UNIVERSIDADE FEDERAL DE LAVRAS

MARIANE FIGUEIRA

INNOVATION MANAGEMENT IN THE GENETICALLY MODIFIED SEED INDUSTRY:
A BUSINESS PLATFORM DYNAMIC APPROACH

LAVRAS – MG
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Tese apresentada à Universidade Federal de Lavras, como parte das exigências do Programa de Pós-Graduação em Administração, área de concentração Organizações, Estratégias e Gestão, para a obtenção do título de "Doutor".

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To my parents
Antonia and José Roberto.

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RESUMO

Visando contribuir para o campo da gestão da inovação, foram analisados processos de inovação a partir de uma perspectiva multi-nível, multi-dimensional e dinâmica. O objetivo do presente estudo foi desenvolver um modelo teórico genérico de plataforma de negócios para analisar processos de inovação na indústria da semente geneticamente modificada (GM). O trabalho foi dividido em quatro capítulos que empregaram os conceitos de dinâmica de modelo de negócios, as dimensões da inovação aberta e o entendimento de plataforma de negócios para compreender processos de inovação de empresas operando no setor da biotecnologia agrícola no Brasil. O primeiro capítulo apresenta o contexto da pesquisa, as questões chave que motivaram esse estudo, o referencial teórico que serviu de base para o trabalho como um todo e o modelo teórico que pode ser visto como uma das principais contribuições desse estudo, servindo de ligação para os outros três capítulos. O segundo capítulo ilustra o conceito de dinâmica de modelo de negócios por meio de um estudo de caso de uma empresa pioneira na área de sementes geneticamente modificadas. O terceiro capítulo expõe os conceitos de modelo de negócio aberto e inovação aberta e, por meio da observação da trajetória histórica da indústria da biotecnologia agrícola, mostra a evolução dos modelos de negócio nesse setor e a caracterização de dimensões da inovação aberta. O quarto capítulo aborda diferentes percepções de agentes do setor de sementes GM sobre a definição e construção de plataformas de negócios e a liderança em plataforma de negócios nesse setor. Para o desenvolvimento desse estudo foram coletadas dados de fontes bibliográficos e documentais e realizadas 22 entrevistas em profundidade e 7 conversas informais com diretores, gerentes e técnicos das seis maiores empresas multinacionais de biotecnologia agrícola presentes no Brasil, uma cooperativa que desenvolve pesquisa, e duas empresas de sementes. Os dados foram coletados nos anos de 2007, 2008, 2010, 2011 e 2013 e analisados de maneira qualitativa. Os principais resultados obtidos mostram que os conceitos de dinâmica de modelo de negócios e as dimensões da inovação aberta fazem parte do modelo teórico de plataforma de negócios. O conceito de plataforma de negócios foi definido como sendo a lógica compartilhada ou a arquitetura que permite a união das competências necessárias para se facilitar a inovação dentro de firmas, em cadeias de suprimentos e entre indústrias. Quatro dimensões de inovação foram identificados: inovação inside que caracteriza a plataforma de negócios interna, inovação outside-in que pode gerar a plataforma de negócios de cadeia de suprimentos, inovação inside-out que pode gerar a plataforma de negócios industrial, e o co-desenvolvimento que pode gerar a plataforma de negócios de cadeia de suprimentos. A evolução das plataformas de negócios no setor estudado se diferencia um pouco com relação ao entendimento encontrado na literatura. Na indústria de sementes GM uma plataforma interna pode evoluir para uma plataforma industrial quando uma empresa de biotecnologia agrícola desenvolve soluções integradas para os consumidores.

Palavras-chave: Biotecnologia agrícola. Dinâmica de plataforma de negócios. Inovação aberta. Sementes geneticamente modificadas.

ABSTRACT

Willing to contribute to the field of innovation management the present study analyzes innovation processes from a multi-level, multi-dimensional, and dynamic perspective. The main objective of this study was the development of a generic business platform theoretical model to analyze innovation processes in the genetically modified (GM) seed industry. The study is divided into four chapters that implement the concept of business model dynamics, the dimensions of open innovation and business platform understanding to analyze innovation processes in the agricultural biotechnology sector in Brazil. The first chapter exposes our research background, research questions that motivated the study, theoretical underpinning that was the basis of the entire study and theoretical framework which can be seen as one of the main contributions of this study, and worked as connecting line for the three following chapters. The second chapter illustrates the concept of business model dynamics through a single case study on a pioneering agricultural biotechnology multinational company. The third chapter approaches the concepts of open business model and open innovation, and through the analysis of the agricultural biotechnology industry's historical trajectory, shows the evolution of business models within the GM seed sector and also the characterization of open business model dimensions. In the fourth chapter we analyze perceptions of the concept of business platforms in the GM seed industry of different agents operating in the sector, considering definition and construction of business platforms and business platform leadership in the GM seed sector. For the development of this study data was collected from documental and bibliographical sources, as well as 22 in-depth interviews and 7 informal conversation carried out with directors, managers and technicians from the six largest agricultural biotechnology multinational companies operating in Brazil, one Brazilian research cooperative and two Brazilian seed companies. Data was collected in 2007, 2008, 2010, 2011, and 2013 and analyzed qualitatively. Results show that the concepts of business model dynamics and the dimensions of open innovation are part of the business platform theoretical framework. The business platform concept has been defined as the shared logic or the architecture that allow gathering the complementary competences necessary to facilitate innovation within firms, within supply chains, and between industries. Four dimensions of innovation were identified: inside innovation characterizing the internal business platform, outside-in innovation generating the supply chain business platform, inside-out innovation which can generate the industrial business platform, and co-development, characterizing the supply chain business platform. Business platform evolution in the sector studied is different compared to the understanding found in the literature. Within the GM seed industry de an internal business platform can evolve to an industrial platform when an agricultural biotechnology company develops integrated solutions to customers.

Keywords: Agricultural biotechnology. Business platform dynamics. Open innovation. Genetically modified seeds.

CONTENTS

CHAPTER 1 General introduction – analyzing innovation processes in the genetically modified seed industry in Brazil 14

1 INTRODUCTION 15

1.1 Thesis overview 18

2 THEORETICAL UNDERPINNING 21

2.1 Innovation and how it affects competition and competitive advantage 21

2.2 Changes in the competitive landscape and new challenges to innovating companies 24

2.3 Business model dynamics 30

2.4 Open innovation 35

2.5 Business platforms 40

2.6 Agricultural biotechnology and the genetically modified seed industry in Brazil 49

2.6.1 The genetically modified seed supply chain: agents and main features 53

2.6.1.1 Main strategic agents operating in the genetically modified seed industry in Brazil 62

2.6.1.2 Monsanto Brazil 65

2.6.1.3 Syngenta 66

2.6.1.4 Dupont/Pioneer 67

2.6.1.5 Dow AgroSciences 67

2.6.1.6 Bayer CropScience 68

2.6.1.7 BASF 69

2.6.1.8 Embrapa 70

2.6.1.9 Coodetec 71

3 RESEARCH CONTRIBUTION – BUILDING A BUSINESS PLATFORM FRAMEWORK FOR ANALYZING INNOVATION IN THE GENETICALLY MODIFIED SEED INDUSTRY 72
4 CONCLUSIONS AND SOME LIMITATIONS 79
CHAPTER 2 How multinational companies create and capture value from innovation through business model dynamics 92
1 INTRODUCTION 94
2 THEORETICAL UNDERPINNING 98
2.1 The business model concept: definition and key components ... 98
2.2 Dynamics of business models: changes in response to strategic hurdles 102
3 RESEARCH DESIGN 105
4 RESULTS AND DISCUSSION 107
4.1 The company 107
4.2 The story 108
4.2.1 Developing products from agricultural biotechnology: building core capabilities and acquiring the vehicle that enabled delivering products to customers 111
4.2.2 Public acceptance of transgenic plants: new communication and social responsibility department, and more transparency 113
4.2.3 Problems and challenges creating and capturing value from transgenic seeds: completing the new architecture of revenues 115
5 CONCLUSIONS 121
REFERENCES 123

CHAPTER 3 The concepts of open innovation and open business model and the dynamics of innovation processes in the genetically modified seed industry in Brazil 128
1 INTRODUCTION 130
2 THEORETICAL UNDERPINNING 134
2.1 Genetically modified seeds and business opportunities 134
2.2 Open innovation and open business model 137
3 DATA AND RESEARCH METHODOLOGY 140
4 RESULTS AND DISCUSSION 142
4.1 The history of the genetically modified seed industry: evolution of agriculture and the emergence of agricultural biotechnology 142
4.2 Impacts of Agricultural Biotechnology on Companies' Competitive Landscape 144
4.3 Current and future trends of innovation processes in the genetically modified seed industry: open innovation and open business models 147
5 CONCLUDING REMARKS 154
REFERENCES 156
CHAPTER 4 The business platform theoretical concept and innovation processes in the genetically modified seed industry in Brazil 161
1 INTRODUCTION 163
2 THEORETICAL REFLECTIONS 167
2.1 The concepts of business platform, business platform architecture, and business platform leadership 167
3 RESEARCH METHODOLOGY 174
4 RESULTS AND DISCUSSION 177

4.1 Understanding architecture and business platform components in the GM seed industry 177
4.1.1 Interdependent capabilities and modules within the transgenic seed industry business platforms 177
4.1.2 Strategies for establishing industry standards and achieving platform leadership.. 185
5 CONCLUSIONS 189
REFERENCES 191
ATTACHMENTS 194

CHAPTER 1 General introduction – analyzing innovation processes in the genetically modified seed industry in Brazil

1 INTRODUCTION

Innovation encompassing new products, new industrial processes and services has been considered a strategic source of growth and sustainable competitive advantage for companies worldwide. In the present though, mastering innovation represents great challenge to companies for many reasons. Especially in sectors where knowledge has an important role, the competitive landscape and ways of innovating have changed and companies face new obstacles to be overcome if they want be successful innovators.

Many scholars have described what they see as changes that impact companies' innovation practices (CHESBROUGH, 2003a, 2003b; TEECE, 2000). Teece (2000) has called the attention to fundamental changes in the global economy that influence the basis of firm level competitive advantage. Decreased costs of information flow, increases in the number of markets, the liberalization of product and labor markets in many parts of the world, and the deregulation of international financial flows have rendered traditional sources of competitive differentiation less effective.

Adding to that it is relevant to note that in the 20th century, industrial corporations were able to innovate only by conducting basic research activities internally, and by carrying the results of that research to the market. Firms developed innovation activities in isolation, and organizations and their researchers were seen as the key aspects of innovation. However, the process of globalization has led to the decrease of isolated innovation activities, the transfer of innovation activities to emerging countries and, especially, to a growing division of innovation labor[1] across the globe (CHESBROUGH 2003b, 2006).

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[1] Chesbrough (2006) has defined 'division of innovation labor' as a system where one party develops an innovative idea but does not carry this idea to the market. Instead, that party sells the idea or partners with another party, who then becomes the one responsible for delivering the idea to the market.

Companies in the past dealt with high development costs and had as the main source of revenue their own market and intellectual property. Due to the complexity of the products, services and technologies in the present and to the process of globalization, innovation has been more multi-sector and represents a combination of resources from various companies. In such a context, Teece (2000) argued that firms' capabilities should be managed dynamically through alliances, and organizational boundaries should be redefined in a more flexible way in order to allow companies to share their core competencies.

An immense wealth of examples on the changes and complexity of innovation processes can be found in the agricultural field in Brazil and other emerging and developed countries. Biotechnology has generated a paradigmatic change in agriculture by enabling the development of radically new products, impacting companies and connecting sectors that were not previously linked to agriculture.

New products derived from agricultural biotechnology such as the transgenic or genetically modified (GM) crops have opened new innovation and business opportunities to companies.

In this context, we pose that new and flexible management tolls would help academia, managers and practitioners manage and better understand innovation processes in the agricultural field of genetically modified seeds.

The concepts of business model dynamics, open innovation and the business platform construct seem appropriate to explain the new logics involved in innovation processes in knowledge based industries such as the GM seed industry.

We believe our object of study or, our overarching case study (the genetically modified seed industry), behaves empirically as the ecosystem explained through the business platform theoretical approach. For instance, knowledge involved in innovating in this field is very fragmented, one single product can have up to 70 patents, owned by 32 different actors, which is the case of the golden rice (AMÂNCIO, 2011; KRYDER; KOWALSKI; KRATTIGER, 2000). For that fact, it is important to partner and gain access to those technologies necessary to complete the innovation processes.

The business platform construct is fit to describe this new innovative reality of collaboration for the fact that it focuses on the architecture or ecosystem formed where companies share their core capabilities in order to enhance and support innovation.

Even though many studies have approached the business platform concept in many sectors, from the automotive industry to information technologies (GAWER; CUSUMANO, 2002; MESQUITA, 2009), there is still much to be accomplished in the field of innovation studies willing to begin filling the existing literature gaps of how business platforms are defined and how they evolve, considering different sectors and disparate technologies.

The answers to questions such as how innovation processes in the genetically modified seed industry in Brazil can be better analyzed; and other questions, such as how companies create and capture value from innovation; how the concepts of open innovation and open business models contribute to the understanding of innovation processes in the GM seed industry; how innovation processes are seen through the lenses of the business platform theoretical concept, and how that perception differs considering the different innovative agents in the genetically modified seed sector, can contribute to the fields of innovation, strategy and management.

In this context, our study has as its main objective to look at innovation through the lenses of new management tools, willing to develop a business platform generic theoretical framework that can be applied to analyzing innovation processes in the genetically modified seed industry in Brazil.

In this first chapter, we contribute to the innovation research field, presenting a multi-dimensional, multi-level and dynamic framework that unites flexible new strategic approaches to analyze innovation such as business model dynamics and open innovation. Strategists and entrepreneurs can use this framework to analyze their business and innovation practices.

The next section presents the thesis overview. The following sections discuss our view of innovation and how it affects companies; the new competitive landscape companies face in the present; the concepts that helped us build our theoretical framework; the generic theoretical framework we have developed for understanding innovation in the field of GM seeds; and some conclusions and limitation of the study.

1.1 Thesis overview

With the development of this study we believe we contribute not only to the understanding and management of innovation processes in the GM seed industry in Brazil, but we also point new tools to analyze innovation (business model dynamics, open innovation and the business platform concept). We connect these tools to the reality of the GM seed industry, collaborating to filling literature gaps, addressing questions that had not yet been answered and contributing to the development of the business platform extant theory.

The first chapter is an introductory chapter which exposes our research background, research questions, and main objectives. In the introductory chapter we develop our theoretical framework, the main contribution of our study, encompassing the constructs that have been applied to answer our research questions in the following chapters of the study. The framework proposed captures a multi-dimensional (innovation inside, outside-in innovation, inside-out innovation, and coupled innovation), multi-level (firm level, supply chain level and industry level) and dynamic (internal platform, supply chain platform and industrial platform) perspective.

In this initial chapter we have presented our overarching case study (the genetically modified seed industry), and some features of innovation and innovative agents in this sector.

The theoretical framework we have presented in this first chapter has also as its objective to work as a connecting line for the following chapters of this thesis, which intend to answer our research questions.

The first chapter is based upon all the data collected for this thesis, including the bibliographical documents, information collected from companies' websites and annual reports, as well as the interviews carried out for the development of the entire work.

We have developed 22 in-depth interviews and 7 informal conversations with key directors, managers and technicians who worked, at the time of the data collection process, for one of the six largest agricultural biotechnology multinational companies operating in Brazil (Monsanto, BASF, Bayer CropScience, DuPont/Pioneer, Dow Agrosciences, and Syngenta), one Brazilian research cooperative (COODETEC), and two Brazilian seed companies (Riber Sementes and Sementes Farroupilha) (Attachment A).

In the second chapter of this study we introduce an illustrative single case study on an agricultural biotechnology multinational company to show how that company managed to restructure itself and respond to the challenges presented by the new biotechnology tool, being able to innovate in the sector. We develop that task answering to question of how multinational companies create and capture value from innovation. To approach that research question we have described business model dynamics which is a flexible tool that allows the understanding of a company's changes in its strategic choices through the changes in the company's business model to respond to strategic hurdles the company faced throughout the path to develop the first products from agriculture biotechnology that were commercialized.

At a third moment, we have presented the concept of open innovation within the genetically modified seed industry (Chapter III). Having in mind the various changes that the companies in that sector go through to be able to work with the biotechnology tool and commercialize the results of the innovation processes, we look at innovation from the perspective of the relationships and the business opportunities that the GM crops open up to companies.

In the third chapter we investigate the history, describe the most important features, and point future trends of the transgenic seed industry, willing to verify if firms' business models for creating and capturing value from innovation shows a tendency to be more open. Through a longitudinal case study with the GM seed industry in Brazil, we develop a qualitative study, aiming at answering to the question of how the concepts of open innovation and open business model can be described in the sector of GM seeds and how they contribute to the understanding of the dynamics of innovation.

