviews' protocol.

Table 3 - Overview of the organizations interviewed and summary of data collection strategy

Organization	Crop ^a	Founding date in Brazil	Nationality	Number of varieties available (2017/18) ^c	Approximate number of breeding employees	Brazilian Regions served	Person interviewed	Interviews duration (minutes)	Interview method
Braspov	NA ^b	1997	Brazilian	NA	NA	Brazil	President	195	WebEx
BF1	S + O	2014	Foreigner	5	5 ^d	GO, MS, SP, PR, RS	Sales representative	23	Skype
BF2	S + O	1974	Foreigner	38	141	Southeast, Middle-West, South	Administrative Director	63	WebEx
BF3	S + O	1973	Brazilian	140	NR ^e	Brazil	(1) IP Coordinator (2) Researcher	41 -	Skype E-mail
BF4	S	2009	Foreigner	117	250 ^d	Brazil	Marketing Manager	35	Phone
BF5	S + C + O	2007	Brazilian	S = 3 C = 4	25	MT, GO, MA, PI, BA	Executive Director	43	Skype
BF6	S + C + O	1995	Foreigner	S = 85 C = 15	NR	Brazil	(1) Soybean marketing and product manager (2) Regulation manager	28 29	WebEx
BF7	S + O	2005	Foreigner	77	100	Brazil	Go to market and Business Intelligence manager	51	Phone
BF8	S + O	2000	Foreigner	55	NR	Brazil	Legal Director	67	In person

continues

Organization	Crop ^a	Founding date in Brazil	Nationality	Number of varieties available (2017/18) ^c	Approximate number of breeding employees	Brazilian Regions served	Person interviewed	Interviews duration (minutes)	Interview method
BF9	S + C	2004	Brazilian	S = 58	180	Brazil	(1) Research manager South	55	In person
				C = 13			(2) Research manager Middle North	23	Phone

Source: Interviews and Brazilian System of Agricultural Zoning of Climatic Risk [SISZARC] (2018)

conclusion

Notes:

^a Crops: soybean (S); cotton (C); others (O)

^b NA: not applicable

^c Refers to the number of soybean or cotton varieties from each breeder, indicated in SISZARC, crop season 2017/18.

^d The breeding firm reported only the approximate number of breeding employees worldwide.

^e NR: not reported

The nine breeding firms studied vary in age, with founding dates in Brazil extending from 1973 to 2014. They also vary in terms of nationality, being three Brazilians and six foreigners. According to Eisenhardt & Graebner (2007) this combination of different characteristics should improve the robustness and generalizability of the results.

Some of the firms in the sample belong to strategic groups within the seed industry or the agriculture inputs industry. The concept of strategic groups was first developed by Porter (1979), who argued that an industry is composed of groups of firms – it could also consist of a single firm –, where each group follows similar strategies in terms of the key decision variables. A broader definition would be “firms competing within an industry, through similar combinations of scope and resources or specific assets that lead them to adopt common strategies within the group, but different from the whole industry” (Cool & Schendel, 1987; Oster, 1994). In other words, the definition of strategic groups approach to the idea of an intra-industry segmentation that might react differently to changes on the environment.

It is worth mentioning that the soybean varieties offered to sale in the 2017/18 crop season jointly by the interviewed breeders comprise 90.5% of the commercial seeds market, according to Mapa (2018). The interviewed breeders asserted that they are responsible for 94% of the commercial seed’s market share. We can see that the measures are quite close, thus the sampling is representative of the soybean seed industry. In the cotton case, according to the interviewed breeders, their market share reaches around 35% of the commercial seeds market.

Although representation is not a feature stressed by case study’s scholars (Baker & Gil, 2013; Eisenhardt, 1989a; Gerring, 2004), I was able to achieve a remarkable number for the soybean seed market. I interviewed more than 90% of this market and three of the four cotton breeders. Therefore, I possibly reached theoretical saturation, and stopped adding cases, once the incremental learning would be minimal. Of course, time constraints also dictated the end of data collection (Eisenhardt, 1989a).

I began the interviews by asking informants about their operations’ features, agricultural crops, market share, Brazilian regions, number of varieties registered, among others. Some questions later proved to be irrelevant to the central problem, and I discarded the answers.

As the interview progressed, I introduced questions about the protection of plant varieties and other efforts of IPRs appropriation. Some probing questions were added, allowing the interviewee to react flexibly to the information that he/she was confronted with. For instance, I presented a brief description of the appropriating mechanisms already described in the literature. I also inquired the interviewees about the use of complementary assets for value appropriation.

The interviews except two, that were answered by e-mail, were recorded and transcribed⁵⁵. Transcriptions were sent to each respondent, so that they could react to any misinterpretation.

4.3.2 Mapa Datasets

Information collected in the interviews was triangulated with three datasets obtained from Mapa. The first regards the production of commercial soybean seeds in the 2017/18 crop season, which was used to measure the breeders' market share, as well as to assist in understanding the information provided by the interviewees.

The second refers to information obtained from the National Agency for Plant Variety Protection⁵⁶ (SNPC), Mapa's body responsible for issuing plant varieties' certificates, for the protection of new varieties released commercially. Data provided contribute to understand the appropriation strategies adopted by breeding firms, as I will discuss further in the Results section. The third dataset regards the varieties registered at the National Plant Variety Registry⁵⁷ (RNC), which is the mandatory registry for all varieties produced and offered for sale in Brazil.

4.4 Data Analysis

I conducted a careful analysis of each interview, and then applied a cross-case analysis to identify similarities and differences, with the aim of identifying constructs across the multiple subunits (breeding firms) and examine whether similar issues and practices emerged in multiple units and in both settings - soybean and cotton (Miles & Huberman, 1984).

⁵⁵ In fact, questions answered by e-mail served to complement the first interview made with BF3 by Skype and BF9 in person.

⁵⁶ Serviço Nacional de Proteção de Cultivares (SNPC).

⁵⁷ Registro Nacional de Cultivares (RNC).

I selected relevant categories or dimensions, for instance, granting of protection certificates, use of the judicial system for prosecutions, adoption of alternative strategies, among others, to look for similarities within groups.

In addition to the interviews' analyses, I used Mapa's datasets to build some descriptive statistics. They served the purpose of giving a better validity to the information gathered through interviews.

4.5 The soybean and cotton seed breeding clinical cases

I discuss both clinical cases in sequence. I first present the soybean seed breeding case. Since the soybean seed industry is bigger than the cotton one, it provides a richer body of information.

4.5.1 The soybean seed breeding case

The sector in which the case develops concentrates important players. The impossibility of disclosing the respondents' names sets the challenge of communicating to the reader the relevance of the firms that take part in the research. Table 4 is an attempt to show it, since the main competitors of the interviewees are among them.

Table 4 - Soybean breeding firms and their competitors

Breeding firm	Main competitors					Frequency of citations
BF1	BF6	BF4	-	-	-	0
BF2	BF6	BF4	BF7	BF9	BF8	1
BF3	BF6	BF2	-	-	-	0
BF4	BF6	BF7	BF9	-	-	6
BF5	BF4	-	-	-	-	0
BF6	NI	-	-	-	-	7
BF7	BF6	BF4	Another BF	-	-	4
BF8	BF4	BF7	BF6	-	-	1
BF9	BF6	BF4	BF7	-	-	2

Source: interviews

Notes: BF – breeding firm; NI – not informed

There is only one mention of a firm, that is not part of the sample, labeled as “another BF”. Breeding firms BF6, BF4 and BF7 were the most cited as competitors of others. The three firms

hold together 72.2% of the commercial soybean seed market, according to Mapa (2018), and 75% according to their own information.

Despite the competition in the market, breeding firms can cooperate in the pre-competitive phase, as, for instance, in the research phase of an improvement of new varieties. Table 5 mentions the partnerships reported by the interviewed firms. The information refers to both R&D partnerships and alliances in the form of licensing agreements, used by the breeders exclusively in the pre-competitive phase of the development of a varieties' portfolio.

Table 5 - R&D partnerships and alliances

Breeding firms	R&D breeding partnerships	Licensing agreements between breeders
BF1	No	Bought two genetic lineages from BF9
BF2	No	Licenses its germplasm to others firms whose identity is confidential
BF3	Several P&D partnerships for further breeding programs. Partners range from MNCs to local breeders.	Licenses its germplasm to others firms whose identity is confidential
BF4	Yes	Licenses its germplasm to other breeding firms whose identity is confidential
BF5	No	No
BF6	No	Licenses its germplasm to other breeding firms whose identity is confidential, as well as the opposite, licenses germplasm from other breeders to compose its own portfolio
BF7	NI	No
BF8	No	No
BF9	Established a partnership with Argentinean breeder Bioceres and a joint venture with Verdeca. The latter targets the development of a drought tolerant GM trait (HB4)	Licenses its germplasm to other breeding firms whose identity is confidential, as well as the opposite, licenses germplasm from other breeders to compose its own portfolio

Source: interviews

Note: Not informed – NI

According to Braspov, in general bigger breeders do not take part in R&D partnerships, since they develop breeding programs outside Brazil, which provide them self-sufficiency in sources of genetic variability. Partnerships for the licensing of varieties between breeders are very active in the soybean seed industry in Brazil. The purpose is to complement their portfolio.