In the fourth chapter we analyze the perception of the concept of business platforms in the GM seed industry by different agents operating in the sector, willing to understand how business platforms are built in the GM seed sector and if we can identify business platform leadership. Through a grounded theory research where we aim at contributing to developing the extant theory on business platforms, we also explore how the GM seed industry business platforms are different from platforms from other sectors.

Next section presents our general theoretical underpinning.

2 THEORETICAL UNDERPINNING

2.1 Innovation and how it affects competition and competitive advantage

As Freeman and Soete (2008, p. 18) had stated, "*in the world of microelectronics and genetic engineering it is not necessary to stress the importance of science and technology to the field of economics*."

Talking about innovation, Freeman and Soete (2008) observed that the importance of innovation in the present is not only related to the fact that it increases the wealth of nations and prosperity, but also because it allows people to do things differently and experience new things. Innovation has the power of enabling life quality change for the better, including new patterns of products and services that did not exist before.

We believe a definition of innovation must include value such as Selman's (2009): "*innovation is bringing into existence something new that can be sustained and repeated and which has some value or utility*."

In our study we pose that without representing value to customers or to the innovative company, a new idea cannot be considered an innovation. We would also like to distinguish between innovation and invention. Invention is not the same as innovation. In general, an invention refers to the result of research activities, such as a patented idea, while an innovation is a commercial product, process or service. We agree with Martin's (1984) understanding that an invention may be viewed as a new idea or concept, but this invention only becomes an innovation when it is transformed into a socially usable product.

Aligned with our understanding Goh (2004) noted that innovation is not creativity alone as it begins with an idea and subsequent implementation to produce new value.

A broad perspective of innovation can be found in Schumpeter's (1982) definition in terms of a new product, a new method of production, the opening of a new market, a new source of raw material, and new ways of organizing within an industry. Nevertheless, all types of innovation defined by Schumpeter (1982) collaborate to enabling the creation of new unprecedented value.

Because innovation unlocks the creation of new value it affects competition[2] and the competitive advantage[3] of firms (Porter, 1996).

Abernathy and Clark (1985) willing to identify the role of innovation in competition posed that the significance of innovation for competition depends on what they have called its 'transilience' – that is innovation's capacity to influence the firm's existing resources, skills and knowledge, having in mind they evaluate innovation in terms of success or failure of the innovating firm in its rivalry with competitors, and are thus concerned with how and to what extent innovation affects the relative advantage of actual and potential competitors.

The scholars explained that technological innovation may influence a variety of economic actors in a variety of ways, and it is this variety that gives rise to the differing views of the significance of changes in technology.

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[2] Abernathy and Clark (1985, p. 4) defined competition as "*a contest among rivals (actual and potential) with different capabilities.*"

[3] Competitive advantage depends on the acquisition or development of particular skills, relationships and resources (Abernathy; Clark, 1985). Abernathy and Clark (1985) propose considering the competitive position of a firm in terms of a variety of dimensions, assuming that products are not homogenous, and that firms compete by offering products that may differ in many aspects: performance, reliability, availability, ease of use, aesthetic appearance, and image, as well as initial cost. According to the scholars, a firm gains a competitive advantage when it achieves a position in one of these dimensions, or a combination of them which is both valued by the customers and superior to that of competitors. On the other hand, the products' features themselves and the firm's position with them are not the fundamental source of advantage. The foundation of a firm's position rests on a set of material resources, human skills and relationships, and relevant knowledge that are the competencies or competitive ingredients from which the firm builds the product features that appeal to the marketplace.

They note that all technological innovation imposes change of some kind, but it doesn’t necessarily have to be destructive. For instance, innovation in process technology may require new procedures handling information and yet utilize existing labor skills in a more effective way. Such changes conserve the established competence of the firm, and even enhance and refine competence making it more difficult for alternative resources or skills to achieve an advantage.

On the other hand, considering the range of effects an innovation might have, on the radical side of it, instead of enhancing and strengthening, this kind of innovation disrupts and destroys. Innovation of this sort changes processes or products to an extent that imposes requirements the existing resources, skills and knowledge satisfy poorly or not at all. In this context, the effect of this radical innovation is to reduce the value of existing competence and in more extreme cases to render it obsolete.

This kind of change is at the heart of Schumpeter’s theory of innovation and economic development in which ‘creative destruction’ is the vehicle of growth. Its effect on competition works through a redefinition of what is required to achieve a competitive advantage (ABERNATHY; CLARK, 1985).

When discussing the effects of innovation and technological change Abernathy and Clark (1985) were talking about the levels of newness that innovation may represent, which can either be incremental (sustaining) or radical (discontinuous).

The process of innovation is usually defined according to its level of novelty. While incremental innovation involves adaptation, refinement and enhancement of existing products and services with high chances of success and low uncertainty considering its outcomes, radical innovation involves leaps in the advancement of technology leading to entirely new products, processes and services (FORTUIN, 2006).

Some authors argue it is the radical discontinuous innovation that has the power of unleashing greater value for it can open new markets, attract new customers, transform entire sectors, or even put the innovative firm in a superior position not having to worry about competitors (HAMEL, 2000; KIM; MAUGBORNE, 2005).

Since there is no doubt that innovation is crucial for the success of companies, besides the definition of innovation and the ways it affects competition, it is relevant to discuss some technology changes and trends that influence companies' competitive landscape and innovative practices in the present.

2.2 Changes in the competitive landscape and new challenges to innovating companies

Strong forces of change, such as globalization, advances in technology, and increasing aggressiveness of competitors are reshaping the competitive landscape worldwide (ILINITCH; AVENI; LEWIN, 1996; VOLBERDA, 1996). Management researchers have produced a large volume of literature in order to examine technological trends and other trends that affect companies' competitive rules and innovative activities (DILK et al., 2008; LEE; OLSON; TRIMI, 2012; SAMPLER, 1998).

Bettis and Hitt (1995) listed some technological trends that have altered the nature of competition and strategy: 1- the increasing rate of technological change and diffusion; 2- the information age; 3- increasing knowledge intensity; and 4- the emergence of positive feedback industry.

Related to the first trend of technological change and diffusion important developments observed are universities becoming significant players in creating and diffusing new technologies globally, and also the growing interest by foreign multinationals in setting up partnerships and long term agreements with universities to gain immediate and direct access to basic and applied science breakthroughs.

Considering the second trend of the information age, information technologies, computers, and telecommunications have evolved in a rapid, complex and chaotic manner with results far beyond envisioned in the past. Decline in the costs and increased accessibility of these resources have created a new competitive landscape.

The third trend of increasing knowledge intensity has organizational learning as a critical component in gaining and maintaining competitive advantage. If technological change is seen as a set of changes in our knowledge (MOKYR, 1990), and if current knowledge is a function of a firm's formal and informal technological learning in prior time periods (WINTER, 1987), then, according to Bettis and Hitt (1995) growing technological orientation and increasing use of computer and telecomunications technology in many industries create greater knowledge intensity.

Regarding the fourth trend of the positive feedback industry, Bettis and Hitt (1995) noted that as experience with production accumulates, the firm learns how to produce more units more cheaply. Besides that, the knowledge and experience gained in the design, certification, and production of a particular automobile, for instance, may make it easier to design, certify, and produce other automobiles, vans or small trucks.

Another interesting feature associated with the positive feedback industry is the fact that technological standards tend to become locked in by positive feedback (BETTIS; HITT, 1995). Widespread adoption of a technology or technological standard creates an atmosphere where new producers or customers find it advantageous to adopt it rather than an alternative.

The technological trends discussed by Bettis and Hitt (1995) have the following implications for the competitive landscape of companies:

a) increasing risk and uncertainty – facing increasingly complex products, and new technologies, new innovative products and strategic alliances that can rapidly alter industry structure, it is important to have a thorough understanding of industry dynamics;
b) the ambiguity of industry – complex innovative products and solutions that deliver bundled attributes and fused technologies to customers have blurred industry boundaries and generated a large number of mergers and strategic alliances between firms;
c) the new managerial mindset – the traditional managerial mindset of the past, based on years of experience and formal strategic planning, has been replaced by a new learning- oriented managerial mindset that emphasizes flexibility in strategy and organization, allowing cooperation and the formation of strategic alliances with current and potential competitors;
d) the redefinition of organization – decreased transaction costs imply a redefinition of organizations.

According to Bettis and Hitt (1995) improvements in information technology have reduced transaction costs of monitoring, control and coordination. Therefore, the calculus of organizing as a way to economize on transaction cost (WILLIAMSON, 1985) has changed in some cases to externalize many transactions. Internet and video conferencing, for instance, make it possible to coordinate and control complex production processes and R&D projects across organizations as opposed to internalizing them in one organization. This, in turn, facilitates greater specialization in organizations.

Bettis and Hitt (1995) explain that these changes represent a movement of disaggregation and reorganization where large multipurpose organizations are replaced by networks of specialized organizations.

The trends discussed are seen as causing since the second half of the 1990's a radical shift in competition among firms, going from static to dynamic competition (ILINITCH; AVENI; LEWIN, 1996; THOMAS, 1996). Static competition takes technology as given, thereby forcing firms to compete on price and costs. On the other side, dynamic or Schumpeterian competition changes technology at various points of the value chain, challenging firms to compete in completely new ways (THOMAS, 1996).

Scholars have described changes that dramatically impact companies competitive advantage (CHESBROUGH, 2003a, 2003b; PRAHALAD; KRISHINAN, 2008; TEECE, 2000).

Teece (2010) argues that developments in the global economy have changed the balance between customer and supplier. New communications and computing technology, and the establishment of reasonably open global trading regimes, mean that customers have more choices, varied customer needs can find expression, and supply alternatives are more transparent. Businesses therefore need to be more customer-centric, especially since technology has evolved to allow the lower cost provision of information and customer solutions.

In line with Teece's (2010) argument, Prahalad and Krishnan (2008) note that a hundred years ago firms adopted a non-differentiation strategy towards customers. In the present this premise has changed and some trends such as connectivity, the low cost of digitization, the convergence of technology, and the emergence of social networks, have changed the way we think about innovation and value creation.

Prahalad and Krishnan (2008) add that this new reality causes the relative balance of power between the customer and the firm to change, making it relevant for companies to treat each customer's experience at a time.

Willing to enable customers to experience unique answers to their problems, firms will have to co-create and co-develop value and solutions. In order to create co-created, personalized experiences, the resources will not be placed in a single company. A large number of facilities may have to work collaboratively, and instead of a predetermined supply chain used for creating products, firms might now need to create a web with various elements articulated, depending on the customer experience the firm needs to create. Firms in the present might have to access multi-institutional and, in some cases, multi-geographic partners to compose the new products or services.

About this new scenery of collaboration in innovation practices, Chesbrough (2003a, 2003b) note that the process of industrial innovation has undergone a significant shift from an internally focused model of closed innovation, which assumed that firms would be able to innovate only by conducting basic research activities internally, and by carrying the results of that research to the market, to a new open innovation paradigm, where external as well as internal ideas as inputs to the innovation process are combined with employing internal and external paths to market for the results of innovative activities.

Adding to the discussion about the changes in the division of innovation labor, Teece (2000) has observed that with complexity becoming increasingly common, new products are rarely stand-alone items. Rather they are components of broader systems or architectures. The scholar noted that organization of firms and industries and the architecture of products are interrelated and that since the relevant intellectual property needed to 'effectuate system-level integration' is almost never owned by a single firm, but widely distributed throughout the industry, new arrangements are needed to support rapid diffusion and expansion of system-level integration architecture. Indeed harnessing the full potential of the technology necessarily involves cooperation amongst industry participants, many of whom might also be competitors.

Teece (2000) has also called the attention to a related development, which is the increase in convergence or integration of previously disparate technologies. Innovation in such an environment by no means occurs automatically, but requires internal structures that are flexible and permeable.

In the present innovation processes' own dynamism has been seen as producing a world that requires in many ways rethinking of innovation itself (CHESBROUGH, 2003a; TORUN; ÇIÇEKÇI, 2007).

Chesbrough (2003a) argues that some reasons to 'innovate innovation' are related to fact that, for instance, today most of the world's smart people are not members of a single team, but rather distributed in multiple institutions. Another reason is the fact that innovation is multidisciplinary, such as bio and nanotechnology, and that a new model of innovation should find ways to leverage the disparate knowledge assets of people who see the world differently.

Complexity involved in Science, technology and innovation activities has motivated the development of generic models able to explain and leverage those processes.

Kline and Rosenberg (1986) note that a useful way to consider the process of innovation is as an exercise in the management and reduction of uncertainty, having in mind that the greater the changes introduced, the greater the uncertainty. The scholars argue that the systems used in innovation processes are among the most complex known and that the requirements for successful innovation vary greatly from case to case. In such a context, a general discussion of innovation requires the exploration of a number of different dimensions, as well as making sure that the implicit models of the innovation process are adequate, since the use of simplistic models can seriously distort thinking.

We agree with and follow Kline and Rosenberg's (1986) understanding that innovation is not an smooth and linear process. Rather than that it is complex and hard to measure.

As we see it, the innovation process is better represented by the chain-linked model developed by Kline and Rosenberg (1986) in an effort to explain such a process emphasizing the socio-technical nature of industry and technology and the necessity to look at it as a complex system.

In the chain-linked model innovation is understood through both, the interactions that occur within the internal environment of the innovative organization, as well as the interactions that occur among organizations and exiting knowledge and research.

Adding to the evidence found in literature of the relevant role played by innovation for firms' competitiveness, some scholars have called attention to the fact that innovation does not always turns into value for customers and the innovative company (TEECE, 2007). The business model is in charge of developing that task (CHESBROUGH; ROSENBLOOM, 2002).

Chesbrough (2007) argued that today, innovation must include business models, rather than just technology and research and development, for the fact that a better business model will often triumph over a better idea or technology.

Having in mind that it is through business models that companies commercialize new ideas, Chesbrough (2010) noted that the same idea or technology taken to market through two different business models will yield two different economic outcomes.

Next section defines and proposes a dynamic approach for the business model concept.

2.3 Business model dynamics

To successfully innovate companies not only have to create value from new ideas, but they have to be able to capture part of the value that has been created (TEECE, 2007). According to Teece (2007) innovators are not always successful in translating a new idea into economic value.

The role of transforming new ideas or technologies into value has been developed by business models (CHESBROUGH; ROSENBLOOM, 2002, TEECE, 2010).

Another element that should be carefully considered when innovating is the fact that business models many times have to change, allowing adaptation and new value creation from innovation processes.

It is the business model that allows a company to arrange strategically all the components necessary to create and capture value in the innovation process. This construct has gained importance in the areas of business strategy and innovation management since the 1990s, as a tool that helps understanding and communicating the logic of a company to create and deliver value, incorporating the complexity and multitude of possibilities of business configurations in the present (OSTERWALDER, 2004; SHAFER; SMITH; LINDER, 2005).

The business model concept has gained importance for the fact that it brings a flexible and fresh new way of looking into the way strategy of the firm is operationalized (MCGRATH, 2010).

Flexibility of business models can be found in Joia and Ferreira’s (2005) understanding that the business model construct can be used as a tool which enables the junction of more than one strategy approach, such as the positioning school and the resource based view, increasing the potential of those approaches in explaining strategic processes.

According to McGrath (2010) the business model concept offers strategists a new way to consider their options in uncertain and fast-moving environments because it involves insight, experimentation and evolutionary learning, contrasting traditional approaches to strategy, such as the industry positioning view. The scholar explains that the positioning school has long proposed that what firms need to do to succeed is to find a truly differentiated and defensible position within an industry. The dilemma is that traditional perspectives such as this give management little latitude for action. Having selected a position in an industry, it is hard to pluck a firm out and move it to some other position.

McGrath (2010) adds that business modeling, therefore, is a useful approach to figuring out a strategy, as it suggests experimentation, prototyping and a job that is never quite finished.

Chesbrough and Rosenbloom (2002) argued that a successful business model creates a heuristic logic that connects the technical potential of technology with the realization of economic value. On the other hand, at the same time that a business model is capable of unlocking latent value from a technology, it might constrain the subsequent search for new, alternative models, later on.

Companies should choose a dynamic approach to develop business models rather than static one. Following this line of thought, Chesbrough and Rosenbloom (2002) argue that in some instances, an innovation can successfully employ a business model already familiar to the firm, but in other cases such a business model will not be able to fit the circumstances of technological or market opportunity. In these later cases, managers will need to expand their perspectives and adapt their business models, in order to capture value from that technology.

Osterwalder (2004) has designed and proposed an ontology that allows to accurately describe the business model of a firm (Figure 1). To fulfill that purpose, in a first step, he identified four main areas that constitute the essential business model issues of a company: product; customer interface; infrastructure management; financial aspects.