4.5.1.1. IPRs protection, royalties' collection and fight against infringement

The first step to protect IP concerning plant varieties is to get the protection certificate, issued to the breeders by the national authority - the SNPC. The second column in Table 6 displays information about the number of protection certificates in force, at the dates of the interviews with each breeding firm. The right column shows the number of varieties registered for sale at the same dates. Any variety produced and offered for sale must be registered at the National Variety Registry (the RNC).

Table 6 - Comparison between number of varieties protected and registered (soybean)		
Breeding firms	Number of varieties protected (SNPC)	Number of varieties registered (RNC)
BF1	0 ^a	5
BF2	68	122
BF3	180	300
BF4	85	185
BF5	11	9
BF6	105	201
BF7	48	135
BF8	84	112
BF9	48	75

Source: based on data retrieved from SNPC and RNC datasets (Mapa, 2017)

Note: ^a There were three varieties in the process of protection on the interview date.

The essential aspect to notice in Table 6 is that all breeders adhere to the legal means of protecting their IP. This is a sign that there is a recognition by the firms that formal protection is necessary and important. All firms adopt the policy of protecting all materials with high marketing potential.

It is important to enlighten that the numbers presented in the table do not necessarily fit as a measure of market share or size of the firms. They relate more to the time of operation in Brazil, since firms that were recently established have fewer registered and protected materials. The second aspect to notice is that, except for BF5, in all firms the number of varieties registered largely exceed the number of protected varieties. This happens for the following reasons.

The time required for the accomplishment of the registration and protection processes is different. The latter is slower, since it requires meeting several technical requirements, stricter than those needed for registry. The first step that breeders take when they develop a new variety with commercial potential is the registry, since it allows them to perform planting and any kind of trading. At this time, in general, firms still do not have the final decision on protection. Most of the breeding firms decide for protection only after the final commercial testing. In addition,

protection certificates expire after 15 years, in the case of soybean and cotton species. Although the shelf life of most modern varieties is around eight years, the time that the variety remains registered is indeterminate.

Even though it is necessary to clarify why there is this difference between the number of protected and the number of registered varieties, the reason does not affect the central problem that I discuss in this thesis.

A PVP system favors the recognition of IPRs of new plant varieties, with the purpose of encouraging innovation through the adoption of mechanisms of privilege. The aim of this system is to ensure the appropriation of economic results as a way to compensate for the resources used and the risks taken in the development of new plant varieties. These economic results are collected in the form of royalties.

The prevailing standard mode of collecting royalties from the soybean breeding activity is based on the current market price of soybean grain. The majority of the interviewed breeders set a price in terms of kilograms of soybean grains per a 40 kg bag of seeds. The value usually ranges from seven to twelve kg - exceptionally beating 15 kg - of soybean grains per a 40 kg bag of soybean seed sold by the seed producer. At the time of the interviews, the price of a soybean bag varied between BRL\$ 150 and 200. Braspov estimated that, on average, the royalty was equivalent to 3 to 8% of the price of the seed bag⁵⁸. The price variation is mainly due to the variety's age or any special feature. Breeding firms set sales targets and apply discounts for achievement. Table 7 links the modes of royalty collection to each breeding firm.

Table 7 – Modes of royalty collection	
Breeding firms	Modes of royalty collection
BF1	standard
BF2	standard
BF3	NI
BF4	standard and other
BF5	NI
BF6	Standard
BF7	NI
BF8	other
BF9	standard

Source: interviews

⁵⁸ Royalties represent less than 0.5% of the farmer's production costs.

BF4 employs two collecting modes, the standard and another one, which is an established percentage of the price charged by the seed farmer over the seed bag. The use of each collecting mode varies according to the trademark, the variety itself and the geographic region.

BF8 sells the basic seed to the seed farmer for a certain price, and the royalty is included in this value. There is no separate charge for the royalty. The seed farmer also pays the breeder a basic seed additive over the amount received on the sale of the seed to the farmer. It is, therefore, an operation not configured as licensing. From the point of view of taxation, it is more interesting to receive for the sale of the seed, instead of licensing. Although BF8 was the only firm to report this collecting mode, the respondent considers it a trend that other firms will adopt. In this way, the collection happens only in the sale of the basic seed, rather than through two different transactions - basic seed sale and licensing.

Given that the protection certificate is the legal device designed to protect the breeder's IPRs, I investigated how the soybean seed industry acts or reacts in the face of potential infringements. Since seed saving is allowed in Brazil, infringements can be: (i) saving seeds without the proper declaration of origin; (ii) trading or exchanging saved or discarded seeds; (iii) smuggling seeds; and (iv) seed counterfeiting. In short, seed illegality lies on the lack of a declaration of origin.

According to Braspov's interviewee, soon after the enactment of the Brazilian PVP regulation in 1997, cases of farmers who practiced clueless piracy were very common. More than twenty years later, it is not the case anymore, and now piracy practice is done consciously. The law protects the breeder in the following way: if he can prove that someone is selling his varieties without permission, he can take a legal action. However, the task of producing materiality, that is, evidence, is very difficult to achieve.

Legally, breeders cannot carry out *in loco* monitoring, that is, enter the farmer's property, take samples, etc. Even if evidence was collected for some reason, it would not be valid. Hence, the breeder can only take some action through Mapa or Braspov.

Mapa is formally responsible for the inspection of the Brazilian seed system. Its role towards piracy should not be only reactive to claims, but mainly proactive, by identifying incidents. Mapa is the only channel that receives complaints from several actors, such as seed farmers, farmers, agri-dealers and breeders.

One of Braspov's administrative functions is to ask for more effectiveness in Mapa's performance. In addition, together with Abrasem, Braspov developed a platform to receive piracy anonymous complaints, through the presentation of primary evidence. After receiving the report, Braspov immediately forwards it to Mapa, which is responsible for the inspect.

However, according to the interviewees, Mapa has failed to properly address this duty. Braspov observed that the government body did not keep up with Brazilian agriculture's growth rate, and this is why the inspection activity is so precarious. The following quotes describe the situation: "Mapa's performance is too limited, and the scarcity of resources prevents the proper inspection of farms" (BF5); "Mapa's ability to produce evidence of piracy is too low" (BF9).

This circumstance motivated the constitution of a task force within Braspov, in the beginning of the years 2010. Created by a restricted group of soybean breeders, the initiative was named "Fighting the illegal use of soybean seeds"⁵⁹, and works as follows. From the reception of a complaint, hired professional investigators start to collect solid evidence, since the complainant cannot always get it. From then on, Braspov, with the authorization of the breeding firm involved in the case, requests a precautionary measure, in order to improve the evidence and add consistency to the complaint. Depending on the results of this precautionary measure, the complainant firm decides to continue, or not, with a primary lawsuit for damages against the pirate, and requests compensation. That is, the firm actually starts a legal procedure.

Because of the task force actions, some interviewees argued that it is possible to notice, in some geographic regions, that farmers are getting more cautious, once they know someone that has been formally accused. For instance, one respondent mentioned that in the state of Mato Grosso the local farmers' associations have reported that farmers are getting more alert to the subject.

Braspov considers that the PVP regulation's article that addresses the punishment for farmer's infringement is very fragile, in the sense that it does not provide enforcement. Quoting Braspov's interviewee: "It is an illusion to think that piracy can be solved with judicial measures". Indeed, such measures have a therapeutic effect, as farmers in the region of the lawsuit have become alert and a sudden increase in the sale of formal seed can be noticed.

⁵⁹ In Portuguese, "Combate ao uso ilegal de sementes de soja".

Thus, the application of legal measures is seen as a way to slow down seed's IPRs infringement. Firms do not expect to recover royalties. If a farmer is convicted, the fine he will pay does not cover the amount that the breeder stopped winning because of piracy. Hence, it is a preventive measure to curb the practice of piracy, and not to compensate the breeder financially. In this sense, it is not a strategy of rent appropriation.

It is worth mentioning that the application of legal measures is a way of giving an answer to the seed farmers. Piracy is also bad for their business, but different from the breeders, they cannot take cases to court, even if they are the whistleblowers.