In a second step, he broke those areas down into a set of nine interrelated building blocks that allow conceiving a business model: product (value propositions); customer interface (customers, distribution channels, and customer relationships); infrastructure management (capabilities, partnerships, and value configuration); financial aspects (cost structure, and revenue model).

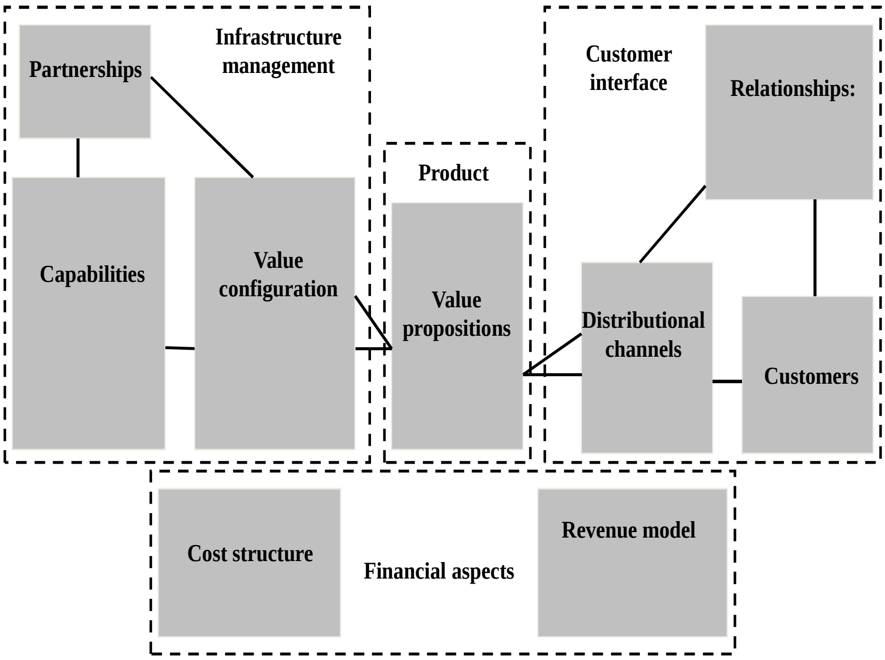

Figure 1 Business model ontology
Source: Osterwalder (2004)

Osterwalder (2004) called the attention to the fact that companies are continuously subject to external pressures that oblige them to constantly adapt their business models (OSTERWALDER, 2004). In this context, our study agrees with scholars, such as Reuver, Haaker and Bowman (2007), who suggest that business models should be dynamic, adapting over time to maintain alignment with changes, such as changes in technology, changes in customer demand, and changes in the regulatory environment of firms.

We believe that business model dynamics can be defined as the process of change in at least one of the components of a company's business model to address the necessary response by the company in face of external pressures, such as technological change, regulatory change, public acceptance, changes in customer demand. The new business model will rearrange strategic choices to allow new value creation and capture.

We suggest an evolutionary perspective of business models, which evolve along time, to allow new value creation and capture. The way we see it, a business model can evolve: 1- from a closed business model to a new closed business model; 2- from a closed business model to an open business model; and 3- from an open business model to a new open business model.

In the first situation, business models can evolve to rearrange strategic choices in the 'internal context' of firms, adapting to change when necessary. In the second situation, they can evolve from a 'closed business model' to an 'open business model', starting to use external ideas to generate innovation, as well as external paths to market. In the third situation open business models can evolve and change to rearrange the necessary business model components within an open business model that will transform a new technology into value using new internal and external ideas to compose innovation as well as new internal and external paths to market.

The next section defines the concepts of open innovation and open business models.

2.4 Open innovation

Firms that identify themselves as innovative have to continuously generate a stream of value-rich products and services, and improve them by time targeting growth markets and finding new ones for their core technologies. To achieve this, they have to start opening their innovation practices (GHAZAWNEH, 2010).

According to Chesbrough (2003b) the process of industrial innovation has undergone a significant shift in how companies generate new ideas and bring them to market, going from a closed innovation model (Figure 2) to an open innovation model.

In the old model of closed innovation (Figure 2), which worked for most of the 20th century, firms adhered to the following philosophy: 'Successful innovation requires control'. Companies had to generate their own ideas that they would then develop, manufacture, market, and distribute themselves.

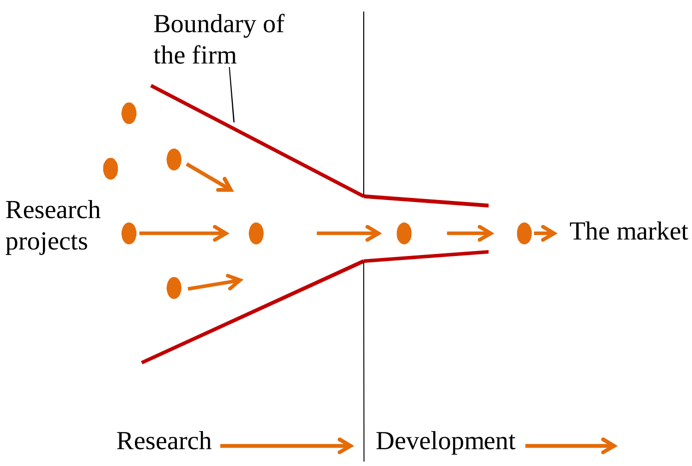

Figure 2 The closed innovation model
Source: Chesbrough (2003b)

For years, the logic of closed innovation was seen as the right way to bring new ideas to market, and companies invested heavily in internal R&D, hired the brightest people, and were able to discover the greatest ideas, allowing them to get to market first and reap most of the profits, which they would then protect by aggressively controlling their intellectual property to prevent competitors from exploiting it.

Toward the end of the 20th century though, according to Chesbrough (2003b), a number of factors started to erode the underpinnings of closed innovation, amongst which are the dramatic rise in the number and mobility of knowledge workers, making it increasingly difficult for companies to control their proprietary ideas and expertise, and the growing availability of private venture capital, which helped finance new firms and their efforts to commercialize ideas that had spilled outside corporate research labs.

Chesbrough (2003b) adds that in the present, leading companies of the past have been encountering strong competition from the startups. Surprisingly these new comers conduct little or no basic research, but instead they get new ideas to market through a different process.

Chesbrough (2003a) mentioned the example of Lucent technologies, the telecommunications equipment company created in the breakup of AT&T in 1996. Lucent inherited the lion's share of Bell Labs – perhaps the premier industrial research organization in the 20th century – from the old AT&T, and this should have been a decisive strategic weapon for Lucent in the telecommunications equipment market. However, things didn't quite work out that way. Cisco Systems, which lacks the deep internal R&D capabilities of Bell Labs, somehow has consistently managed to stay abreast of Lucent. The answer to how Cisco manages to stay atop its market has to do with the fact that although Lucent and Cisco competed directly in the same industry, the two companies did not innovate in the same manner. Lucent devoted enormous resources to exploring the world of new materials, seeking fundamental discoveries that could fuel future generations of products and services. Cisco, on the other hand, deployed a rather different strategy. Whatever technology the company needed, it scanned the world, and acquired from the outside, usually by partnering or investing in promising startups. Within this example of open innovation, Cisco was able to keep up with R&D output of perhaps the finest industrial research organization in the world, without conducting much research of its own.

This is not an isolated example. Other companies as successful as Cisco are Intel and Microsoft (CHESBROUGH, 2003a; 2003b). Open Innovation can be briefly defined as utilizing external as well as internal ideas as inputs to the innovation process, combined with employing internal and external paths to market for the results of innovative activities (CHESBROUGH, 2003b).

In the new model of open innovation (Figure 3), the firm commercializes internal ideas as well as ideas from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current business (CHESBROUGH, 2003b).

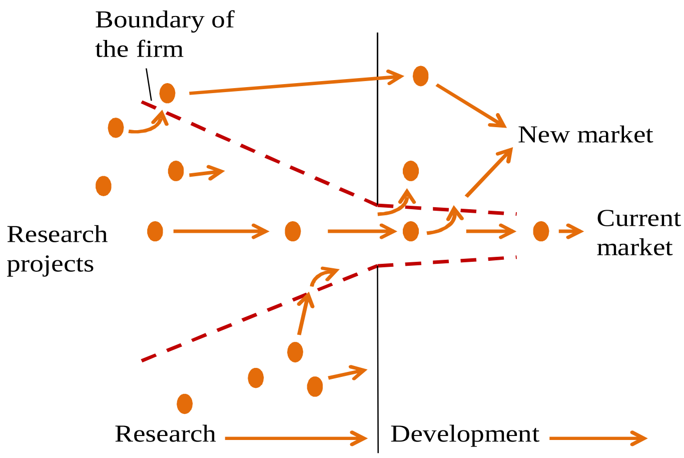

Figure 3 The open innovation model
Source: Chesbrough (2003b)

The boundary between the company and its surrounding environment is porous in the model of open innovation, enabling innovation to move easily between the two (CHESBROUGH, 2003b).

In other to develop open innovation companies have to understand and implement ‘open business models’. According to Chesbrough (2006) a business model performs two functions: a) it creates value, by defining a series of activities from raw material through to final consumer, that will present products or services with value being added through the various activities; and b) it captures a portion of the value created, by establishing a unique resource, asset, or position within which the firm enjoys competitive advantage. An open business model creates and captures value using the new division of innovation labor, leveraging more ideas due to the inclusion of external concepts, and using assets, resources or positions from other companies’ business.

Some scholars willing to understand the implementation of open innovation, and if there were identifiable patterns, have distinguished different dimensions of open innovation: outside-in, inside-out, and coupled process or co-development (CHIARONI; CHIESA; FRATTINI, 2011; GASSMANN; ENKEL, 2004).

Gassmann and Enkel (2004) analyzing a database of 124 companies identified three core open innovation processes. The first one, the outside-in process, enriches a company’s own knowledge base through the integration of suppliers, customers, and external knowledge sourcing and is able of increasing a company’s innovativeness. In the second innovation process, the inside-out process, the external exploitation of ideas in different markets takes place through licensing IP or multiplying technology by channeling ideas to the external environment. The third innovation process identified, the coupled process, links outside-in and inside-out by working in alliances with complementary companies.

In the coupled innovation process of open innovation, cooperation involves the joint development of knowledge through relationships with specific partners which can be implemented through joint ventures and alliances with universities and research institutes (GASSMANN; ENKEL, 2004). This third dimension of open innovation is the one where both partners benefit equally, and usually it is motivated by an organizational learning imperative.

According to Gassmann and Enkel (2004) to apply each of the open innovation approaches effectively the company needs different core capabilities as follows:

a) the outside-in innovation process is related to the ‘absorptive capability’ – having in mind that technology, knowledge generation, and application processes are increasingly sophisticated and expensive, the ability of a firm to recognize the value of external information, assimilate it, and apply it within the boundaries of the firm to generate new value is critical to the innovative company;
b) the inside-out innovation process requires ‘multiplicative capability’ – to successfully exploit knowledge externally and commercialize ideas, the innovative company needs to be able to strategically select external partners, that are willing and able to multiply the new technology, as well as codify and transfer its knowledge to the external partner;
c) the coupled innovation process requires ‘relational capability’ – the company’s capability to build and maintain relationships with partners, enabling joint development in strategic alliances is seen as a source of competitive advantage. A company can be differentiated by the networks to which it is connected, and the alliances that it

can undertake. Therefore, the relationships with complementary companies can be a firm's major asset within open innovation.

In our study we propose that business model dynamics as well as the dimensions of open innovation are part of the business platform theoretical concept. In the next section we define business platforms, which can be seen as the architecture built to unite companies' complementary capabilities in order to develop complex products or services to customers in the new knowledge era.

2.5 Business platforms

Focusing the relevance of the relational aspect for the success of innovating companies in the present, the business platform concept explains strategic actions that connect companies' complementary core competencies[4] to leverage innovation.

Business platforms seek to enable organizational interactions between companies to create value through the combination of interorganizational resources, expanding the sources of innovation.

According to Sawhney (1998) in the 21st companies face challenges related to attending customers that are becoming very sophisticated and demanding of customized products, forcing firms to adopt high-variety strategies. On the other hand, competition is becoming intense, with industry convergence, deregulation, globalization, and internetworking, forcing companies to hold the line on prices. The scholar poses that the solution is to adopt 'leveraged high-variety strategies' – strategies that allow firms to achieve

[4] Core competencies, according to Prahalad and Hamel (1990), are a company's critical resource, they are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies, they are about organization and work and they do not diminish with use, unlike physical assets.

high variety and high growth, without a corresponding increase in costs or complexity – and that the key to leveraged high-variety strategies is ‘platform thinking’ – “*the process of identifying and exploiting commonalities among a firm’s offerings, target markets, and the processes for creating and delivering offerings*” (SAWHNEY, 1998, p. 54).

Sawhney (1998) explains that because of certain products’ commonalities, such as a common underlying technology, a common set of basic components, or targeting a related set of customers, companies’ offerings can be managed as families with a common underlying logic (this **shared logic** is the platform). Platform thinking is thus defined as the process of identifying and exploiting the shared logic and structure in a firm’s activities and offerings to achieve leveraged growth and variety.

Parker and Alstyne (2008) note that platform ecosystems are a common feature of the information economy. Products such as personal computers, cell phones, and gaming systems, can be described in terms of systems where developers build applications on top of a platform.

According to Gawer (2009) platforms, which are used inside firms, across supply chains, or as building blocks that act as engines of innovation and redefine industrial architectures, are a phenomenon affecting most industries from products to services in the present.

The scholar mentioned the case of Microsoft Windows, which is a good example of just how much we lack the understanding about platforms. Gawer (2009) argued that the two antitrust lawsuits brought against Microsoft, a dominant firm in the operating systems market, by the US Department of Justice and the European Commission, have resulted in unprecedented fines and have also revealed extreme differences in the opinions of firms involved and the regulatory authorities.

US and European regulatory authorities upheld very different rulings. Nevertheless, economists and management scholars took different stands as to whether Microsoft's business practices were anticompetitive.

Gawer (2009) noted that a central issue addressed in the lawsuits was the potentially adverse effect Microsoft's business practices could have on competition, industry, innovation and social welfare. The controversial practices ranged from Microsoft's decision to bundle its Windows software with other complementary products to its decision to withhold information on how to connect complementary products to Windows.

Gawer (2009) explained that Microsoft Windows is an industry platform – a building block, providing an essential function to a technological system – which acts as a foundation upon which other firms can develop complementary products, technologies or services.

Various aspects of platform thinking have been discussed in the product design, marketing, operations, strategy, and technology management literature (BALDWIN; WOODARD, 2009; GAWER, 2009).

According to Baldwin and Woodard (2009) system designers have long exploited the opportunities to create families of complex artifacts through the development and recombination of modular components. They have noted that an especially common design pattern has been associated with the concept of a platform, which they have defined as a set of stable components supporting variety and evolvability in a system by constraining the linkages among the other components.

The scholars observe that although the term platform is used in diverse ways that seem difficult to reconcile, the fundamental architecture behind all platforms is the same: the system is partitioned into a set of core components with low variety and a complementary set of peripheral components with high variety. The set of components with low variety constitutes the platform. They are the long-lived elements of the system and thus implicitly or explicitly establish the system's interfaces – the rules of governing interactions among the different parts.

Baldwin and Woodard (2009) explain that interfaces establish the boundaries of modules, which according to Baldwin and Clark (1997), are components of a system, whose elements are powerfully connected among themselves and relatively weakly connected to elements in other components. The scholars explain that because they define points of weak linkage in a network of relationships, modular interfaces reduce the coordination costs and transaction costs across the module boundary. The existence of modules in a large system reduces the cost of splitting design and production across multiple firms, and this kind of disaggregation gives rise to modular clusters or business ecosystems of complementary and competing firms (BALDWIN; WOODARD, 2009).

Baldwin and Woodard (2009) emphasized that, besides receiving little attention up to now, the relationship between platforms and architecture is crucial to understanding the nature of platforms and hence the dynamics of platform-based innovation and competition.

They recall that a platform project creates products and processes that embed an architecture for a system, which is responsible for enabling other features to be added or existing features to be removed in building derivative products.

The fundamental feature of platform architecture, in Baldwin and Woodard's (2009) view is that certain components remain fixed over the life of a platform, while others are allowed to vary or change over time (Figure 4).

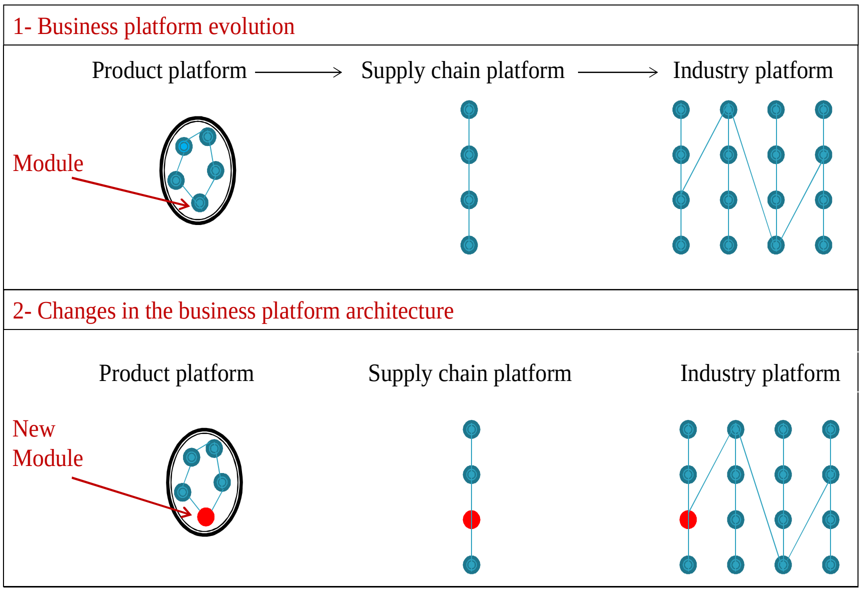

Figure 4 Business platform dynamics and evolution

Another important property of platform systems is that they are evolvable, in the sense that they can adapt to unanticipated changes in the external environment (BALDWIN; WOODARD, 2009).

In essence, according to the scholars, a platform architecture displays a special type of modularity, in which a product or a system is split into two sets of components, one with low reusability and the other with high variety. The first set is called ‘the platform’. The second can be called ‘the complements’ of the platform. The combination of stability and variety in the architecture makes it possible to create novelty without developing a new system from scratch. This is why platform systems are evolvable.

Considering evolvability of platforms, Gawer (2009) explained that platforms are designed and used in three main settings: inside firms, across supply chains or as industry platforms. She suggested an evolutionary perspective on platform emergence, under which internal platforms evolve into supply chain platforms, which then can evolve further into industry platforms (Figure 4).

According to Gawer (2009) platforms are building blocks (they can be products, technologies or services) that act as a foundation upon which an array of firms (sometimes called a business ecosystem) can develop complementary products, technologies or services.

The scholar notes that the first setting within which we can find the term platform is within firms for new product development. This type of platform can be called ‘product platform’ or ‘internal platform’ and has been defined in many different ways.

For instance Sawhney (1998) and Ghazawneh (2010) have defined a product platform as a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced. It is a collection of common building blocks, especially the underlying core technology, that can be implemented across a wide range of products (SAWHNEY, 1998; GHAZAWNEH, 2010).

The product platform could also be defined as products that meet needs of a core group of customers, being designed for easy modification through the addition, substitution or removal of features (GAWER, 2009; WHEELWRIGHT; CLARK, 1992).

Gawer (2009) explains that companies have successfully used product platforms to control high production and inventory cost and long time to market.

The second type of platforms defined is the supply chain platform (GAWER, 2009), which extends the product platform to the context of supply chains.

According to Gawer (2009) a supply chain platform is a set of subsystems and interfaces, forming a common structure from which derivative products can be efficiently produced by partners along a supply chain. A supply chain platform is different if compared to the internal platform because the different elements of the final system are not designed and produced internally, but designed and produced by different suppliers along the supply chain, or among suppliers and a final assembler.

The scholar observes that while the architecture of product or internal platforms and supply chain platforms is the same, the existence of external different economic players introduces inter-firm relationships and collaboration/competition dynamics.

The third type of platforms discussed by Gawer (2009) is the industry platforms, which are products, services or technologies developed by one or several firms, serving as foundations upon which other firms can build complementary products, services or technologies. Examples of industry platforms would be Microsoft Windows operating system, Intel microprocessors, Apple's iPhone, Google Internet searching engine, Facebook networking site, operating systems in cellular phones, and some genomic technologies.

Gawer (2009) explains that a main difference between supply chain platforms and industry platforms is that in the industry platforms, firms developing the complements do not necessarily buy or sell from each other, are not part of the same supply chain, nor share partners or cross-ownership.

Regarding dynamics and evolution of platforms, internal platforms can evolve into supply chain platforms, which then can evolve further into industry platforms (GAWER, 2009). Because internal platforms create value in a way that allows a facilitated division of labor, modules and rules of interaction are defined, they also allow the migration of knowledge outside the firm and facilitate imitation of modules by others, making assembler firms more vulnerable to entry and competition on modules from component maker firms. According to Gawer (2009), especially if the system maker cannot protect its intellectual property on the system, the internal platform then evolves into a supply chain platform.

Gawer (2009) has also discussed another possibility. If there is a pool of firms with the capability to create significant value in components; if the value to end users provided by the assembler becomes relatively low compared to the value of components; and if component makers can find other markets to sell to, besides their previous assembler-custormer, then the system-maker firms lose control of their supply chain and the supply chain platform can evolve into an industry platform.

Two elements that have been discussed in the existing literature related to industry platforms that still have to be approached are 'platform leadership' and 'interdependence' (GAWER; CUSUMANO, 2002; GAWER, 2009; GAWER; HENDERSON, 2007; SUGANO, 2005; WEST, 2003).

Scholars such as Gawer and Cusumano (2002), West (2003) and Gawer and Henderson (2007) argued that in the formation of a business platform, a leader produces a product or service that represents his/her core competency, providing that competence within an infrastructure for conducting business and leading others in the industry, who collaborate to the platform with complementary specific products or services.

Iansiti and Levien (2004) who connected Walmart's success to creating, managing and evolving an incredibly powerful business ecosystem developed the term 'keystone firm', equivalent to what Gawer and Cusumano (2002) and Gawer (2009) called the 'platform leader', that is a firm that drives industry-wide innovation for an evolving system of separately developed components.

Gawer and Cusumano (2002) studied Intel's rise to platform leadership and the transformation of that company from a simple component maker, supplying to a system architecture that it had not designed, into a major source of influence over the evolution of this system.

Cusumano and Gawer (2002) called the attention to the fact that companies which are leaders of their business platforms, such as Intel, do not live in a vacuum and that, in fact, many times they are dependent on the innovative activities of partners.

In the business platform literature interdependency is a recurring element. Indeed scholars have defined platforms in terms of evolving systems of interdependent pieces (GAWER; CASUMANO, 2002); sets of modular interdependent capabilities (CALKINS; SVIOKLA, 2006); systems of interdependent components (GAWER; HENDERSON, 2007); ecosystems of interdependent firms (BALDWIN; WODAARD, 2008); and interdependent industry ecosystems (TEE; GAWER, 2009).

In our study we propose that the innovative scenario observed in the genetically modified seed sector can be understood through the business platform theoretical construct and we develop a generic dynamic theoretical framework to analyze innovation processes in that sector.

The genetically modified seed industry has been through significant change in the past thirty years, and complexity of innovation in the sector has rendered some good examples of how difficult it can be for companies to innovate in the area.

The discovery of recombinant DNA and the emergent biotechnology in the 1970s generated a radical change in the technological and organizational patterns of all the sectors directly or indirectly related to life sciences. Agriculture and the entire agricultural industry supply chain have been influenced by the new technology (SILVEIRA et al., 2011).

The next section presents the competitive scenario created by the application of biotechnology to agriculture.

2.6 Agricultural biotechnology and the genetically modified seed industry in Brazil

Change and technological innovation have especially been considered important sources of economic growth in the history of agriculture, mainly for the past thirty years, when several significant changes have been witnessed with the emergence of the new biotechnologies[5]. In the 1970's, the new biotechnologies emerged, generating a growing consensus of a critical need to improve management tools and organizational forms in order to understand and replicate agricultural innovation (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA, 2011; GRAY; WESEEM, 2008; SUN; LUI; ZHOU, 2011; VANHAVERBEKE; CLOODT, 2006).

Many studies have highlighted the importance of agricultural biotechnology to a country's competitiveness (COMMITTEE ON SWEDEN'S POLICY FOR GLOBAL DEVELOPMENT, 2002; EUROPEAN UNION, 2010; MISTRA, 2011). The technology has promised farmers, as well as companies, potential benefits such as greater agricultural efficiency, better crop yields, reduced agricultural inputs, such as pesticides, due to plants that are herbicide tolerant or pest resistant, reduced vulnerability to environmental stresses, offered, for instance, by drought tolerant crops, or seeds with improved nutritional content, and seeds that produce more sugar to be used as a raw material for biofuel production (BASF, 2013; KALAITZANDONAKES, 2000; MITRA, 2001).

[5] The biotechnologies can be classified into three categories (NOSELLA; PETRONI; VERBANO, 2004): i) traditional biotechnologies – are thousands of years old, fermentation is an example; ii) modern biotechnologies – were developed after the industrial revolution, examples might be the biological processes used to obtain vaccines, enzymes and hybrids; and iii) new biotechnologies – have been developed since 1970, with the discovery of DNA recombination and cell fusion.

In the present, biotechnology, more commonly referred to as genetic modification (GM) or genetic engineering (GE), allows researchers to remove individual genes from one species and insert them into another without the need for sexual compatibility (Cockburn, 2004). Indeed, the new biotechnologies applied to agriculture have introduced improved products that confer beneficial agronomic characteristics to some crops.

In this context, seeking to capitalize on the opportunities afforded by new biotechnology techniques, companies have accelerated their research and development programs to commercialize and profit from the results.

To illustrate that biotechnology has a promising potential, some scholars have showed that biotechnology traits[6] (approved events such as the one present in the RR soybean) have contributed to reduce the use of pesticides, from 1996 to 2010, by 352 million kg of active ingredient, consequently reducing environmental impact on areas devoted to biotech crops (BROOKES; BARFOOT, 2010; JAGGARD; QI; OBER, 2010).

Crop producers have recognized the benefits of the technology and the last Annual Report of the International Service for the Acquisition of Agri-biotech Applications [ISAAA] on the global status of commercialized genetically modified crops (James, 2012) showed that 2012 marked an unprecedented 100-fold increase in biotech crop hectarage to 170 million hectares from 1.7 million in 1996, when biotech crops were first commercialized. The global area of biotech crops has grown every single year since its first commercialization in 1996 (James, 2010).

According to James (2012) for the fourth consecutive year, Brazil fortified itself as a global leader in biotechnology crops. The country ranked

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[6] Plant traits are any morphological, anatomical, physiological or phenological features measurable at the individual level, from the cell to the whole-organism level (VIOLLE et al., 2007). According to this definition, plant traits may characterize anything from a leaf dark respiration rate to a maximum plant height (KATTGE et al., 2010).

second only to the U.S. in worldwide GM crop hectarage, reaching 36.6 million hectares in 2012 compared to 30.3 million in 2011 (JAMES, 2012).

Brazil is the only tropical country considered to be a major player in the world's agricultural field thanks to many years of scientific research with the aim of enhancing its natural advantages (SILVEIRA; BORGES; BUAINAIN, 2005).

Transgenic research in Brazil is considered strategic for the country's development and it is conducted under the leadership of public institutions, such as the Brazilian Agricultural Research Corporation (Embrapa) and a number of universities, with the participation of private domestic and multinational corporations (SILVEIRA; BORGES; BUAINAIN, 2005).

Brazil has policies and public investments addressed to developing agricultural biotechnology companies to promote a more innovative context for Brazilian companies in the sector, such as the Policy for Biotechnology Development (BRASIL, 2007). Nevertheless, Brazilian companies don't seem to get to the final stages of innovation (AMÂNCIO, 2011).

Besides the existence of a strong research and development network and the fact that Brazil is the second largest world producer of transgenic plants, research and development that generates innovation in the GM seed sector in Brazil is in large part brought from other countries that are where the headquarters of the multinational corporations are located (DAL POZ, 2006).

We believe that if companies seek to be more innovative within the sector of genetically modified seeds it is necessary to understand the innovation process in that sector and those factors that affect or facilitate innovation.

According to Silveira, Borges and Buainain (2005) the acknowledgment of the importance of research to the competitive edge in agribusiness and economic development has led several agents – both public and private – to promote and intensify scientific development in Brazil. However biotechnology is a complex business which involves high costs and high expectations towards continuous innovation (ORGANIZAÇÃO PARA A COOPERAÇÃO E DESENVOLVIMENTO ECONÔMICO - OCDE, 2005) as well as complexity related to the many proprietary and protected technologies involved in developing a genetically engineered seed.

Innovating in the field of agricultural biotechnology is a complex process, and a a result of cumulative knowledge.

Silveira et al. (2011), note that there is no reason to support the naïve assumption that from an extensive scientific basis, originated with the DNA discovery, there is the possibility of creating a radically innovative product without the integration among agents throughout the process to generate a commercial product originated from agricultural biotechnology.

Silveira et al. (2011) explained that there is a game of valuing knowledge assets and value creation even before the commercialization of products derived from agricultural biotechnology and, especially, there is a process of collective confirmation of the fact that the technological trajectory is already being built in the stage of research and development of intermediary technologies.

Silveira et al. (2011) explain that the steps to develop a commercial product originated from research in the agricultural biotechnology area, unlike other products from different sectors, it is not only the result from the insertion of a gene in a plant, which is the commercial target. The final product already reflects a maturity degree of the technology.

Delineating the different steps in the development of a genetically modified organism, the scholars point to the complexity present in the process and the need of benefiting from the cumulative knowledge provided by the participation into networks. They also emphasize the difficulty to access patented technology, that is not owned by the innovator, where establishing contracts with partners that have the proprietary technology or verticalizing research is necessary.

In this sense, crucial to the understanding of innovation practices in the sector is the specification of the steps of innovation and getting a genetically modified crop to market, as well as the main agents that participate within the supply chain.

2.6.1 The genetically modified seed supply chain: agents and main features

According to Kloppenburg (2004) it was only in the end of the 19th century that seeds and plants became objects of exchange and commercialization, especially because American researchers had concluded their studies on the hybrid corn.

Until the adoption of the hybrids, private companies were still tributary to the public sector, which was responsible for both, the replication of the genetic basis as well as the development, adaptation and diffusion of new plant varieties.

Hybridization, an intraspecies cross breeding technique, which consists of the cross in between plants of two different varieties of same species, used in the improvement of self-pollinated as well as some cross pollinated crops, allowed the private companies' appropriation of new plant varieties, of corn for instance, consolidating large companies such as Pioneer in the United States. Nevertheless, the limitations of the hybrids to certain species assured the maintenance of the public sector's strategic position, where some crops unable to hybridize became the target of ambitious international breeding programs, which developed varieties adapted to the use of chemical input packages (KLOPPENBURG, 2004; PRINGLE, 2003; WILKINSON; CASTELLI, 2000).

In the 1970's, when the new biotechnologies emerged, the seed industry was reorganized based upon a new scientific paradigm that reached every type of crop, causing a redefinition of the labor division between the public and the private sectors when the seed industry became increasingly interesting to companies from the private sector (MURPHY, 2007; KLOPPENBURG, 2004).

Biotechnology was not the only factor to affect the direction of innovation toward private companies, a new regulatory framework and the emergence of stronger intellectual property (IP) rights in biological innovations in the 1980s was also another important element (GRAFF et al., 2003).

In Brazil the Plant Cultivar Protection Law[7] of 1997 (BRASIL, 1997), which aimed at encouraging private investment in plant breeding is widely perceived as a radical change with regard to the protection of IP (CARRARO, 2005).

Some scholars have argued that the Plant Cultivar Protection Law generated a much better suited environment in Brazil for the development of technological innovation in the seed industry (ZYLBERSTYAJN et al., 1998).

We should note that plant biotechnology research is not a single activity, but a sequence of activities covering the continuum that goes from generating ideas, to testing these ideas, developing them into commercial products and commercializing them (PRAY; OEHMKE; NASEEM, 2005). The process of producing a transgenic plant variety[8] uses public knowledge, proprietary knowledge and technology protected by intellectual property, money and other

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[7] The Plant Cultivar Protection Law (PVP), (BRASIL, 1997), regulated by Decree 2.366/97, guarantees inventors, the so-called plant breeders, Intellectual Property rights for these plant varieties, or cultivars. The protection of a cultivar ensures to its holder the rights to commercial reproduction in the Brazilian territory, preventing third parties during the period of protection from producing the cultivar, offering it for sale, or from commercializing it, without the authorization of the holder.

[8] According to Spooner et al. (2003), botanical 'variety' is a rank in the taxonomic hierarchy below the rank of species and subspecies and above the rank of form (form/variety/subspecies/species).

inputs. According to Pray, Oehmke and Naseem (2005) the research produces genetically modified plants, possibly along with patents on improved research protocols, such as new genetic sequences, transformation techniques, or new promoters, which are then inputs into a commercialized variety.