Table 8 shows breeding firms' attitudes concerning the infringement of seeds' IPRs. Columns two to four present the firm's engagement in different actions to curb illegal seeds. The last column indicates the firms that, in some point of its existence, had already filed legal measures against farmers who practiced piracy.

Table 8 – Breeding firms involvement against IPRs infringement				
Breeding firms	Engagement in preventive anti-piracy actions			Has already filed legal proceedings?
	Braspov task force	Awareness campaigns	Others	
BF1	No	No	None	No
BF2	Yes	No	None	Yes
BF3	No	No	None	NI
BF4	Yes	Yes	None	Yes
BF5	No	No	None	No
BF6	Yes	No	None	NI
BF7	NI	Yes	None	NI
BF8	Yes	No	internal initiative	Yes
BF9	Yes	Yes	None	No

Source: interviews

The majority of respondents take part in Braspov's task force. BF9, although participating in the initiative, declared that it never filed a legal proceeding. Three firms chose not to answer about their *modus operandi* regarding the adoption of legal measures against farmers, and one of these did not tell about its involvement with the Braspov initiative. For them, a client prosecution is always a delicate subject.

Three firms admitted that going to court to prosecute infringements is a practice adopted when it is necessary and possible. Three others firms stated that until then they had never tried to initiate a lawsuit. BF1 and BF5 argued that the pirated amount did not justify the adoption of

legal measures, while BF9 said that piracy is difficult to prove, and when applicable, the penalty was difficult to enforce.

Still regarding the adoption of legal measures, Braspov's interviewee mentioned Coodetec's case. The former breeding firm, in the early 2000s, held almost 30% of the national soybean seed market; therefore, its varieties were largely pirated. At that time, Coodetec filed lawsuits - between 2004 and 2010 they were about 50 - but faced great difficulty to enforce the law. There were few final sentences in favor of the company, and in several cases the parts made agreements. Only one case went to the second instance, and after more than 13 years was not finished yet.

Regarding Table 8, BF4, BF7 and BF9 mentioned campaigns to raise the awareness of farmers about the benefits of certified seed, and the risks of using saved and pirated seeds. BF7 uses social networks to emphasize the risks of lower yields, and argues that the use of certified seed is important for rewarding R&D's expenses. BF9 calls on the importance of the certified seed quality versus the low germination and low vitality of the informal seed. The firm also mentions the importance of royalties for R&D sustainability.

Despite its participation in the Braspov task force, BF8 also has an internal Protection and Security team that leads a program to fight piracy. When this team identifies the need for an investigation, this is outsourced to a specialized investigation agency that, in addition to conducting the investigation, must find evidence. If the team understands that there are sufficient elements to file a consistent complaint, it notifies Braspov or Mapa and then files a lawsuit. Like Braspov, BF8 interviewee stated that "the firm's objective is not to recover economic investment, since the cost of a lawsuit, in most cases, does not justify it. The problem is that not carrying out these actions contributes to increased piracy. It is, therefore, an inhibitory action against illegality".

4.5.1.2 Alternative IPRs appropriation strategies

As previously discussed, the Brazilian institutional environment concerning IPRs of plant varieties, from the breeder's point of view, is fragile, since it largely allows saving seeds. My intention was to understand the efforts carried out by breeders to appropriate rent, regarding farmers' compliance with IPRs. I turn now to the analysis of this issue.

Based on the mechanisms of plants IPRs appropriation previously reported by the literature (see Section 2.3.2), I presented to the interviewees a table describing each of them and asked about their adoption. I also asked them to give more information about the strategy operationalization, in order to capture the precise way in which it was put into practice by Brazilian soybean and cotton breeders. During the interviews, I raised questions about other alternative mechanisms employed.

Figure 7 describes each of the five identified strategies. The first three relate to the strategies that were in the descriptive table that I showed to the interviewees. The other two refer to strategies that emerged from the interviews.

Figure 7 – Description of alternative IPRs appropriation strategies

Monitoring
• BF practices private monitoring - from the sowing to the time of harvest - in order to curb illegal practices.
Higher release price
• The BFs try to maximize price in year one since they expect the farmer will save the seeds in year two. Adoption is subject to regional competition.
Rapid innovation
• BF rapidly launches new varieties making seed genetics become outdated in a short period pushing the farmers to purchase new seeds every year.
IPR's coexistence
• The BF purposely adds in its seed genetics a patented biotech trait with the aim of appropriating potential germplasm royalties. This is made possible by the existence of two kinds of IPRs - plant breeders rights (PBRs) plus patent - in the same seed. The threat of surcharge exercised by the patented trait owner works as an incentive to the farmer not to save the seed.
Trademark
• BF charges royalties for the use of the "BF Technology" brand regarding varieties that have fallen into public domain.

Source: interviews, Endres & Goldsmith (2007) and Goldsmith et. al (2006).

Table 9 summarizes the appropriation strategies adopted by each breeding firm. Sometimes a breeding firm adopts a given strategy, not with the purpose of IPRs appropriation but with a marketing purpose, for instance.

Table 9 – Alternative IPRs appropriation strategies adopted by soybean breeders in Brazil

Breeding firm	IPR's appropriations strategies					
	None	Monitoring	Higher release price	Rapid innovation	Trademark	IPR's coexistence
BF1	X	-	-	-	-	-
BF2	X	-	-	-	-	-
BF3	-	-	-	-	X	-
BF4	-	-	-	X	-	X
BF5	-	X	X	X	-	X ^a
BF6	-	X	-	-	-	X
BF7	X	-	-	-	-	-
BF8	-	X	-	-	-	-
BF9	-	-	X	X	-	X
Times mentioned	3	3	2	3	1	4
Minimum market share	17%	38%	11%	36%	2,5%	70%

Source: interviews

Note: ^a BF5's interviewee intends to adopt, due to the R&D pipeline established by the firm for the next years. In the next subsections, I comment on the five IPRs appropriation strategies adopted by the interviewed firms, as well as on the non-adoption of strategies chosen by some of them.

4.5.1.2.1 Non-adoption

Firms that comprise at least 17% of the commercial seed market share in the soybean seed market are not engaged in any alternative mechanisms of appropriating IPRs. BF1, BF2 and BF7 do not adopt any strategy for this purpose.

Since BF1 operates a small volume of seeds, BF1's interviewee considers that seed saving is not a problem for his firm; therefore, it does not consider the adoption of any strategy in the short run. The interviewee said: "we know who are the farmers that save our seeds, and for now we see it as positive, because it is an indication that our product is good. It is a way of spreading our brand". However, he stressed that in the medium term the firm will probably have to take action on this.

For BF2, the best way to improve rent appropriation from IPRs is by achieving a good positioning of the technical product, prior to launching new varieties, and a well-focused market development. The interviewee understands that this kind of behavior has gained relevance in relation to the past, when breeding firms made little investments in technical orientation,

leaving the whole responsibility to the farmers. Attention to seed quality is also very important to gain farmers' loyalty, thus avoiding seed saving.

This is the structure that should prevail, according to BF7. The work should focus on designing a good business strategy to gain market share, thus offsetting the losses that result from the weak institutional environment.

Attention to quality is also a BF9 tactics. Although different from BF2 and BF7, since BF9 does adopt different strategies for IPR appropriation, the firm is also concerned, just as its seed farmers, to improve the quality of the seeds as a way to induce farmers to buy a new seed every year.

BF1 and BF7 claim that higher release price and rapid innovation are strategies to increase sales, market share, and consequently the company's profitability, rather than a value-appropriation strategy relative to IPRs. One may charge a high price for new varieties that offer distinctive benefits to the farmers, whose supply is often low. If farmers do not acknowledge such benefits, obviously there will be a price adjustment.

4.5.1.2.2 Monitoring

Monitoring of farmers is done by BF5, BF6 and BF8. In the first case, the act of monitoring is a consequence of the organizational configuration of the breeding firm, which is linked to a farmers' cooperative. Therefore, BF5 has access to several farmers' transactions, such as monitoring. However, as farmers may be considered as BF5 owners, BF5 cannot use monitoring to take any appropriation action, even if it may do so in some future circumstance.

BF6 forms a strategic group within the seed industry. It is a biotech firm, and, for this reason, its monitoring strategy focuses mainly on protecting its GM trait. Once it attains this strategy successfully, it also appropriates indirectly the IPRs relative to the varieties.

BF8 practices monitoring, but said that it is not systematic; it is done by sampling, in response to any relevant information received from a geographic region that deserves special attention on the field. BF8 interviewee defined it as a passive monitoring.

4.5.1.2.3 Higher release price

The higher release price is adopted as an appropriation strategy by firms that comprise at least 11% of the commercial seed market share. Both BF5 and BF9 confirmed the adoption of this strategy.