McElroy (2004) argued that a system with separate nomenclature for agricultural biotechnology, accommodating the unique features of product development in this industry should be encouraged, drawing on the understanding that such a system would enable the various constituencies within the agbiotech industry – venture, strategic and institutional investors, intra-company collaborators, technology licensors and regulatory agencies – to better understand and value agbiotech products and the companies developing them.

McElroy (2004) posed that the process of development of an agricultural biotechnology product can be divided into five stages: a) trait identification/generation; b) crop transformation; c) field efficacy/tests; d) regulatory approvals; e) commercial stage (Figure 5).

Stage 1, trait identification/generation, starts with a product concept definition or a scientific innovation and ends with the confirmation of a trait or technology efficacy in a transgenic model plant system. This phase of discovery includes the definition of the product concept, the discovery of a target, trait or technology, the evaluation and improvement of the lead target, trait or technology, and the preliminary evaluation of the efficacy of the trait or technology in an appropriate model plant system. Early discovery stage involves filing patent applications to protect the underlying IP, and late discovery stage includes the publication of transgene efficacy information in model plant systems in academic journals. This stage takes lasts from 3 to 5 years.

Stage 2, crop transformation, starts with the initial transformation of the target crop or plant production system and ends with an initial demonstration of the trait's or technology's functional efficacy and plant phenotypic effect in transgenic target plants grown under nonproduction greenhouse or test field conditions. This stage includes the application for government regulatory permits to grow and/or transport transgenic crop or other plant materials containing the transgene of interest and the publication of transgenic crop efficacy information in academic journals. The duration of this stage is from 1 to 2 years.

Stage 3, field efficacy, starts with a determination of the trait’s or technology’s functional efficacy in early transgenic events characterized under nonproduction test conditions and ends with selection of the final transgenic event (a transgene situated in a specific location in the crop genome) under diverse field or other production conditions.

This stage involves both the publication of geographical region-specific results of field trials carried out by public entities such as university extension staff and state government agriculture departments, and the transgenic event-specific initiation of government regulatory approval for food and feed use in at least one country where traits can be grown or imported to. This stage lasts from 1 to 3 years.

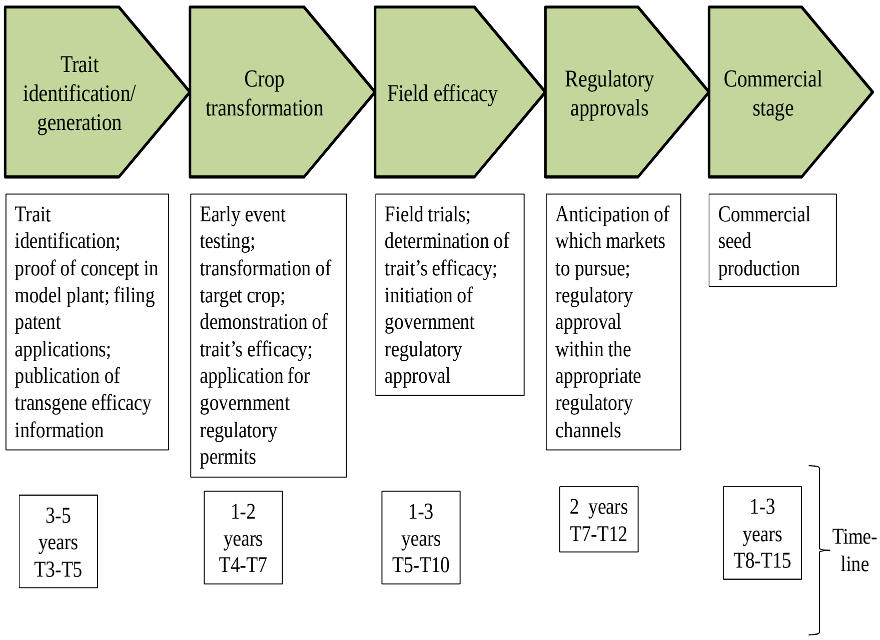

Figure 5 Product development cycle in agricultural biotechnology
Source: Adapted from McElroy (2004).

Stage 4, regulatory approvals, starts with final event selection and accompanying regulatory application and ends with the achievement of regulatory approval for product sale in major markets. The decision to launch an agbiotech product either regionally or globally is similar to the decision for traditional pharmaceutical products. The regulatory strategy must anticipate and address which markets to pursue, and work within the appropriate regulatory channels. This stage is completed when there is regulatory approval for food and feed use in at least one country where the agbiotech traits can be grown or imported. This stage lasts 2 years.

Stage 5, the commercial stage, starts with the generation of product supply that contains the final selected and regulatory approved events and ends with substantial product sales. This stage is completed when commercial sales initiate. This stages lasts from 1 to 3 years.

According to the studies developed by Carraro (2005) and Zylberstyajn et al. (1998) we can pose that three distinct groups of companies compose the plant biotechnology supply chain (Figure 6) developing the activities that allow the generation of agricultural biotechnology innovation: a) biotechnology companies; b) breeding companies; and c) seed companies, or multipliers.

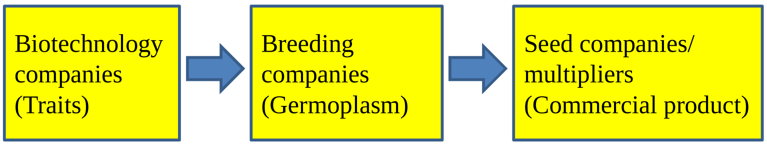

Figure 6 Genetically modified seed supply chain: main agents

Zylberstyajn et al. (1998) researching the Roundup Ready soybean agroindustrial system in Brazil noted that once biotechnology companies develop quality traits, or modified genes, to be inserted in productive vehicles (seeds), which have to be adapted to regional soil and climate conditions, usually germplasm[9] developed in Brazil, companies and national research agencies can benefit from that new technology.

Making a distinction among the different types of companies operating in the R&D and multiplying seed system in Brazil, Zylberstyajn et al. (1998) noted multinational companies, in charge of developing R&D in biotechnology establish contracts with Brazilian companies inserted in the R&D of plant varieties, developing germplasm adapted to Brazilian conditions. Usually, such companies also develop activities of regionally adapting varieties. Companies developing adapted plant varieties usually establish contracts with seed multipliers. Therefore, companies in the process of research and development of

[9] Germplasm is living tissue from which new plants can be grown. It can be a plant, a seed or another plant part – a leaf, a piece of stem, pollen or even just a few cells that can be turned into a whole plant. Germplasm contains the information for a species' genetic makeup, a valuable natural resource of plant diversity. Germplasm is maintained for the purposes of studying, managing, or using the genetic information it possesses (DODDS; KRATTIGER; KOWALSKI, 2007; SEEDQUEST, 2013).

varieties and their regional adaptation can benefit from the introduction of quality traits as licensing contracts established the use of germplasm as the ‘vehicle’ for such genes. In the case of seed producers, licensing contracts involving the payment of royalties and mechanisms of control over the intellectual property of the genetic material are established. Such companies can benefit from increased demand for seed due to modified genes that find acceptance by the agricultural sector.

Explaining in more detail, companies developing traits, such as Monsanto, Syngenta, Dow, among other companies, have large research and development programs in the discovery and evaluation of new genes that can be used in plants to confer them with desirable features. There are cases in which these large multinational companies buy these technologies from smaller companies or even from research institutions. In this area, they make high investments. Once developed, evaluated, and approved, the new trait needs to be approved by the regulatory authorities, such as The National Technical Commission on Biosafety (CTNBio) in Brazil, and it also has to be approved in all the countries where companies intend to grow and commercialize the final product containing the event. Biotechnology companies, after developing these events, can license them to other companies – companies that develop plant varieties – so these events are present in as many varieties as possible, and thus reach the largest market possible.

Companies developing varieties are breeding companies or germplasm companies, such as Coodetec, TMG, among other companies. We should note that companies developing transgenic traits can also develop varieties, which is the case of Monsanto, Syngenta, DuPont-Pioneer.

Companies developing varieties license the transgenic events from biotechnology companies developing those transgenic events.

Companies such as Coodetec, for instance, receive the new events in some seeds that are used to make the first crossings. From there, they can multiply these seeds to be use more than once, and they can also use the offspring resulted from the crossings to develop new transgenic varieties. Companies developing varieties also need to follow all the biosafety standards, especially if the events have not yet been approved in all the countries where the product will be commercialized.

Varieties developed by germplasm companies, are multiplied by seed multiplying companies, also through licensing. The multiplying company acquires an initial amount of seeds from the variety developing company and multiplies them through a few generations (4 at the most), and sells those seeds directly to farmers. The price of the seed that the multiplier sells to the farmer includes the royalty from the varieties (germplasm royalty). The multiplier then pays the variety company the value corresponding to the royalty on every seed that has been commercialized by the multiplier.

The royalties charged for the transgenic events can be paid directly in the seed – in this case the multiplier also pays this value to the biotechnology company, which developed the transgenic event – or the royalty fee can be paid through a bank transfer, which charges only the royalty fee for the transgenic event, which is paid after the purchase of the seeds. If there is no payment in the moment of the purchase, a fee will be charged when the grain is delivery to the trading company.

To use Monsanto’s transgenic events, for instance, or events from any other biotechnology company, companies that develop varieties need to establish a technology licensing agreement with the company that owns the technology. But there is no collection of royalties from a biotechnology company to a variety developing company which uses Monsanto’s technology. The royalty is charged only from the final customer (the farmer).

In this context, if we were to summarize what happens in the seed industry in Brazil, we could say that companies developing traits develop new technologies and license them to companies that develop varieties. Companies developing varieties license those varieties to seed multipliers or seed growers. And companies that multiply seeds or seed growers sell those seeds to the farmers.

According to Carraro (2005), licensing is a critical element for breeders/variety companies, which has fundamental impacts on the seed industry, taking into account the previous link in the supply chain, the biotechnology companies. Just as seed producers depend on partnerships to receive new varieties, the success of cultivar[10] breeders is determined by their ability to license-in genes from biotech companies that can be inserted in their cultivars.

Carraro (2005) adds that an essential component for both, seed producers and seed breeders, the contracting system for the use of protected cultivars, developed rapidly, as soon as the first cultivars were released. Since then, each breeder has developed its own licensing model, forming distinct group of licensed companies, according to pre-established criteria, such as technical criteria on quality, and forms of commercialization. The scholar observes that licensing is probably the model that provides the greatest production scale to a cultivar or a breeder, for the fact that it counts with the sum of several production, dissemination and distribution structures, resulting in an immense sales potential.

[10] According to Spooner et al. (2003) cultivar (the word is originated from ‘cultivated’ ‘variety’) is a systematic group of cultivated plants that is clearly distinct, uniform, and stable in its characteristics and which when propagated by appropriate means, retains these characteristics.

Another relevant element for the analysis of innovation in the genetically modified seed industry in Brazil is the description of the main agents operating in this sector. The next section approaches that element.

2.6.1.1 Main strategic agents operating in the genetically modified seed industry in Brazil

To define the main agents in our study we use Malerba's (2002) understanding of sectorial systems of innovation. Malerba (2002) proposes that a sectorial system of innovation and production is a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. According to the scholar, sectorial systems have a knowledge base, technologies, inputs and demand. The agents interact through processes of communication, exchange, co-operation, competition and command, and their interactions are shaped by institutions.

Malerba's (2002) definition of strategic agents is useful to our research objective. The scholar explains that strategic agents in the sectorial innovation systems are organizations (firms and non-firms) and companies, networks and research centers, and universities, working especially in the processes of generation, diffusion, adoption and use of new technologies in the innovation system. They have the technological skills necessary to the process of organizing and implementing strategically comprising attributes of demand. The strategic agents' actions can accumulate experience and learning, build innovative advantages that affect productivity and sectorial competitiveness, or establish barriers to entry, impacting market structures on relations with the demand. Such actors can affect behavior and heterogeneity of firms, their skills and organization as well as the forms of interaction with the industry knowledge base.

The organization of the strategic agents in the sectorial innovation systems is one of the main aspects defined by Malerba (2002) which affect innovation dynamics in a determined innovation system, influencing change and existing features. In such a context, knowing who are the strategic agents which are part of the genetically modified seed sector, as well as the behavior of strategic agents, and their strategic choices, is crucial for the development of this study.

We should note, considering the stages of the developmental cycle of agricultural biotechnology products, that not every stage of the innovation cycle is carried out by a single company, and that strategic alliances, collaborative agreements, and networks often take place, influencing companies' ability to innovate.

According to Amâncio (2011), strategic agents within genetically modified seed sector, can be identified by the analysis of their successful achievements within the different stages of the developmental cycle of an agricultural biotechnology innovation (Figure 8).

Amâncio (2011) notes that, for instance, in the first stage, which is the identification/generation of a transgenic trait, success can be measured by the number of patents filed within the agricultural biotechnology area. Within the second stage, involving crop transformation, and the third stage, field trials, the best way of identifying successful companies is by analyzing the number of applications for planned release of plant genetically modified organisms GMOs to the environment, authorized by CTNBio.

Data compiled by CTNBio shows that, same as in the rest of the world, few plant species are targets of research in Brazil. Mostly, commodities such as cotton, corn and soybeans are targeted by research. There is also some research including sugar cane, rice, eucalyptus and beans. According to Amâncio (2011) the leading companies in the number of applications for planned releases into the environment are Monsanto Brazil, Syngenta, Dupont/Pioneer, Dow AgroSciences, Bayer, BASF and Embrapa. The Central Cooperative for Agricultural Research (Coodetec), and the Sugarcane Technology Center (CTC) also stand out, focusing their research on the development of soybean, wheat and sugarcane.

Considering the last two stages in the development of an agricultural biotechnology product – regulatory approval and commercial stages – Amâncio (2011) notes that only a few species have been the focus of innovation, cotton, corn, and soybean. And plants that have been approved are mainly first generation products – presenting herbicide tolerance and insect resistance characteristics. Again multinational companies, such as Monsanto, Bayer, Syngenta, and DuPont own the largest number of regulatory approvals.

Drawing on data on protected transgenic cultivars, Amâncio (2011) observes that for cotton protected cultivars Monsanto, the *Instituto Matogrossense do Algodão* and Bayer have the majority of protected cultivars.

Considering the soybean protected cultivars, Monsanto, Embrapa, Coodetec, *Associados Don Mario*, DuPont-Pioneer, Granar, Nidera, and Syngenta are the market leaders. And in the corn sector, DuPont, Monsanto, Dow, Syngenta, Agromen *Technologia* and Nidera, dominate the market.

We should note that in 2011, the Brazilian Agricultural Research Corporation (Embrapa) received the approval from CTNBio for planting and commercializing a bean, genetically modified to be resistant to the golden mosaic virus (INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS - ISAAA, 2013; VELOSO, 2013).

Drawing on Amâncio’s (2011) study we have identified the following companies as the main genetically modified Brazilian seed industry strategic agents: Monsanto Brazil, Syngenta, Dupont/Pioneer, Dow Agrosciences, Bayer CropScience, BASF, Embrapa, and we could say the Central Cooperative of

Agricultural Research (Coodetec), is a potential strategic agent, having in mind that Coodetec has been expanding its strategies in research, development and innovation in the agricultural biotechnology sector.

2.6.1.2 Monsanto Brazil

Monsanto is a relatively new company that was founded in 1901, in Saint Louis, United States, with the purpose of supplying saccharin to pharmaceutical companies. Soon it began to expand its business and in 1919 it became a multinational company (MONSANTO, 2001).

In the present it is completely focused on agriculture, developing conventional and genetically modified seeds, biotechnology traits and herbicides. Monsanto’s strategies are focused on empowering farmers to produce more from their land while conserving natural resources, such as water and energy. In Brazil the company commercializes seed brands in crops like corn, cotton, and soybeans. Monsanto develops research in agricultural biotechnology that allows offering in-the-seed trait technologies for farmers, such as crops which are herbicide tolerant and insect resistant (MONSANTO, 2013a).

In the 1980s, the company began to develop research with genetically modified plants, and its first product derived from agricultural biotechnology was the Roundup Ready soybean, a genetically modified soybean seed tolerant to the glyphosate herbicide, launched in the U.S. market in 1996, and in Brazil in 2005. In 90s Monsanto saw biotechnology as the best answer to the problems faced by farmers producing crops, In the present we can say that the company counts more on integrated solutions that can unite many sectors to solves farmers’ problems.

Since the 2006/2007 harvest, the Bollgard cotton, a pest resistant genetically modified cotton, obtained approval from the Biosafety National Technical Committee on Biosafety (CTNBio) and was released for commercial planting. The company has received approval for planting and commercializing other GM varieties in Brazil since then.

In February 2009, Monsanto acquired the remaining 49% of MDM, reinforcing its position in the cotton market (MONSANTO, 2013b).

The company's business models are opened in the commercialization aspect, for the fact that the company broadly licenses its seed and trait technologies to other seed companies. Monsanto also manufactures Roundup® and other herbicides used by farmers, consumers and lawn-and-garden professionals (MONSANTO, 2013a).

2.6.1.3 Syngenta

Syngenta is a young company but it stems from an industrial tradition going back almost 250 years. The company was formed in 2000 by the merger of Novartis Agribusiness and Zeneca Agrochemicals. It is a global company present in over 90 countries (SYNGENTA, 2013).

In 2004 Syngenta acquired Advanta, one of the world's leading seed companies.

Just like the market leader Monsanto, Syngenta develops and commercializes agrochemicals, seeds and biotechnology and does not prioritize one area, biotechnology for instance, over the others. Its strategies focus the integration of different technologies such as biotechnological solutions and agrochemicals.

Syngenta has a strong participation in the markets for corn, soybean and cotton, conducting research for the release of cultivars that are herbicide tolerant and insect resistant. Market approval of two GM corn events (one insect resistant corn and one double stacked corn, insect resistant and herbicide tolerant) represented the beginning of a new phase of growth for the company's operations in Brazil (LOPES, 2009).

2.6.1.4 Dupont/Pioneer

The giant chemical company DuPont founded in 1802, in Delaware, United States, fully acquired Pioneer Hi-Bred International, the largest seed company in the world, in 1999. In 2005, Pioneer was officially incorporated by DuPont Brazil, resulting in DuPont/Pioneer (PIONEER, 2013).

DuPont operates in Brazil for over 30 years, and in the present it is a company focused on research and development, production and commercialization of corn and soybean seeds, as well as seed industrial processing and technical support on management practices information. It is present in over 90 countries and in Brazil it has 7 research stations located in major producing regions. The company works mainly with corn, soybean, and seed treatment (PIONEER, 2013).

In the area of biotechnology in Brazil, the company's research focuses corn and soybeans. The company is a leader in the market of genetically modified corn, having 219 hybrid cultivars registered by 2011 and it has also released cultivars of Roundup Ready soybean seeds (AMÂNCIO, 2011).

2.6.1.5 Dow AgroSciences

Dow Agrosciences is the agricultural division of the Dow Chemical Company, which was founded in 1897, in the United States, and today is present in 160 countries.

Dow AgroSciences develops leading-edge crop protection and plant biotechnology solutions. The company was originally known as DowElanco and began in 1989 as a joint venture between the Agricultural Products business of the Dow Chemical Company and the Elanco Plant Sciences business of Eli Lilly and Company. The company was renamed in 1997 when Dow acquired 100 percent ownership of the business (DOW AGROSCIENCES, 2013).

Dow has always worked with chemicals products and in the present the company focuses its research and development efforts in agrochemical products, and plant breeding, having in mind that biotechnology research has increased within the strategic plans of the company.

The company’s strategy is related to the development of GM products accessing a large number of seed companies. Dow develops research mainly with transgenic corn, but the company also works with genetically modified cotton and soybean.

Dow has alone or in partnership with other companies approved GM products that are commercialized in Brazil. For instance, Herculex corn was developed from an alliance formed between Dow and DuPont/Pioneer and it is insect resistant and tolerant to the *glufosinate-ammonium* herbicide (DOW AGROSCIENCES, 2013).

2.6.1.6 Bayer CropScience

Founded in 1863 in Germany, Bayer is a large company inserted in the health, agrilculture and innovative materials sectors, present in over 120 countries.

Bayer CropScience is a world leader in innovation within the agricultural field, working in the areas of crop protection, seeds and plant biotechnology. Company’s investments in R&D focus the market of agrochemicals, and plant biotechnology is seen within the company as a strategy for the development of integrated platforms, bundling transgenic events with the use of agrochemicals commercialized by the company (BAYER CROPSCIENCE, 2013).

In the biotechnology field in Brazil the company invests in research of soybean, cotton and corn transgenic cultivars. It owns the technology of herbicide tolerance to the glufosinate-ammonium, which received the name of ‘LibertyLink’, The company has commercial approval for soybean, corn and cotton transgenic events (BAYER CROPSCIENCE, 2013).

2.6.1.7 BASF

Founded in 1865 in Germany, the BASF group works with a wide range of products, including acrylic monomers, chemicals, pigments, plastics, textile chemicals and crop protection products.

BASF Plant Science, a subsidiary of the BASF Group, is one of the world’s leading suppliers of plant biotechnology solutions for agriculture. The company has about 840 employees. With the purpose of being an industry-leading technology platform for gene discovery, BASF Plant Science has specialized in developing plant properties that increase the yield and quality of important crops such as corn, soybean and rice. In collaboration with partners, these genes are introduced into the crops, which are then subsequently marketed. BASF Plant Science maintains partnerships with, among others, Cargill in the USA, with the Centro de Tecnologia Canaviera (CTC) as well as the state-funded agricultural research corporation, Embrapa, in Brazil, and Bayer CropScience (BASF, 2013).

BASF Plant Science is collaborating with the agricultural company Monsanto in the industry's largest collaborative venture. The collaboration’s focus is on developing traits that improve yield and provide stress tolerance for the five major crops: corn, wheat, soybeans, canola and cotton.

A collaboration agreement between Embrapa and BASF has resulted in a herbicide-tolerant soybean called Cultivance® system, which was approved in 2009 in Brazil and is expect to be commercially launched in Brazil for the growing season 2014/15 (BASF, 2013).

2.6.1.8 Embrapa

Founded in 1973, the Brazilian Agricultural Research Corporation (Embrapa) is the leading provider of new technologies for Brazilian agribusiness, especially biotechnology.

Embrapa began working with biotechnology in the early 80s in Brazil, and in 1986 the company launched the Research Program for Agricultural Biotechnology.

Embrapa develops biotechnology research with different plant species and has as its strategic goals to develop the whole cycle of a biotechnology product, from the identification of genes till the commercialization of the product.

So far, Embrapa has carried out field tests with various GM products, involving soybeans, cotton, beans, papaya, potato and banana, and it has already obtained market approval for products such as the soybean resistant to the imidazolinone family herbicide in partnership with BASF, and the bean resistant to the golden mosaic virus (AMÂNCIO, 2011; RIBEIRO, 2013).

2.6.1.9 Coodetec

The Central Cooperative of Agricultural Research (Coodetec) is a result from farmers concern about developing their own technology and crops of soybean, wheat and corn, in a strategic way, and to participate more actively in the scientific and technological process of domestic agriculture.

The beginning of Coodetec is in 1974, when the Cooperatives Organization of the State of Parana (OCEPAR in Portuguese) created its research department, focused on the research and development of new varieties and hybrids. In 1995 the cooperatives decided to extend the project by creating Coodetec, which absorbed the work and gene pool developed so far. Coodetec currently has 36 cooperatives affiliated and located in 6 Brazilian states. Over the years it has released various new varieties in the Brazilian and Latin American market, granting Coodetec a leading position in the soybean and wheat markets as well as an increasing market share in corn.

Coodetec has applications for planned release of plant genetically modified organisms to the environment, authorized by CTNBio such soybean and wheat which are modified to be drought tolerant (AGRURAL, 2013).

After describing the main strategic agents in the genetically modified seed sector we can start building our theoretical framework for analyzing innovation in that sector.

3 RESEARCH CONTRIBUTION – BUILDING A BUSINESS PLATFORM FRAMEWORK FOR ANALYZING INNOVATION IN THE GENETICALLY MODIFIED SEED INDUSTRY

Aiming to answer our research question: how business platforms are defined and how they evolve, considering different sectors and disparate technologies, and in our case, taking the agricultural biotechnology sector into account, and yet, having in mind that the new biotechnologies applied to agriculture imply blurred industry boundaries, the possibility of bundling products from different agents operating in distinct industries and causing product synergies and complementarities to arise, a multi-dimensional, multi-level and dynamic framework that allows to analyze innovation might contribute to the innovation research field.

The relationships among companies inserted in the genetically modified seed sector seem to present features that can be explained by the business platform theoretical perspective (Figure 7).

The building blocks representing possible innovation processes, or dimensions of innovation, in the theoretical framework proposed are: 1- inside innovation; 2- outside-in innovation; 3 inside-out innovation and coupled innovation process.

If we take the first innovation dimension in consideration, inside innovation can be explained through business model dynamics.

We should pay attention to the fact that business models can evolve from a closed to a new closed business model; from a closed to an open business model; and from an open to new open business model.

In (Figure 7), inside innovation is the case in which a closed business model evolves and transforms itself into a new closed business model. Whenever a company faces new obstacles in the innovation path, originating from the internal or the external environment that hampers value creation or capture from a new technology – an example would be Monsanto's RR soybean seeds in Brazil in 2002. Monsanto faced the difficulty of capturing value from the RR technology present in the soybean seeds for the fact that it had not yet been approved for commercialization in Brazil, and adding to that, it was being black-marketed from Argentina and commercialized in Brazil.

The well-known case of the transgenic Roundup Ready soybean seeds in Brazil forced Monsanto to reorganize its strategic choices internally and create ways to solve the problem. In the example mentioned, Monsanto, the technology developer, or the innovator, had to implement changes in its business model, specifically in its business revenue model, to be able to start collecting on its technology.

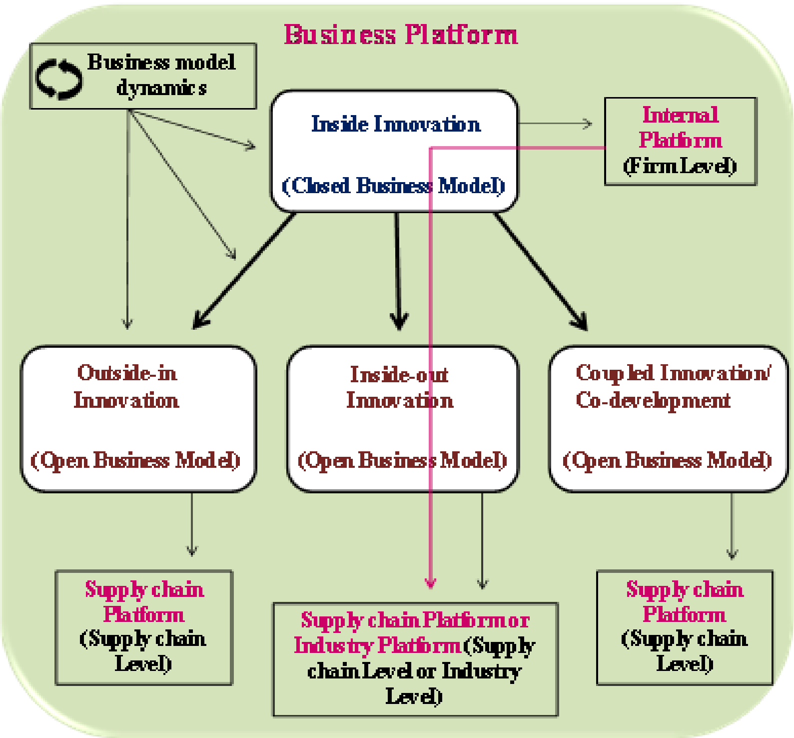

Figure 7 Generic business platform for the genetically modified seed industry in Brazil

The building blocks representing possible innovation processes, or dimensions of innovation, in the theoretical framework proposed are: a) inside innovation; b) outside-in innovation; c) inside-out innovation and coupled innovation process.

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We propose that at this point, when Monsanto renewed a component within its business model to allow capturing value from innovation, the company made changes internally that allowed the reorganization of strategic choices in the internal context of the firm.

Since it was not the only change the company implemented within its business model to allow value creation and capture from the 1980s to 2002, and for the fact that Monsanto had to connect knowledge internally to be able to innovate, we have called this first type of innovation process inside innovation.

Recalling our definition of a business platform as the shared logic or the architecture that allows gathering the complementary competences necessary to facilitate innovation within firms, within supply chains, or between industries, we believe we can say Monsanto structured an **internal business platform** that allowed leveraging innovation from biotechnology.

Another example of internal reorganization of competencies to allow new product development and value creation can be found in Coodetec's history. Coodetec, a Brazilian research cooperative had to completely change its way of carrying out research and development to be able to work with transgenic plants in the late 1990s. One of the first strategic hurdles the research institution faced was the fact that with the introduction of biotechnology to the breeding programs, investments had to be much higher.

For instance, to work with the development of transgenic seeds, a seed company has to have separate areas for handling, processing and storing the GM products. Seed companies also begin having to develop many processes that did not exist before, such as the responsible product management, separating and monitoring GM fields to avoid contamination.

Coodetec had to hire more people and also qualify its collaborators, and if we consider the regulatory processes, then the investments are extremely higher.

We also propose that an internal business platform in the genetically modified seed industry can evolve to a **supply chain business platform** (Figure 7).

Monsanto at a first moment, and later on, all of the other multinational companies operating in the GM seed industry in Brazil, realized that opening the company's business model, and licensing the technology of the Roundup Ready trait, and soon later many other products, such as the technology for Intacta soybeans, would confer the company the largest market share possible.

It is relevant to note that one of the main debates in the field of business platforms is how and how much to open platforms to external developers (GAWER, 2009). It is indeed an issue when companies have to invest millions of dollars in the research and development of a GM seed.

Companies most certainly plan on recouping their investments. In the genetically modified seed sector, where the investments for developing a new GM product can sum up to 40 million dollars (SILVEIRA et al., 2011), it seems easier to open up the commercialization side of the innovation processes.

In cases, such as the one of Intacta soybean seed, in which there is the licensing-out of technology, we can argue that a supply chain business platform is formed. Drawing on this example, we observe that an internal business platform evolves to a supply chain business platform, where other participants form the same supply chain as Monsanto, such as Coodetec, Riber *Sementes*, or Farroupilha *Sementes*, help create value from the product, either by adding quality germplasm or by targeting new customer markets.

The outside-in innovation process is also a recurrent practice in the GM seed industry in Brazil. For instance, when a company licenses-in a valuable trait, or in the case of the Smart Stax corn, in which there is the cross-licensing of technologies between Monsanto and Dow Agrosciences, companies benefit from outside flows of knowledge and from external competencies to enable innovation processes. In this case of outside-in innovation, we can also observe the formation of a supply chain platform.

Another innovation process is the coupled innovation process. An example would be the transgenic soybean seed jointly developed by BASF and Embrapa, called Cultivance. In this case, we can also observe a supply chain business platform.

One last example we would like to approach is the possibility of an inside-out innovation generating an **industry business platform** (Figure 7). An example would be Monsanto bundling technologies from distinct industries to offer better solutions to the customer, such as the case of its Precision Planting technology.

Another example, where the commercialization of the technology bundles distinct technologies within the customer solution is Syngenta's PLENE for sugar-cane.

In the case of Monsanto, the company's precision planting technology, YieldSense, allows monitoring information meant to enable sound decisions on hybrids and field management zones (PRECISION PLANTING, 2013). The technology changes the way grain flow is measured, with a sensor and paddle that eliminate the variations of current yield monitor technology and is compatible with John Deere. In the near future it might include other companies from distinct industry sectors such as John Deere.

In the case of Syngenta, recognizing the importance of integrated crop solutions, the company's PLENE™ is a breakthrough technology in sugar cane planting, combining chemistry, plant genetics and application technology to provide a truly integrated solution (SYNGENTA, 2011).

Noting that Brazil needed a more efficient planting system, PLENE involves the mechanical planting of single bud setts using much lighter equipment reducing soil damage. The planting equipment has been developed in partnership with John Deere, also forming an industrial business platform.

What we can observe is that these two examples of industrial platforms are built in the context of agricultural management systems, surpassing the offers of GM products and including field management.

An interesting conclusion we can draw with this exercise of observing the evolvability of platforms in the GM seed industry, is that it varies from what was suggested by Gawer (2009).

Instead of finding that internal platforms evolve into supply chain platforms, which then can evolve further into industry platforms, we have observed that internal platforms in the GM seed industry can evolve into industry platforms when biotechnology companies bundle products or services from distinct industries with its own technologies to create the customer solution.

4 CONCLUSIONS AND SOME LIMITATIONS

In our study we have propose that the innovative scenario observed in the GM seed industry in Brazil can be explained through the theoretical perspective of the business platform.

We have developed a multi-dimensional and dynamic theoretical framework which we believe contributes to filling the literature gaps of how business platforms are defined and built and how they differ considering different technologies.

We have observed that business model dynamics as well as the dimensions of open innovation are part of the business platform theoretical concept.

As we define it a business platform can be understood as the shared logic or the architecture of systems and subsystems that allow gathering the complementary competences necessary to facilitate innovation within firms as internal platforms, within supply chains, and between industries.