For BF5, the main goal of price differentiation when launching a variety is to raise a higher amount of rent early, because they know that many farmers will save their seeds. BF9 agrees that this strategy is difficult to put into practice, because, in general, the market defines the price, but, anyhow, the firm tries to do it.

Braspov considers this strategy too risky. The interviewee argues that whenever a plant variety becomes famous due to its characteristics, before the launching, generally the first sales will have prices higher than normal. Controlling the supply of an easily reproducible species, such as soybean, is done only once. If the product falls into the farmers' taste, and there is not enough seed available in the market, the farmers will save the seeds.

According to Braspov, the appropriation strategy of higher release price was widely used prior to the enactment of Brazilian PVP regulation. At that time, small private breeding firms were able to survive thanks to this appropriation strategy.

As already stated, other breeding firms understand that charging a higher price when launching a new variety should be considered a marketing strategy of price positioning, rather than an IPRs appropriation strategy.

4.5.1.2.4 Rapid innovation

Rapid innovation, as an appropriation strategy, is adopted by firms that comprise at least 36% of the commercial seed market share. BF4, BF5 and BF9 confirmed this strategy's adoption.

BF5 explained how this strategy is put into practice. When the breeder makes a crossbreeding, he selects several lines, which always have minimum variations among them; these minimal variations allow the development of different varieties in a short period. Those breeding firms that have decided for the rapid innovation strategy, launch the first version of a variety, and two

years later release a slightly better version, which incorporates one of those minimal variations. Then, again, in a short period they launch another variety that incorporates another minimal variation. This is done in order to make farmers notice and believe that if they buy new seeds every year, they will always buy a more innovative product.

BF9 points out that the adoption of the rapid innovation strategy, besides being primarily an appropriation strategy, is also a marketing strategy to gain market share.

Regarding rapid innovation, BF6 and BF7 argue that the continuous launching of new plant's varieties, or, in other words, the permanent portfolio renewal, aims at marketing positioning and not IPRs appropriation.

Braspov's interviewee considers that the rapid innovation strategy proved to be very useful prior to PVP's regulation enactment. At that time, breeding firms used to launch variety after variety, because they only made money in the first sale. "The firm fostered the product for a year, left everyone "mouth-watering", put a huge volume of bags on sale, and then started to work on another variety. He considers that, currently, this appropriation strategy does not make sense anymore.

4.5.1.2.4 Trademark

In the licensing agreements that BF3 establishes with seed farmers, the firm includes legal clauses regarding both plant breeders' rights and IPRs related to the use of the trademark "BF3 Technology", granted by the Brazilian National Institute of Industrial Property (INPI). Thus, BF3 charges royalties for the use of the brand, even on cultivars that are already in the public domain.

4.5.1.2.5 IPRs coexistence

It refers to the exploitation, by breeding firms, of the scheme developed to collect royalties related to the GM soybean technology, described earlier in Section 2.3.2. Through this scheme, the biotech firm forces farmers to use commercial seeds. This is possible because the company increases the charge at different points of contact with the farmer. The fee is lower when collected at the time of sale of certified seeds, and increases as the firm identifies that the farmer is using saved seeds. By encouraging the use of certified seeds, the biotech firm provides to the

breeding firms, which have varieties that contain a patented gene, the possibility of increasing royalties' collection regarding these varieties.

Differently from the strategies discussed above, the IPRs coexistence appropriation strategy is not found in the literature. I sought it through different questions, to capture and understand other forms of appropriation, besides those that were already discussed.

I asked respondents if the breeding firm adopts any other form of protection for their IPRs, besides legal protection; if so, interviewees should indicate what were these other forms. Then I presented a table with the strategies described in the literature, so that they could indicate which of them were adopted. Next, I asked what led companies to introduce GM traits in their varieties, and if having patented GM varieties would affect, in some way, the appropriation of IPRs regarding the varieties owned by the firm. Finally, interviewees were asked about the firms' assets that supported the recovery of their property rights⁶⁰.

Thus, at least 70% of the market comprises breeding firms that adopt the IPRs coexistence strategy. BF4, BF5 and BF9 have spontaneously described the achievement of this appropriation strategy, which consists of deliberate insertion of a patented gene within breeder's varieties, with the purpose of improving the possibility of appropriation of the IPRs related to the variety (germplasm).

BF6, as a biotech firm, has the greatest interest in introducing the patented GM trait in many varieties, to gain scale and to recover its investments in genetic engineering research. Although the IPRs coexistence appropriation strategy is helpful to improve BF6 appropriation on its varieties (germplasm), it is not a deliberate strategy for doing so, and the primary objective is to spread its patented GM technology as much as possible.

The name chosen for the strategy - IPRs coexistence - tried to capture its essence, which allows breeding firms to improve rent appropriation through the mutual existence of the two rights in the same seed. The following statements describe the idea.

⁶⁰ Only BF4 answered positively to the question about complementary assets, referring to its team of Technical Assistance and the promotion of customer loyalty.

“For firms that do not have their own patented GM trait, it is interesting to make a partnership with a biotech firm protected by the Patent Law, in order to appropriate value regarding their germplasm” (Braspov’s interviewee).

In response to the question about what strategies, mechanisms or practices BF4 uses to secure its IPRs, the interviewee asserted that "working with patented technologies that promote the use of formal seeds".

“[...] therefore, the insertion of a patented trait is practically mandatory, as a way of compensating the investment in research carried out by BF5” (BF5’s interviewee).

“We use patented GMO as a means to protect the varieties as well. Therefore, recently our firm started to avoid the release of conventional varieties or GMOs varieties that have IPRs already in the public domain, even if they are good for the farmer, because the firms do not receive anything, or receive less for it. We prefer to launch varieties with patented GMO technologies, aiming to curb seed saving. That is, the insertion of a GMO trait, with a patent in force, within our varieties is a strategy of value appropriation on the varieties, and not only a response to the farmer’s demand” (BF9’s interviewee).

Another testimony from BF9 helps to understand the relevance of the IPRs coexistence appropriation strategy. The interviewee declared that, on the date of the interview (2017), the firm had two conventional varieties considered the best for the farmers in their region of adaptation - wide resistance to the cyst nematode. According to the interviewee, both are the most pirated varieties in the Central region of Brazil. In the South, the company has a GMO variety resistant to soybean rust, but with an expired patent, and it is also the most pirated in the region.

Breeding firms BF3 and BF8, although they did not consider the insertion of the gene as a deliberate strategy, agree that it offers a possibility of appropriation. “Even if this is not its original designation, it is clearly positive for all breeding firms” (BF8 interviewee).

Breeding firms agree that the IPRs coexistence is not the main function of a GMO introgression, but it is rather an opportunistic use. The interviewees are unanimous in sustaining that the first

function is to add value to the product, in order to meet the demand of the farmers who seek greater yields.

Keeping this in mind, I understand that the argument of the IPRs coexistence appropriation strategy needs better support. In order to do this, I examine some numerical evidence in the next section.

4.5.1.3 Descriptive statistics on the IPRs coexistence appropriation strategy

From 1997, the year that Brazilian PVP Law came into force, until 2018, SNPC has granted protection for conventional and GM varieties. In the latter case, four different GM technologies have been inserted into soybean varieties, as described below:

- a) GM soybean tolerant to glyphosate herbicide, popularly known as Roundup Ready Soybeans or just **RR1**. This technology was developed by the former Monsanto, whose RR1 patent expired in Brazil in 2013⁶¹;
- b) GM soybean insect resistant and tolerant to glyphosate herbicide, called Soybean Intacta RR2PRO, or just **IPRO**. This technology was also developed by Monsanto to replace RR1 and provide more benefits to the farmer. The first IPRO Brazilian soybean varieties were protected in the year 2013. In the crop season 2017/18, IPRO technology was present in 66% of the commercial soybean seed planted area. Patent in force ⁶²;
- c) GM soybean tolerant to the glufosinate ammonium herbicide, known as **LL** soybean, whose technology was developed by Bayer. Its market share is almost null. Patent in force;
- d) GM soybean tolerant to herbicides of the chemical group of imidazolinones. Named as Cultivance 127 and known as **CV** soybean, it was developed by a partnership between Embrapa and Basf. Although there are some varieties protected by this technology, it was not produced commercially. Patent in force.

⁶¹ The patent on RR1 technology was granted to Monsanto in USA in 1990, for 20 years. In 2013, Monsanto was fighting in the Brazilian courts to get an extension of its patent until 2014, but the Superior Court of Justice, in response to a lawsuit filed by the production sector, determined the end of royalties' collection by the company, regarding RR1 technology.

⁶² The IPRO technology patent is being challenged in court by associations of soy producers, who claim that it presents no novelty in relation to the previous technology. Since November 2017, the patent is *sub judice* at INPI (personal communication, July 25, 2018)

Using information provided by Mapa, regarding the production area of soybean commercial seed in the crop season of 2017/18, Figure 8 shows the participation of each technology in each breeding firm seed production area, as well as in the country's total seed production area.

Figure 8 – Participation of soybean seed technologies in the seed commercial production area in the crop season 2017/18 (in %)

Source: based on data retrieved from Mapa (2018).

Note: Soybean LL's participation reaches less than 1% and is not visible in the figure.

One can observe that just over 66% of the soybean seed crop in Brazil is protected by patents. Following our reasoning, this is the market share of commercial seeds, in which the protection granted by a patent can reach the varieties, in order to benefit the breeding firms.

The individual examination of each breeding firm strengthens the respondents' statements about the adoption of IPRs coexistence appropriation strategy. The breeding firms that declared to adopt the strategy (BF4 and BF9) or assumed that the ease of appropriation is a benefit provided by the patent to the breeders (BF3 and BF8), are the firms whose percentage of the relative area cultivated with varieties that carry the patented technology is higher than the area cultivated with other technologies (expired patent or conventional).

Although BF5 makes available for sale only varieties with RR1 technology, the firm argued that intends to adopt the IPRs coexistence appropriation strategy due to the R&D pipeline established for the coming years.

Figure 8 depicts BF1, BF2 and BF7 with relatively less portfolio's representation of IPRO soybean, in comparison with RR1. Besides being non-adopters, they also did not acknowledge, during the interviews, IPRs coexistence as a possible appropriation strategy. Instead, they observed that the introgression of a patented GMO into varieties is only a way to respond to the farmer's needs.

BF6, being a biotech firm, has as a primary goal to offer as much patented GM technology as possible. The offering of other technologies is just to complete its portfolio.

Another lens to look at the numbers is through the issuing of plant variety protection. Figure 9 displays the historical series of soybean protection certificates issued since the enactment of Brazilian PVP Law, in 1997, until the end of 2017.

Figure 9 – Historical series of soybean protection certificates issued since the enactment of the Brazilian PVP Law

Source: based on data retrieved from SNPC/Mapa (2018).

The first protection certificates for IPRO soybean varieties were issued in the year 2013, the same year as the RR1 patent ceased. The year 2016 was the turning point, when the protection of IPRO varieties surpassed RR1s. It is worth mentioning that soybean farmers' associations claim that, in fact, there is no technological innovation in the benefit delivered to the farmers, between both technologies (Aprosoja, 2017). Because of this complaint, IPRO patent is *sub judice* at INPI, and the technology holder must deposit the royalties in a court account.

If there is no difference in the benefits delivered to farmers from both technologies, a plausible explanation for the increasing number of protection certificates issued for varieties in which the IPRO technology is present is that firms - both the patent holder and the breeders - are interested in advancing IPRO soybean to increase the number of varieties that carry a valid patent. Hence, breeding firms have a better chance to appropriate IPRs. This scenario shows the IPRs coexistence appropriation strategy put into practice.

Figure 10 comprises the period between 2013, when SNPC issued protection for the first IPRO varieties, and July 2018. It shows the representation of IPRO varieties in the portfolio of protected soybean varieties, when comparing the IPRs coexistence appropriation strategy between adopting firms and the non-adopters.

Source: based on data retrieved from SNPC/Mapa (2018).

Note: * 2018 data goes until the end of July.

It is interesting to observe that, since 2014, IPRO's participation in the protected portfolio of the breeding firms that adopt the IPRs coexistence appropriation strategy are steadily increasing, while the same trend is not seen in the group comprising the others interviewed firms. Chapter 5 discusses the implications of these results. Next section closes Chapter 4.

4.5.2 The cotton seed breeding case

Differently from the soybean seed industry, which accounts for 37% of the whole Brazilian seed industry, the cotton seed industry reaches only 1% of the total (Abrasem, 2016). Even so, it is worthwhile to examine this industry more closely, for three reasons.

The first, and more important, is the fact that cotton bears similarities with soybean in terms of its reproductive characteristics, hence the practice of saving seeds is also common among cotton farmers. The informal cotton seed market is about 45% of the whole market. The seed saving practice is very common in the cotton farming for the reasons described below:

- a) the cottonseed (pit) is a by-product whose sale as a seed is a way of adding value;
- b) as the cotton harvest occurs in the dry season, it is easy to produce good quality seed⁶³;
- c) in general, cotton farmers are large - the five largest farmers hold around 30% of the total cotton crop area -, which means better access to seed production infrastructure.

Summing up the ease of producing good quality cotton seed encourages the use and acceptance of informal seed by cotton farmers.

The second reason concerns the fact that the GMO technology is also very important for cotton production. In the crop season 2016/17, GMO adoption reached 78% of the production.

Finally, there is a practical and opportunistic reason. Among the breeding firms interviewed, three of them, BF5, BF6 and BF9, are also cotton breeders, which facilitates the research process. Thus, taken the above together, the cotton seed industry is an empirical setting suitable for proving the theoretical propositions of this thesis.

⁶³ The soybean harvest is done in the rainy season, which requires a more sophisticated structure to achieve good seed quality.

Several aspects, already discussed in the soybean case study, happen in the same way in the cotton case; therefore, I will not discuss them again. I briefly go through these aspects just to recall. Whenever there are any idiosyncrasies, they will be examined more carefully.

The three cotton-breeding firms interviewed hold together about 35% of the cotton seed market. It is a very concentrated market, with only four active cotton-breeding firms in Brazil.

Table 10 displays the comparison between the number of cotton varieties protected and registered, in September 2018.

Table 10 – Comparison between number of varieties protected and registered (cotton)		
Breeding firms	Number of varieties protected (SNPC)	Number of varieties registered (RNC)
BF5	2	28
BF6	11	48
BF9	20	33

Source: based on data retrieved from SNPC and RNC datasets (Mapa, 2018)

As in the soybean case, all cotton-breeding firms adhere to legal means for protecting their IP. The interviewed firms asserted that they adopt a policy of protecting all materials with high marketing potential. The difference between the number of registered and protected varieties follows the same trend as in the soybean case - basically timing and commercial reasons.

The three interviewed firms complained about the extent of the informal seed market in the cotton crop, but contrary to what was observed in the breeding firms' engagement against IPRs infringement in the soybean case, in the cotton seed market the picture is different. The profile of cotton farmers is different from that of soybean's, the former are fewer but larger. These characteristics imply some resistance of firms in resorting to the application of legal measures.

Given this context, BF5, BF6 and BF9 said that they employ the same appropriation strategies adopted in the soybean case, as Table 11 shows.

Table 11 – Alternative IPRs appropriation strategies adopted by cotton breeders in Brazil

Breeding firms	IPR's appropriations strategies			
	Monitoring	Higher release price	Rapid innovation	IPR's coexistence
BF5	X	X	X	X
BF6	X	-	-	X
BF9	-	X	X	X
Minimum market share	8%	31%	31%	36%

Source: interviews

To use the following appropriation strategies does not depend on the agricultural crop, whether cotton or soybean: monitoring, higher release price and rapid innovation. The IPRs coexistence appropriation strategy is based on the royalty's collection scheme of GM technology, which is possible thanks to patent enforcement. The royalty's collection scheme, in turn, must be adapted to cotton singularities. I describe below how such scheme works in this case.

Unlike soybean, for which it is possible to carry out GM technology detection tests at the time of grains delivery, this technology is not traceable in the cotton lint, the main product from cotton crops. For this reason, the holders of existing GM cotton technologies⁶⁴ - the former Monsanto and Bayer, now one MNC - outsource the monitoring of cotton crops to a hired audit company.

Technology holders manage a single registry in which breeding firms and seed farmers report the amount of seed sold and the identity of the buyer. The provision of data for this registry is established in the licensing agreements between biotech firms and breeding firms. By using this registry, or by means of satellite mapping, one knows who the cotton farmers are. Audit firms enter the farms and check the presence of the technology, by analyzing the leaves of the cotton plants. From that, it is possible to compare with the cotton-seeds invoices kept at the registry office. If the biotech firm confirms the lack of compliance regarding its IPRs, when the lots of cotton arrive at the processing units the farmer has to pay a fine⁶⁵.

⁶⁴ In the crop season 2017/18, the GM cotton varieties carried seven GM technologies with one or more of the following genetic traits: glyphosate tolerance; glufosinate ammonium tolerance, and resistance to the insect order lepidoptera.