We have identified four dimensions of innovation processes:

Inside innovation – for example Monsanto business model dynamics to create and capture value from Roundup Ready soybean technology (internal business platform);

Outside-in innovation – Cross-licensing between Monsanto and Dow Agrosciences for the development of the Smart Stax corn (supply chain business platform)

Inside-out innovation – Monsanto licenses Intacta technology to Coodetec (Supply-chain business platform); or Monsanto bundles technology together to offer a better solution to the customer, such as Monsanto's Precision Planting (Industrial business platform)

Coupled process/ co-development innovation – BASF and Embrapa co-develop the Cultivance GM soybean seed (supply chain business platform).

Analyzing innovation in the GM seed industry in Brazil we can pose that evolvability of platforms is observed in the GM seed industry, even though it is to some extent different from what was suggested by Gawer (2009).

Gawer (2009) had suggested that internal platforms evolve into supply chain platforms, which then can evolve further into industry platforms. We have observed that internal platforms in the GM seed industry can evolve into industry platforms when a biotechnology company allows its technology to be bundled within a product or service, composing the customer solution with other technologies from distinct industries.

Considering the limitations of this study, there are two main concerns. First, this research should be extended and include all of the other agents developing complementary research and products in the GM seed industry, such as universities and other research institutions and also, it should include the customer link of the value chain to allow the access to a broader understanding of value creation from platforms.

The second suggestion that would help improve and complete this study would be to replicate it, considering a larger number of partnerships within the GM seed industry and also to apply it to other industries.

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CHAPTER 2 How multinational companies create and capture value from innovation through business model dynamics

ABSTRACT

Willing to answer to the research question of how multinational companies succeed in creating and capturing value from innovation, this paper aims at filling the literature gaps of defining business model dynamics, and showing business model dynamics in real practice. Through a qualitative single case study on Monsanto, an agricultural biotechnology multinational company, and the way the company's subsidiary managed successfully to change its business model willing to respond to strategic hurdles faced throughout its historical trajectory in Brazil, we illustrate business model dynamics. The case study that has been developed shows that technological change, the nature of innovation, existing regulation and other external pressures force business model change to enable value creation and capture from a new technology. Results also show that in fast moving and disruptive sectors it might be necessary to complete business model design and evaluation with regulatory and social aspects to explain adaptability and success.

1 INTRODUCTION

This chapter is part of a larger study that aimed at answering the overarching research question of how innovation processes in the genetically modified seed industry in Brazil can be better analyzed, and developing a generic theoretical framework for analyzing innovation processes in that sector.

Innovation and new product development as major drivers of competitive advantage have been well studied in a variety of sectors (PORTER, 1985; TIDD; BESSANT; PAVITT, 1997; TUSHMAN; ANDERSON; O'REILLY, 1997).

An issue that has gained importance in innovation studies is the fact that companies can only innovate if they are successful transforming new ideas or technologies into value (CHESBROUGH; ROSENBLOOM, 2002). Difficulty to develop that task has been attributed to a lack in understanding how to adapt the company's business model to a new idea or technology (TEECE, 2010).

A company which has managed successfully to stay atop its market, continuously innovate, and adapt to competitive environments is Monsanto, which was the first agrochemical company to enter the genetically modified seed market and in little time became leader of its sector.

Same as for the rest of the world, in Brazil, Monsanto is a leader in the genetically modified (GM) seed market, with proprietary ownership of the majority of products that have been approved by the Brazilian regulatory institution, the Biosafety National Technical Committee (CTNBio, in Portuguese) (CONSELHO DE INFORMAÇÕES SOBRE BIOTECNOLOGIA - CIB, 2012).

Monsanto alone invests more than $1 billion every year on research and development of new seeds, which is the amount spent by Monsanto's main competitors all together (FREITAS JÚNIOR; VELOSO**,** 2012). In Brazil

Monsanto controls 73.2% of the transgenic cultivars – commercial plant varieties – certified by MAPA (Ministry of Agriculture, Livestock and Supply) (MARINHO et al., 2012).

Brazil is a promising market for companies working in the genetically modified seed sector for many reasons. The speed with which producers have adopted the new technology has been quite impressive lately.

During the 2011/2012 crop year, Brazil planted 31,8 million hectares with biotech crops (CÉLERES, 2012). The planted area with GM seeds in the Brazilian crop year of 2012/13 (October 2012 through September 2013) reached 37,57 million hectares and the planted area with GM seeds in the crop year of 2013/14 is expected to reach 40,3 million hectares (CÉLERES, 2013).

Besides being the second largest producer of biotechnology crops in the world, some other aspects have attracted the multinationals attention such as Brazil's biodiversity, scientific competences in plant breeding and seeds that are already adapted to the country's different regions.

Brazil has about 44.000 to 50.000 species of plants, which represent approximately 18% of the global plant diversity (MARIANTE; SAMPAIO; INGLIS, 2009).

According to Mariante, Sampaio and Inglis (2009) over the last decade, Brazil has achieved significant results in agriculture related research due to high investments in science and technology. The country is a world leader in tropical agricultural research and a reference in forest breeding programs. It is one of the few countries in the world that can probably double food production, using relatively less energy than other commodity producing countries.

Another relevant measure is related to agricultural research, which from 1990 to 2005, was responsible for the development of 529 new plant cultivars, including sugar cane, soybean, wheat, orange, rice and coffee, adapted specifically to the different climate and soil conditions of the Brazilian's producing regions (TEIXEIRA, 2010).

On the other hand, despite this positive scenario for Monsanto in the present, the company has faced many problems throughout its path to innovation, such as the difficulty to communicate the value carried by its RR technology in the 90s, and the several years the company took to collect on its technology present in the genetically modified soybean seeds in Brazil.

In that context, how is it that multinational companies such as Monsanto succeed transforming a new technology into value, and capturing part of the value its innovation has created?

We propose that business model dynamics and evolution, which involve changes in the business model components to allow adapting a new technology to a new competitive environment, might help answer that question.

A company's business model can be understood as the logic of a company to make money through its value propositions (TEECE, 2010). We agree with the explanation proposed by Teece (2010) which states that the business model is composed of all the elements involved with transforming a new technology into value, delivering that value, and capturing part of the value created.

This paper aims at filling the gap identified in literature which is the need for defining business model dynamics (DEMIL; LECOCQ, 2010) at a first moment. Secondly, it is also one of the objectives of this paper to fill another literature gap and show the real practice of the business model dynamics (HACKLIN; WALLNÖFER, 2012).

Business model dynamics is illustrated through a single case study on Monsanto, an agricultural biotechnology multinational company, and the way the company's subsidiary managed to adapt successfully and innovate in Brazil.

Through the analysis, with longitudinal and cross-sectional approaches of Monsanto’s historical trajectory, with focus from the 1970s, which marks the beginning of biotechnological research that would result in the first transgenic plants, up to 2006, when the company had already approved genetically modified soybean and cotton transgenic seeds to be planted and commercialized in Brazil, this paper intends to tackle the research question.

This paper is organized as follows: after this introduction, the next section presents the business model concept, and defines business model dynamics. The third section exposes our research design. Fourth section presents our results and discussion and the fifth section presents the study’s main conclusions.

2 THEORETICAL UNDERPINNING

2.1 The business model concept: definition and key components

For innovation to happen there has to be a new idea which represents value for a certain group of customers. Nevertheless, a new idea is not translated into value unless it is delivered to the market through a good business model (CHESBROUGH, 2010; TEECE, 2010).

Despite the lineage that goes back to when societies engaged in barter exchange, business models have become a popular concept in the mid-1990s, leveraged by the emerging knowledge economy, and e-commerce (MAGRETTA, 2002; OSTERWALDER; PIGNEUR; TUCCI, 2005; SHAFER; SMITH; LINDER, 2005; TEECE, 2010).

The origins of the business model concept have been related to communication and information technologies, especially the Internet (AL-DEBEI; AVISON, 2010; OSTERWALDER; PIGNEUR; TUCCI, 2005; ZOTT; AMIT; MASSA, 2010).

One of the impacts of communication and information technologies is the growing number of possibilities of a company's businesses configurations, allowing the development of new ways to create and deliver value (AMIT; ZOTT, 2001; OSTERWALDER, 2004). On the other hand, reengineered organizational forms imply a larger number of stakeholders, and more complex businesses, which might hamper the intervention of managers and strategists (OSTERWALDER, 2004). It is in that context that the business model concept has been employed as an alternative management tool to allow the understanding and communication of business decisions and to explain the new value creation mechanisms.

Drawing on the understanding that an appropriate definition for the business model concept should be willing to bridge the gaps present in the extant literature, integrating and synthesizing earlier work in that area, we define a firm's business model as the logic that exposes how the company creates and captures value from its value propositions and those business components related to the strategic choices employed to develop that task.

Osterwalder (2004) has designed and proposed a rigorous conceptual model of business models, which he has called ontology, in order to tackle the business model concept and provide the basis for new management tools as shown in (Figure 1). The scholar's main objective was to provide an ontology that allowed to accurately describe the business model of a firm. To fulfill that purpose, in a first step, he identified four main areas that constitute the essential business model issues of a company: product; customer interface; infrastructure management; financial aspects.

In a second step, he broke those areas down into a set of nine interrelated building blocks that allowed conceiving a business model: product (value propositions); customer interface (customers, distribution channels, and customer relationships); infrastructure management (capabilities, partnerships, and value configuration); financial aspects (cost structure, and revenue model).

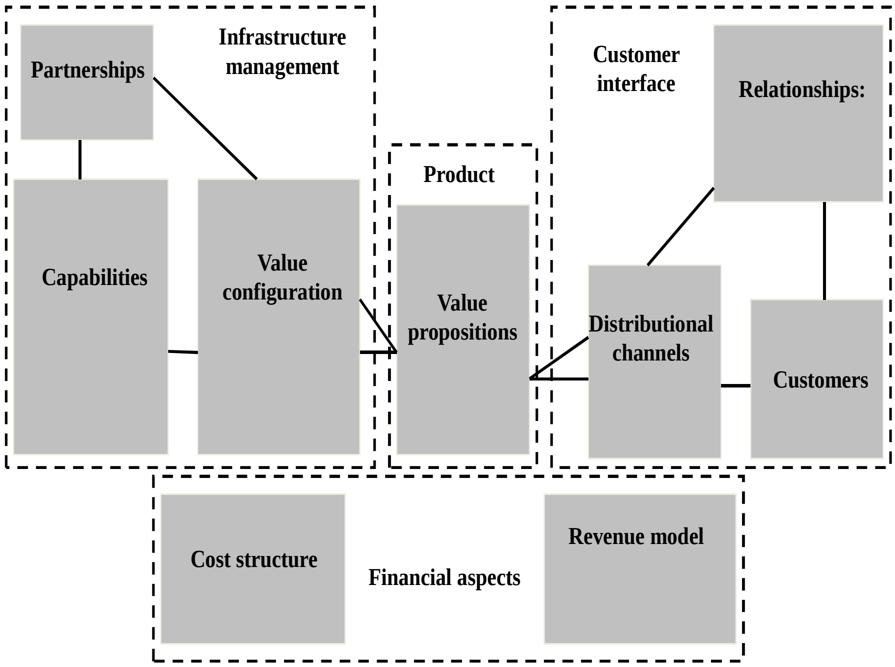

Figure 1 Business model ontology
Source: Osterwalder (2004)

Even though Osterwalder (2004) has stressed the role of the business model in expressing the logic of a company to create value, it doesn't describe how value capture, which is a crucial part of being successful in the innovation process, takes place.

Chesbrough and Rosenbloom (2002) contribute to the issue of capturing value from innovation approaching the role of business models in providing the link that translates between technical and economic domains and discussing how latent value from a new technology is translated into economic outputs. The scholars have also presented a new element in the business model discussion which is the need for search, learning, and adaptation for effective business models.

According to Chesbrough and Rosenbloom (2002) firms and startups take technology to the market through a venture shaped by a specific business model which functions transforming technical inputs into economic outputs as shown in (Figure 2).

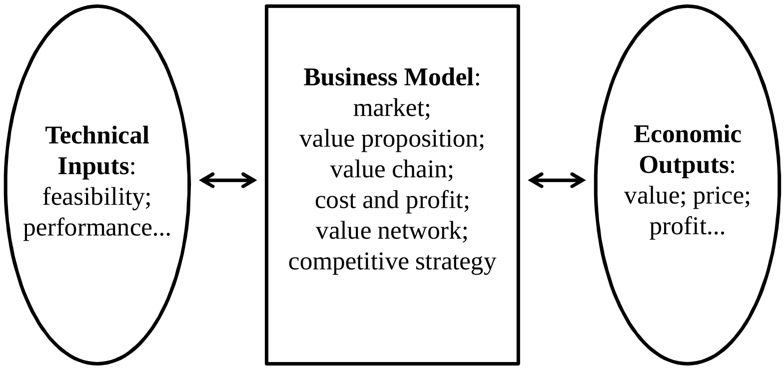

Figure 2 The business model mediates between the technical and economic domains
Source: Chesbrough and Rosenbloom (2002)

According to Chesbrough and Rosenbloom (2002) in some instances, an innovation can successfully employ a business model already familiar to the firm, but in other cases such a business model will not fit the circumstances of technological or market opportunity. In the later cases, managers will need to expand their perspectives to find the right business model, or as they called it, the ‘right architecture of revenues’, in order to capture value from that technology.

The authors connected the failure of incumbent firms to manage effectively in the face of technological change to the difficulty of those firms in perceiving and then enacting new business models when technological change requires it. Chesbrough and Rosenbloom (2002) seemed to be willing to narrow the gap around how adaptation and dynamics of business models affected a firm’s innovative success.

Most literature developed around the theme of business models sees the construct through a static approach or as a snapshot and description at a specific moment in time of how a company creates value (OSTERWALDER; PIGNEUR; TUCCI, 2005; REUVER; HAAKER; BOUWMAN, 2007). On the other hand, like the present study, some scholars have stressed the need to dynamize the business model construct, so it can help explain success throughout innovation processes (CAVALCANTE; KESTING; ULHØI, 2011).

2.2 Dynamics of business models: changes in response to strategic hurdles

Even though there seems to be a consensus that to remain competitive firms must continuously develop and adapt their business models, relatively little is known about how managers can achieve this transformation (WIRTZ; SCHILKE; ULLRICH, 2010).

Usually a model, being a simplified representation of a real physical entity or system, is something static (OSTERWALDER; PIGNEUR; TUCCI, 2005). However, a company's business model is continuously subject to external pressures that oblige that company to adapt (OSTERWALDER, 2004). Linder and Cantrell (2000), and Osterwalder (2004) list some of the pressures that directly or indirectly influence a business model:

a) Technological change – changes on technology pressure managers to reflect how new technology can be adopted to improve the business logic of the firm. For instance with the rise of the Internet firms started adopting new web based channels.
b) Competitive forces – An example would be the Compac versus Dell battle. Compaq (now HP) threatened by Dell, which was extremely successful with its direct-to-customer Internet strategy, was forced

to rethink its strategy and introduced its own direct Internet distribution channel. However, the company did not align the new business model with its business organization and faced a hostile reaction from its resellers, who argued Compac was competing with them.

c) Changes in customer demand – changes in consumption patterns, revenue increases and fashion changes, for instance. The shift from fixed-line to mobile telephony is a good example of a change in customer demand.

d) Changes in the social environment – For instance, if a company's business model is centered around low cost production in developing countries it might draw the attention of non-governmental organizations that could mobilize public opinion against the firm. This happened to Nike regarding the ethics of its operations in Vietnam.

e) Changes in the legal environment – The introduction of new privacy laws can make the use of some business models illegal, for instance, if a company has relied on customer information without the customer's explicit accordance. Anti-spamming laws may wipe-out business models based on sending out large trunks of unsolicited mails. New taxes may make a company's product too costly and therefore uninteresting for the customer.

We agree with Demil & Lecocq's (2010) understanding that the business model can be seen through two different approaches. One of them is the static approach – a blue-print for the coherence between core business model components. The second one is a more transformational approach that allows addressing change and innovation in the organization or in the model itself to enable the analysis of business models and properly adapt and make changes in the business models when necessary.

Reuver, Haaker and Bouwman (2007) add that companies have to adapt their business models over time to maintain alignment with technology, regulation and market development. The scholars tackle the question of how external forces drive internal business model design choices.

According to the scholars, external factors, such as socio-economic trends, technological developments, and political and legal changes are important to the understanding of how business models are used in practice.

We believe that business model dynamics can be defined as the process of change in at least one of the components of a company's business model to address the necessary response by the company in face of strategic problems caused by pressures from the external environment, such as technological change, regulatory change, public acceptance, changes in customer demand. The new business model will rearrange strategic choices to allow new value creation and capture. Next section exposes our research design.

3 RESEARCH DESIGN

We have conducted a single case study (SIGGELKOW, 2007) with qualitative analysis (STRAUSS; CORBIN, 1990). According to Siggelkow (2007) single-case studies can richly describe the existence of a phenomenon. The scholar also argues that single case studies help sharpen existing theory by pointing to gaps and beginning to fill them.