⁶⁵ Biotech firms apply different productivity indexes; these are taken into account in this check, and the farmer can work within a broad range.

It is important to mention that the authorization for the audit firm to enter the farms is signed by the farmer, when buying the seed. The company is responsible for the sale of the seed to him, and conditions the commercial transaction to the signature of his authorization, where the farmer also declares that he will respect the IPRs of the GM technology holders. Since not all farmers agree to sign the term, another way to detect the GM trait is through a detection test prior to cotton ginning. The biotech firm, by signing an agreement with the cotton-processing unit, receives authorization to proceed with the tests.

Prior to Monsanto's acquisition by Bayer, the former used to fine the infringing farmer in 10% of the original royalty value, and the latter charged the double of the royalty value.

Breeders' claim in favor of the deliberate adoption of the IPRs coexistence appropriation strategy, based on the above scheme, was even more emphatic than in the soybean case. The following quotes shows it.

"Thanks to the enforcement of the IPRs concerning the GM technology, cotton-breeding is still economically feasible in Brazil" (BF9).

"Seed saving and piracy are connected and are a serious problem to cotton-breeding activity. Currently (2017), the best way to recover research investment in light of these problems is to license the GM technology from Monsanto and Bayer" (BF5).

"[...] therefore, the insertion of a patented trait is practically mandatory, as a way of compensating the investment in research carried out by BF5" (BF5 interviewee).

BF5 interviewee admitted that, paradoxically, if, on one hand, the adoption of IPRs coexistence strategy is a way to advance appropriation, on the other hand, holders of the GM technology are permissive regarding the accuracy of the cotton planted area, for which the farmers have to collect royalties, as part of a commercial negotiation on agrochemicals' supplies. For instance, the farmer declares that he planted a smaller area than the actual one, but the MNC, which is looking at the supply of agrochemicals, turn a blind eye to these differences. In short, it encourages the informal seed market that harms the breeders. This circumstance is usual in the cotton market, which is operated by large farmers, who MNCs do not want to lose as customers. Implications of the findings presented in this chapter are discussed in Chapter 5.

5 DISCUSSION AND CONCLUSIONS

This doctoral dissertation set out two distinct objectives, one empirical and other theoretical. The former was to understand the efforts of breeding firms to appropriate rent regarding the farmers' compliance with IPRs. The latter was to bring contributions to advance RBV, on the issue of protecting the firm's value creation.

By means of two case studies, I found that, despite the extensive use of the legal protection provided by the plant protection certification, and the exceptional use of trademark by only one firm, soybean and cotton breeders in Brazil adopt alternative arrangements. Farmer's monitoring, higher release price and rapid innovation repeat strategies already reported by the literature.

However, the most important alternative strategy, in terms of the representation of the firms that adopt it, emerged from the field research. Named as IPRs coexistence appropriation strategy, it is centered on the legal protection provided by the patent, but adds elements of private order. The reasoning of this strategy design provides support to meet the theoretical goal, and for this reason, it is deeply discussed throughout the dissertation and in the next section.

This final chapter is organized as follows: next section discusses the case studies results, followed by the section that consolidates the theoretical contribution. The concluding remarks comprise considerations on the interrelation between IPRs and market consolidation, implications of the adoption of the IPRs coexistence strategy, limitations of the research, and suggestions for further investigation on the addressed theme.

5.1 Results and discussion

The introduction of a new variety of plant in the market results from a breeder's previous hard R&D working for developing a distinct and innovative product. To receive a legal protection certificate, the new variety must present clear differences from any other that exists when granting the application for protection. In other words, it means that market introduction assumes the uniqueness of that variety. Since this in line with RBV requirements (Barney, 1991;

Peteraf, 1993), this new variety has the potential to create competitive advantage for the breeding firm.

However, RBV has failed to address the role of property rights in its models. The theory implicitly assumes that the property rights of resources are safe. This is not true in most of the business environment. The seed industry in Brazil highlights this gap, thanks to the farmers' privilege, which provides them the unlimited possibility of capturing breeding firms' value, by saving the seed.

Hence, breeders need to make efforts to develop alternative appropriation mechanisms. In this dissertation, my purpose was to identify and explore such mechanisms. To do this I tried to integrate the theory of property rights to RBV. The propositions that emerged are discussed below, in the light of the results achieved through the soybean and cotton seed breeding clinical cases.

From Barzel's (1997) concept of resource as a bundle of attributes, to which property rights can be assigned, I claim that each of the technical and agronomic features of a seed can be considered an attribute. Liking this concept to Foss and Foss' (2006, 2008) entrepreneurial view of the discovery of new potentially valuable resource attributes, I advocate that, given the introgression of a patented GM trait into a seed, it acquires one more attribute, in addition to those for which it was designed – to meet a production challenge -, which is the possibility of strengthening IPRs appropriation of plant varieties by the breeders.

Proposition 1 was defined as: the recognition of new resources' attributes, due to the specification of property rights, offers the potential for the creation of sustainable competitive advantage; and proposition 1a read: The adoption of well-defined IPRs appropriation mechanisms promotes the sustainability of competitive advantage.

One of the criticisms regarding the traditional RBV literature concerns the lack of a proper assessment of the role of property rights in the generation of a sustainable competitive advantage. I argue that, by bringing elements of property rights to the discussion, the gap between potential and realized value could be better understood.

Throughout the soybean clinical case study, I gathered evidence that breeding firms recognize the IPR's enforcement provided by the patented GM trait as a "new" attribute, with the potential to create value. This value is precisely the possibility of improving the appropriation of rent from their varieties' IPRs.

Three interviewed breeding firms – BF4, BF5 and BF9 - assumed that they accessed the patented GM trait and inserted it on their varieties, not only with the purpose of attending farmers on their demands for better technical/agronomic features, but also for improving IPR's protection. Two other firms – BF3 and BF8 -, said that although they do not take this action strategically, it is a valuable feature that helps firms to better appropriate rents.

The soybean case study demonstrated that all interviewed firms seek to legally protect the entire portfolio of varieties offered for sale, through a protection certificate. Data provided by SNPC showed that since 2014, the share of patented GM technology in the protected portfolio of BF4, BF5 and BF9 is steadily increasing, while the same trend does not occur with the other interviewed firms.

Taken together, all this evidence indicates that there is a recognition by the firms that control at least 40% of the soybean and 30% of the cotton formal seed markets, that there is a potential value in using GM technology for a second purpose, besides the one for which it was originally designed.

This reasoning is not relevant for biotech MNCs. They do not adopt this strategy deliberately. Why not? For them, the GM technology primary goal is commercial, that is, to attain economic gains through its sale. The patented gene is not a means to achieve another goal, as is the case of breeders. For MNCs, the patented gene is their main product, and a variety is just a vehicle that carries the gene, while for the breeders a variety is relevant. Since MNCs control about 35% and 70%, respectively, of the formal soybean and cotton markets (see Figure 3 and Figure 4), the representation of the firms who adopt IPRs coexistence strategy and recognize the new seed attribute is relevant. Therefore, propositions 1 and 1a hold.

Rapid Innovation is an appropriation strategy, by which the genetic features of the seed get outdated after two periods of cropping, and a new variety is rapidly launched by the breeding firm, in order to re-establish the firm's monopolistic position. It increases yield drag and

significantly changes the seed-saving calculus, so that farmers will prefer to buy new seeds instead of saving the outdated variety. Rapid innovation is adopted by firms that control at least 36% and 31%, respectively, of the formal soybean and cotton seed market.

The attainment of the rapid innovation strategy is related to the breeder's ability to constantly offer new plant varieties that bring an advantage to farmers. Hence, putting this strategy into practice requires a distinctive germplasm bank (resource), whose attribute is to fulfill the farmer's needs. However, a different attribute must exist or be developed, which is the speed in generating new varieties. To meet both requirements, the germplasm bank can be viewed as a resource that offers some kind of competitive advantage to the breeder, in order to convince the farmer that it is worth buying a new seed. Again, property rights' configuration drives the exploration of certain attributes of the resources. Proposition 1 holds once more.

Foss and Foss (2006) argue that the value of the attribute to the resource owner depends on whether he holds secure property rights over the relevant attribute. In other words, the value of the resource attribute depends on how well the system of property rights is designed. I extend their assertion by suggesting proposition 2, which states: holding one single attribute of a resource, with well-defined property rights, increases the possibility of rent appropriation of the resource as a whole, *ceteris paribus*.

The validity of this proposition is strictly related to the deliberated adoption of the IPRs coexistence appropriation strategy. The protection of rights through a patent provides a better enforcement than that provided by plant's rights. The breeding firm, by realizing that GM technology involves the protection attribute, besides the technical attribute, decides to internalize this relevant attribute into the seed, seeking to improve rent appropriation concerning the IPRs of the seed germplasm. If the firm can do this by licensing its rights over this relevant attribute, it increases the possibility of changing potential value into realized value.

It is undoubtedly true that firms use the strategy in question to improve the appropriation of their varieties. Although it is quite difficult to assert at what extent has the breeder inserted the patented gene into its variety with the purpose of protection, all information gathered in both case studies points quite strongly in this direction. The above discussion concerning proposition 1 and 1a also serves for proposition 2.

It is also worth to stress some collected evidence. For instance, those firms that declared to be adopters of the strategy, or assumed the existence of the appropriation benefit – BF3, BF4, BF8 and BF9 – are the ones whose relative area planted with varieties that carry the patented GM technology surpasses the area planted with other technologies.

The last evidence that helps the validation of proposition 2 is the fact that even with the farmers' argument that the most widespread patented technology did not hold any innovative feature, in the last two years of the historical series of protected soybean varieties - 2016 and 2017 -, the technology in question was mostly used, and also the most cropped (66%) by seed farmers in the season 2017/18.

5.2 Conclusions

Along this doctoral dissertation, I stressed the need to advance on the linking between the Property Rights Perspective and RBV, as argued by Kim and Mahoney (2002; 2006; 2007) and Foss and Foss (2005, 2006). I did this, particularly based on the attributes to the resource unbundling idea, which requires two premises for proper application.

The first relates to the need of integrating into the RBV theory the idea that property rights over resources can be split. It requires a shift from the traditional RBV assumption that the resource is the irreducible unit of analysis, by looking at them as bundles of property rights. The IPRs coexistence appropriation strategy is supported by this premise. One critical point that emerged from the case studies concerns the fact that the seed is a resource that can be dismembered into few attributes, to which individual property rights can be assigned. Therefore, the breeding firm can benefit from the superior protection offered by a single relevant attribute.

This empirical evidence is in line with the theoretical argument by Foss and Foss (2006, p. 56): “the value to the resource owner of the attribute depends on whether he holds secure property rights to the relevant attribute.”

However, I suggest that this assertion can be better expressed as “the value to the resource rights holder of the attribute depends on whether he has secure property rights to the relevant attribute”. By changing “owner” to “rights holder”, I incorporate an advance in the RBV misconception, that the proprietary condition over resources is imperative to achieve a

sustainable competitive advantage. It is not, the empirical evidence offered by the case studies has shown that RBV should relaxes the ownership condition.

The second premise refers to the accurate definition of property rights over the relevant attribute, in the sense that it can deliver value to its right holder. Once there is a system of well-defined and enforceable property rights - the patent right for instance - which can be accessed by a given firm, because a resource is a bundle of attributes to which the firm can enjoy the benefits offered by a single one, the firms will shape the appropriability regime in their favor.

Putting it differently, the relatively wide adoption of the IPRs coexistence appropriation strategy confirms that, when the State does not provide a secure system of property rights protection, alternative arrangements arise. Firms find ways to avoid the adverse effects of weak institutions.

In a more general sense, this dissertation pointed to the idea of accessing economic rights, *à la* Barzel, towards a resource that can be dismembered in few attributes, to which individual property rights can be assigned, and then enjoy the superior protection offered by the relevant attribute.

This finding can be interesting, for example, to understand brand's strategy, which can be used by firms that offer products with easily capturing features. These firms, by incorporating a relevant attribute, such as a strong brand, would achieve a higher protection of their value.

Thus, the main theoretical contribution of this dissertation is in favor of the incorporation of property rights' elements to better consolidate RBV as a strategic doctrine. A secondary contribution is actually a concern about future reflections on the Brazilian PVP System, and will be briefly developed in the next sections, where I also recall the issue of market consolidation.

5.3 Final remarks

This closing section addresses subsidiary issues to the core purpose of this dissertation, regarding property rights dimensions, as well as the breeding sector.

5.3.1 IPRs and market consolidation

Paraphrasing the words of one of the interviewees, who said “Brazilian soybean is in the shadow of the patents”, I complete by saying that also is cotton. Along this dissertation I revealed that the main soybean breeding firm, which used to be Monsanto, which also holds the patent trait that is introgressed in 66% of the seeds produced in the 2017/18 crop season in Brazil, and in 64% of all soybean varieties protected by breeders in 2017. This last figure also incorporates the varieties that carry Bayer GM trait, since both companies underwent a consolidation process. The merged MNC holds all GM traits commercially available of soybean and cotton varieties.

However, as shown in this dissertation, part of this huge capillarity was achieved thanks to the adoption of the IPRs coexistence appropriation strategy, both by soybean and cotton breeders, which, in turn, is a response to the current Brazilian PVP System that shows the weak institutional environment faced by them.

Competition authorities increasingly worry about the effects that market concentration may have on innovation, especially concerning new General Purpose Technologies (GPT)⁶⁶, such as artificial intelligence and CRISPR-Cas9⁶⁷. Scholars are concerned about competition authorities being prepared to address the real relevant market to comprise innovation and IPRs dimensions, for the assessment of M&A transactions. Likewise, various anti-trust remedies will have to be adopted also for IPRs regulation circumscription (A. Ivanov; D. Davis; E. Fox, personal communication, November 11, 2017).

For instance, merger cases, as those involving Biotech Agrochemical MNCs, have signaled to the competition authorities the need to test more dynamic approaches in assessing possible

⁶⁶ Bresnahan, Stern and Trajtenberg (1996) argue that GPTs should have the following characteristics: “pervasiveness”, as the idea is that GPT should spread to most sectors of the economy; “improvement”, as GPT becomes better over time, the costs of using it are reduced; and “innovation spawning”, as GPT should facilitate the invention and production of new products or processes.

⁶⁷ CRISPR-Cas9 is one of the genome-editing group of technologies that give scientists the ability to change an organism's DNA. It was adapted from a naturally occurring genome editing system in bacteria. The bacteria capture snippets of DNA from invading viruses, and use them to create DNA segments known as CRISPR arrays. The CRISPR arrays allow the bacteria to “remember” the viruses (or closely related ones). If the viruses attack again, the bacteria produce RNA segments from the CRISPR arrays to target the viruses' DNA. The bacteria then use Cas9 or a similar enzyme to cut the DNA apart, which disables the virus. The CRISPR-Cas9 system works similarly in the lab (Genetic Home Reference, 2018).

restrictions on innovation competition, going beyond a simple analysis of the merger's effect on product market competition, technology market competition, or even innovation market competition.

This debate is extremely important, since the trade-off between rising concentration in global agricultural R&D and innovation is still controversial. If on one hand such a consolidation provides highly innovative products for farmers, on the other hand the greater market power resulting from the structural changes in agricultural input industries means that farmers may pay higher prices for purchased inputs (ETC Group, 2015; Fuglie *et al.*, 2011)⁶⁸.

In a different way, Lianos (2017) notices that the emergence of integrated technology/traits/seeds/chemicals platforms may build new barriers to entry, as potential entrants would need to offer an integrated solution to farmers. This may suffocate disruptive innovation, if, in the absence of a merger, firms were able to enter one or two segments of the market without the need to offer an “integrated” platform product.

5.3.2 Adoption of the IPRs coexistence strategy, persistence of its institutional causes and future technologies: implications for public policies and management practices

The likely spreading of the IPRs coexistence appropriation strategy may have important implications in several areas. For instance, costumer preferences are changing fast all over the world, and several groups of interest oppose to GMOs.

The excessive use of GM traits in agriculture has been responsible for damages to biodiversity. One of these damages is the genetic base narrowing, which reduces genetic diversity. Ultimately, such a consequence is detrimental to breeding firms because it reduces its source of genetic variability for the improvement of new varieties.

Still from the breeder's point of view, the IPRs coexistence appropriation strategy furthers a kind of dependency between breeding firms and biotech firms, which exhibit an unbalance in

⁶⁸ Until recently, a common view was that, because of the well-documented “inverted U-shape” relationship between innovation and market concentration, mergers were likely to have an adverse effect on innovation, if market concentration were already high. New cases and new economic papers have challenged this idea, arguing that the refutable presumption that mergers lead to less innovation might contribute to better policies (P. Régibeau, personal communication, November 11, 2017).

terms of bargaining power, which might be harmful for Brazilian breeding firms. In addition, the low investment capacity of these firms, compared to MNCs, makes this unbalance more evident⁶⁹.

In favor of the breeding firms, the Precision Breeding Innovation (PBI) comprises the so-called New Breeding Technologies (NBT), which in turn encompass a set of new methodologies and approaches that differ from the traditional genetic engineering strategy with transgenes. The most promising techniques are related to Gene Editing, a technology that gives scientists the ability to change an organism's DNA by allowing genetic material to be added, removed, or altered at particular locations of the genome. Gene editing in agricultural crops offers significant potential for trait improvement, without the introduction of foreign DNA. The latter is a welcome feature in terms of public acceptance.

Several approaches to genome editing have been developed. The one called CRISPR-Cas9 has generated a lot of excitement in the scientific community, because it is faster, cheaper, more accurate and more efficient than other existing breeding methods (Genetics Home Reference, 2018). That is, CRISPR-Cas9 offers opportunities for the emergence of more competitive and less integrated market structures in the traits/seeds segments (Sternberg, 2018).

The regulation concerning NBTs is quiet new worldwide, and was established in some countries between 2017 and 2018, while in others it is still subject to debate. Since genome editing in crops results in the absence of recombinant DNA/RNA in the final product, regulation aspects have been controversial. While Brazil and the US, for the mentioned reasons, understood that the final products are not GM, the European Union considered them as such, since they would be 'disguised GMOs'.

Since the GMO label for NBT products has been ruled out by CTNBio, experts believe that their IPRs assignment will be provided by the PVP system that is already established in Brazil. Hence, in view of the new possibilities that are glimpsed with the use of NBTs, is it reasonable to suppose that the traditional GMO technology will lose relevance? Will the use of the IPRs

⁶⁹ Braspov's interviewee reported that, on average, breeding firms in Brazil invest 10-15% of the revenue in the research and development of new varieties. He also recalled that this figure could be higher if the sector did not lose about 30% of the billing because of informality.

coexistence appropriation strategy find support in technical terms? How will the breeders protect their IPRs in view of the current legislation?

As one can observe, there are many possibilities still undefined. Our findings about the deliberate adoption of the IPRs coexistence appropriation strategy can offer insights to improve public policies and institutional conditions to better balance the Brazilian PVP System for protecting future technologies.

To finish, this dissertation findings, which connect the possession or access of one single resource attribute, with well-defined property rights, to the possibility of increasing rent appropriation of the resource as a whole, may offer implications for management practices of firms in different market sectors.

5.3.3 Limitations

Empirically, the dissertation focused on a very specific industry, considered relevant to generate a case in which the firms face comparable environmental pressures. However, at the same time, in theoretical terms one should be cautious in generalizing the results.

The requirement for confidentiality, on the part of some interviewees, made it difficult to disclose certain research findings. Otherwise, some results could have been better incorporated in the development of the ideas.

Another limitation refers to the small number of breeding firms in Brazil, mainly in the cotton case, which made it impossible to carry out quantitative analyses to achieve more robust results.

5.3.4 Suggestions for future research

I suggest future research on three distinct issues. One relates to a better consolidation of the theoretical ideas developed in this thesis. In this sense, it would be interesting to see empirical research on other industries or market sectors, trying to deepen the integration between RBV and property rights, in order to explain sustainable competitive advantages. This could be done mainly by using the unbundling argument.

The second front refers to advancing on the empirical findings revealed by this dissertation. In order to expand the understanding of the emerged phenomena, that is, the performance of the IPRs coexistence appropriation strategy, it would be very fruitful to investigate its occurrence in countries with similar institutional features and crops production endowments, like the intensive spread of GMO plantations.

Another promising path for future research, in this same front, is the intersection between IPRs protection and innovation. It would be very interesting to measure if the adoption of any of the alternative appropriation strategies described in this thesis would produce more or less innovation. It could be done, for instance, by comparing the non-adopters with the adopting firms.

Finally, the third relevant stream of research is to advance in the comprehension of the interface comprising IPRs and market consolidation. As highlighted before, the deepening of this issue would be welcome by the competent authorities in several jurisdictions.

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APPENDIX A - Interview script

Interview script (free translation from Portuguese)

About me:

Hello, I am Camila Dias de Sá, PhD student at the School of Economics and Administration of the University of São Paulo (FEA-USP) and a researcher at CORS (Center for Organization Studies) since 2014. I was an assistant professor at Insper (2010-2014), a PENSA researcher (2008-2010), and a consultant at Markestrat (2007-2013). I graduated in Agronomic Engineering from ESALQ (2002), and I hold a Master's Degree from FEA-USP (2010). I also acted in other companies of the Agrobusiness sector between 2003 and 2007.

About my research

From 2008, when I started the Master program, I have been studying institutions and organizations, with application in the Agribusiness. Since then, I keep a special interest on the topic of intellectual property applied to agriculture. In my PhD dissertation, I investigate the value appropriation efforts undertaken by companies that operate in the seed sector, regarding the compliance of rural producers with those companies' intellectual property rights. Therefore, to advance my research, it is essential to understand how these firms are working, in order to ensure the appropriation of their property rights.

In the end of my research I will prepare an executive draft with the main findings. Please tell me if you want to receive a copy.

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Confidentiality:

We will keep secrecy of the information communicated during the interview, according to the respondents' directions. Therefore, we request that, at the end of the interview, he/she indicate the desired level of confidentiality.

Name of the organization:

Name of the respondent:

Position in the organization:

E-mail:

1. What are the agricultural crop(s) that the organization works with, indicating their order of importance.
2. What is the size of the market accessed by the organization, for each crop?
3. Does the organization operate in all the main producing regions, or only in specific regions? Mark the answer that best represents the organization's operation.

☐ Operates in the main producing regions
☐ Operates only in specific producing regions. In this case, mark which they are.
4. What is(are) the object(s) of the efforts undertaken for the protection of the organization's intellectual property against rural producers?
☐ Gene
☐ Lineage
☐ Cultivar (variety)
5. In what year was the organization founded?
6. In what year did the organization begin activities of plant breeding?
7. How many employees does the organization have?
8. How many employees are dedicated to the breeding activity?
9. Who are the main competitors of the organization, specifically in the plant breeding activity?
10. Does the organization have R&D partnerships for plant breeding? Who are the main partners?
11. On the protection of varieties through a certificate issued by SNPC.
 - a. How many of the organization's varieties are protected?
12. What is the reason why some varieties were/are not protected?

	Protection expired and the cultivar fell into the public domain
	The return potential does not compensate for the protection
	The organization does not protect all its varieties. Inform the reason.
	Another reason (inform which)

13. Does the organization adopt any other form of protection in order to curb illicit practices by rural producers that use its materials?

Yes	
No	

14. How does the organization operate? Which are the strategies, mechanisms or practices adopted to secure the intellectual property of its own varieties? Are there differences regarding the crops?

15. Check if the company adopts any of the means described below for securing the appropriation of its property rights. If there are differences between crops, please identify them.

	Monitoring of rural producers. Private monitoring practices – from the sowing to the time of harvest – in order to curb illegal practices.
	Higher release price. Company try to maximize price in year one, since you expect that the farmer will save the seeds in year two.
	Rapid innovation. Seed genetics purposely becomes outdated in a short period, pushing the farmers to purchase new seeds every year.
	Product bundling. The organization conditions access to varieties to the purchase of other inputs and services, and to royalties' payment for varieties in the public domain.

16. Are the strategies/mechanisms/practices employed to guarantee the organization's intellectual property used uniformly throughout the national territory and for all crops?

Yes	
No	

- a. Is there any differentiation between strategies/mechanisms/practices employed, considering the distinct agricultural crops that the organization works with? Explain.

- b. Is there any differentiation between strategies/mechanisms/practices employed, considering the distinct geographical regions of the country? Explain.
- c. Is there any differentiation regarding the form of organization of rural producers? For instance, is there a differentiation in the adopted strategies when producers are gathered in cooperatives or associations? Explain.

17. Does the organization have GM varieties?

Yes	
No	

18. How many of the varieties sold by the organization are GM?

19. Why did the organization choose to introduce GM traits in its varieties?

20. The fact of owning GM varieties affects in any way the appropriation of intellectual property related to the varieties owned by the company? Explain.

Yes	
No	

21. Which assets of the organization help in the recovery of its property rights? Ex.: teams that offer services of sale, after-sale and technical assistance, complementary products, such as other inputs and services, among others.

22. How is the relationship of the organization with the seed farmers of its materials? Describe it.

23. Have you ever filed legal proceedings? How is (was) it?

Confidentiality:

- () I agree to disclose all the content mentioned/discussed during the interview.
- () I agree to disclose only part of the content mentioned/discussed during the interview, according to my orientation on the confidential topics/points.
- () I agree that all the content of the interview can be used in the study, but without being associated with the organization that I represent, even if its name is revealed as one of the respondents.
- () I agree that the whole content of the interview can be used in the study, but without being associated with the organization I represent ; and I also request that the name of the organization is not disclosed as one of the respondents.