This study presented cross-sectional and longitudinal dimensions (HEDMAN; KALLING, 2003), which allowed, in addition to assessing the company's business model at a given point in time, also, to look at the business model over time, at different points in time.

The case study research design is particularly relevant to our objective having in mind that our research question has the explanatory nature of examining 'how' multinational companies create and capture value from innovation through business model dynamics, in the real context of a company in the genetically modified seed industry.

The unit of analysis for our study was Monsanto Brazil. The company was deliberately chosen as our unit of analysis for being a pioneer in research and development and commercialization of products derived from agricultural biotechnology. Monsanto was the first company to develop a GM seed and commercialize that product in the world. Besides, it was also the first company to have its technology inserted in soybean seeds cultivated in Brazil.

This study's main sources of evidence for data collection were documentary and bibliographic references, in-depth interviews, using semi-structured questionnaires (ALENCAR, 2003), and informal conversations. Annual reports, internal publications, and publications directed to Monsanto's external public containing information about the company's history and new products were examined.

We have conducted eight (8) in-depth interviews and two (2) informal conversations with seven (7) company managers from key areas within the Monsanto (soybean, corn, cotton, agrochemicals, communication and social responsibility, and sales). The interviews were recorded and transcribed. During the conversations we took notes.

Interviews and informal conversations were carried during May, 2007 – when we asked respondents questions related to the company's business model components and evolution (Attachment B – questionnaire 1); and during June, 2008, when we went back to the field to double check answers previously collected and verify if the changes in Monsanto's business model could be seen as business model dynamics (Attachment B – questionnaire 2).

A content analysis tool, the thematic analysis (MINAYO, 2000), was implemented to select our categories and find those changes that allowed the investigation of business model dynamics in Monsanto Brazil.

The categories identified in this study are circumscribed in the following strategic hurdles or challenges that Monsanto faced along its historical trajectory to be able to innovate and profit from its first products derived from agricultural biotechnology: a) **developing products from agricultural biotechnology**: building core capabilities and acquiring the vehicle that enabled delivering products to customers; b) **public acceptance of transgenic plants**: new communication and social responsibility department, and more transparency; c) **problems and challenges creating and capturing value from transgenic seeds**: completing the new architecture of revenues.

Understandings proposed by Chesbrough and Rosenbloom (2002) and the business model components or building blocks proposed by Osterwalder (2004) (Figure 1) were used to form the analytical basis for the empirical research.

4 RESULTS AND DISCUSSION

4.1 The company

Monsanto is a relatively new company. While sharing the name and history of a company that was founded in 1901, the Monsanto of today is an agricultural company (MONSANTO, 2013a). It is a technology based company which develops conventional and genetically modified seeds, biotechnology traits and herbicides. The company's customers are farmers, or crop producers.

Monsanto invested more than $1.5 billion last fiscal year researching new tools for farmers. The company concentrates the vast majority of its R&D efforts on new biotech traits, elite germplasm, breeding, new variety and hybrid development, and genomics research. Other R&D projects support the company's current products, including improved formulations of Roundup herbicide (MONSANTO 2013b).

The company was founded in Saint Louis, United States in 1901 to produce saccharin and supply pharmaceutical companies, but soon it began to expand its business and in 1919 it became a multinational company with the acquisition of RA Graesser Chemical Works, in Ruabon, Wales (MONSANTO, 2001).

Monsanto settled in Brazil in 1951 and during the years that followed the company grew both through the success of its products or through the acquisition of established companies in specific fields to which Monsanto wanted to expand (HERTZ et al., 2001; MONSANTO, 2001).

Monsanto was already a large company with chemical, pharmaceutical, agricultural and food businesses in 1997, when it decided to separate from the chemical area. In the 1980s, the company began to develop research with genetically modified plants, and its first product derived from agricultural biotechnology was the Roundup Ready soybeans, genetically modified soybean seeds tolerant to the glyphosate herbicide, launched in the U.S. market in 1996. With the approval of the Biosafety Law in Brazil in 2005, Monsanto released that product in the Brazilian market.

Since the 2006/2007 harvest, the Bollgard cotton, a pest resistant genetically modified cotton, obtained approval from the Biosafety National Technical Committee on Biosafety (CTNBio) and was released for commercial planting. The company has received approval for planting and commercializing other GM varieties in Brazil since then.

In February 2009, Monsanto acquired the remaining 49% of MDM, reinforcing its position in the cotton market (MONSANTO, 2008).

4.2 The story

In the late 1970s, and early 1980s Monsanto looked for alternative businesses that were not so dependent upon the chemical business (HERTZ et al., 2001). At that time Monsanto faced two major problems. The first one was related to the restriction on the amount of oil – base product for most of Monsanto and the other chemical companies' products - that entered the United States. The second problem was $20 million in losses due to a ruling from the Food & Drug Administration, which prohibited the sales of a plastic soft drink bottle produced by the company, made of styrene-acrylonitrile copolymer, claiming that unpolymerized acrylonitrile remaining in the plastic might cause cancer and birth defects (HERTZ et al., 2001).

In the 70s and 80s (period in which large part of the agrochemical molecules were synthesized), companies, such as Bayer CropScience, DuPont, Monsanto, among others, worked with the research and development of insecticide, fungicide and herbicide molecules, or products for agriculture. By the late 70s and early 80s, Monsanto, the fourth largest chemical company in the United States at the time, initiated a major change in its products and focus (HERTZ et al., 2001; MONSANTO, 2001).

The change in the organization's focus is in large part due to the synthesis in 1970 of the glyphosate molecule, base product for the Roundup Ready herbicide, by one of Monsanto's researchers. Such discovery led to the expansion of Monsanto's investments in businesses related to agriculture.

According to Hertz et al. (2001), Roundup, established in world markets in 1974, soon became the company's most profitable manufactured commodity. The fact that the herbicide, aside from being very potent, broke down quickly in the soil, and did not leach into the water supply, collaborated to the product's huge popularity and profitability in terms of business, which meant that Monsanto could afford research onto new technologies.

On the other hand, all the other chemical companies developing solutions to farmers had portfolios to offer their customers, and Monsanto had only the glyphosate. A relevant issue at this point is that for the development of agricultural products, companies need to have a line of research. They have to be working in partnership with university research teams, for instance, and Monsanto was not an agricultural company.

A positive aspect at that point in time is that Monsanto's researchers, one specifically, Ernest Jaworski, a PhD studying how Roundup was non-toxic to animals and still lethal to plants, had his passion in biotechnology (HERTZ et al., 2001). Jaworski believed the next agricultural revolution would go beyond chemical approaches and envisioned a plant able to protect itself not through herbicides but through its own genetic configuration.

In the late 1970s, the company started the molecular biology program (MONSANTO, 2001). Returning to the beginning of the 70s, according to Hertz et al. (2001), Monsanto's board of directors decided to create a firm called

Advent, with the intention of ensuring that Monsanto had good research in the various fields in which it worked. In 1976, it acquired a holding of Genentech, one of the first biotech firms, as its first entry into the genetics businesses. Other joint ventures such as Biogen and Genex, followed.

In the 80s, Monsanto had a vision which was, with the advent of genetic engineering, there were two alternatives, either take money from the mineral commodities with which Monsanto worked and invest in molecules of agrochemicals, or why not think in line with the new biotechnology tool and make some sort of investment in plants that would not need the agrochemical molecules?

The company's researchers were even cleverer and had an insight and everything happened from then on. Monsanto was the first company to invest in agricultural biotechnology and the first to identify genes that if inserted into plants would determine characteristics in those plants which would make them need less molecules developed by Monsanto's competitors and could then use some of Monsanto's own molecules.

Once the company made the decision of investing in biotechnology and creating new value propositions (OSTERWALDER, 2004) in the late 70s, some challenges had to be well studied and approached. One of the first strategic hurdles Monsanto faced in the path to innovating in the agricultural biotechnology field was related to finding the answers to basic questions such as how to transfer cloned genes into plant cells and then regenerate healthy, fertile plants from those cells. To develop that task the company had to build new core capabilities (PRAHALAD; HAMEL, 1990).

4.2.1 Developing products from agricultural biotechnology: building core capabilities and acquiring the vehicle that enabled delivering products to customers

Facing the strategic hurdle of answering scientific questions that would lead to the development of final commercial products, such as ‘is it possible to insert new DNA into a plant cell’; or ‘would the modified single-plant cell grow into a whole new plant that exhibited the new trait’ (HERTZ et al., 2001), Monsanto had to make changes in the core capabilities component (OSTERWALDER, 2004) of its business model.

The company faced new challenges related to research, crucial to the development of transgenic plants that would follow. Monsanto was used to selling plastics, rubber. What is the characteristic of a company that sells those products? High volume and low costs, like any commodity producing company. When Monsanto convinced its shareholders that their business was agricultural biotechnology, it faced completely different technological requirements. In line with the argument of Linder and Cantrell (2000), Osterwalder (2004) and Reuver, Haaker and Bouwman (2007), technological change unleashed business model change. The company had to assemble laboratories, hire researchers from different areas of expertise, and establish research in different parts of the world (Figure 3).

In 1979 Monsanto began to assemble its molecular biology team hiring gene cloning, DNA transfer, plant-cell and tissue culture researchers. The group which had begun with two scientists and one secretary numbered 36 people in 1981 (HERTZ et al., 2001). Besides the research team that firmly established Monsanto’s strategic research focus on biotechnology, the company established a new research laboratory in Saint Louis in 1980 (MONSANTO, 2001), and the Life Sciences Research Center in Chesterfield in 1984 (MONSANTO, 2013a).

Monsanto's researchers succeeded in genetically modifying a plant cell in the end of 1982, for the first time in scientific history (MONSANTO, 2013a). In 1985 they developed tomatoes that were tolerant to the Roundup Ready herbicide (HERTZ et al., 2001).

When the company's researchers answered the questions that hampered them from creating products from biotechnology, other core capabilities still had to be mastered.

Monsanto had discovered the gene that made plants tolerant to herbicides. But the company did not have the vehicle through which it would deliver that technology to the farmer. In that context, another important asset the company had to acquire was the seed.

As Kloppenburg (2004) explained, in arable agriculture, it is the seed that provides the essential material link between research and the market. It is in the form of seeds that new plant varieties become commercial products.

To access the seed vehicle in the 1990s Monsanto engaged in a number of acquisitions. From 1996 to 1998 Monsanto acquired companies such as Calgene, Dekalb, and Cargill.

In Brazil Monsanto acquired Agroceres, Asgrow, Braskalb and Monsoy, renewing part of its core capabilities component (OSTERWALDER, 2004) in its business model (Figure 3).

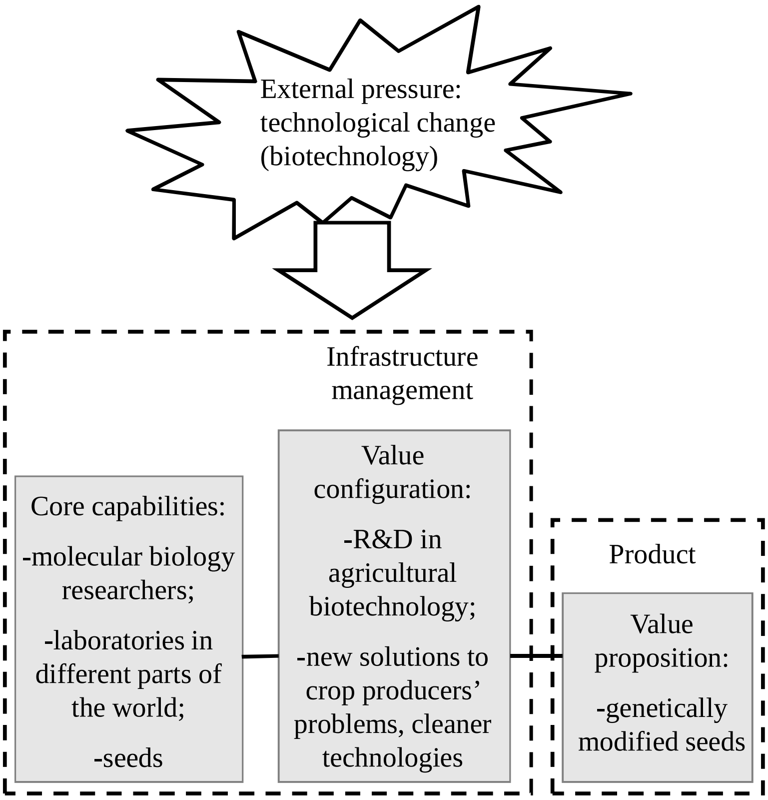

Figure 3 Changes observed in the infrastructure management of Monsanto's business model in response to technological change

4.2.2 Public acceptance of transgenic plants: new communication and social responsibility department, and more transparency

In the late 80s, and early 90s Monsanto's researchers focused on the commercial application aspect of its first products based on biotechnology. After the creation of plants that were herbicide tolerant Monsanto's next project, according to Hertz et al. (2001), was to create plants which were resistant to insects.

The first plants developed by Monsanto are called first generation biotechnology products (KALAITZANDONAKES, 2000), which have been crops with improved agronomic properties, such as herbicide tolerance or resistance to insect pests. Second generation biotechnology products are crops with enhanced quality traits, such as corn with high oil and lysine content (KALAITZANDONAKES, 2000).

In the debate concerning the marketing of genetically modified plants, to ignore public acceptance is not an option for companies working in the GM seed sector. With the release of GM crops in the 1990s, many conflicts started developing between agribusinesses and many activists in developed countries. Activists protested against the new technology and the agribusiness companies' claim of genetically modifying crops and food (PRINGLE, 2003).

The second strategic hurdle Monsanto faced in the path to developing new products from biotechnology that could be commercialized was related to public acceptance. Monsanto had to admit that it had been mistaken about the lack in the 1990s of communication and information exchange with the public about GM products. To respond to that problem the company had to make more changes in its business model's core capabilities.

Monsanto had not been very careful when it did not prepare itself for the way the public would receive the news about the transgenic crops. Society demanded information, and the company communicated the novelty of the transgenic plants very poorly. In the beginning, the company did not know how to deal with this issue. Monsanto's managers were more concerned with receiving the regulatory approval for its products, in the United States from EPA and USDA. Besides that, Monsanto's researchers were so certain the company's products were good that once the regulatory institutions approved it, Monsanto didn't think of discussing the new product with society.

In that context, the company learned that an image and customer relationship based upon transparency (Figure 4) would be the best way to act with respect to the new technologies. Furthermore, the company implemented changes in the communication department (Figure 4), which had to grow, hiring and training more employees, and move on to consider not only the farmer, but society as a whole.

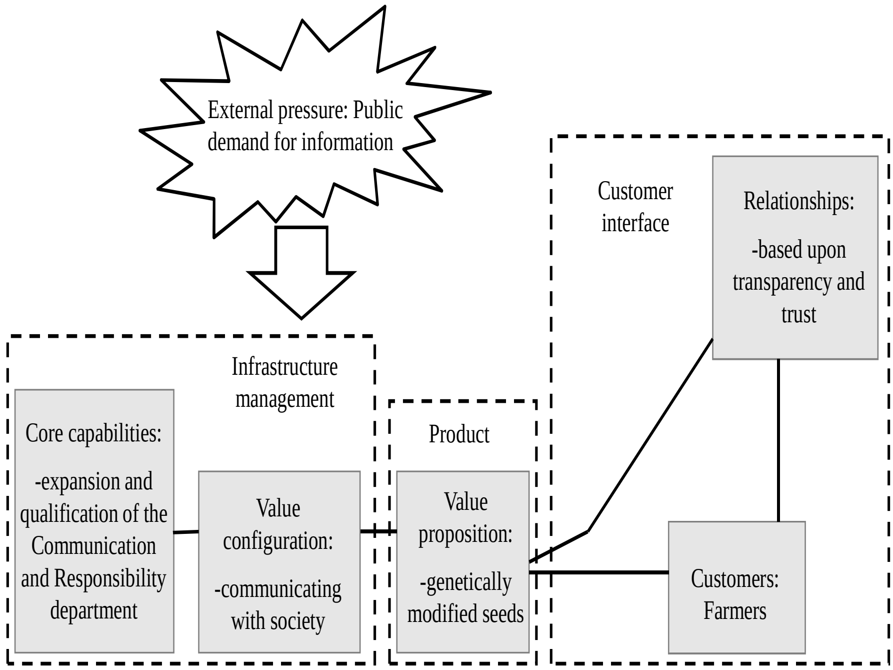

Figure 4 Changes observed in the infrastructure management of Monsanto's business model in response to the public demand for information and its impact in the business model's customer relationship component

4.2.3 Problems and challenges creating and capturing value from transgenic seeds: completing the new architecture of revenues

With the technological innovation of GM seeds, Monsanto changed the way of creating value to farmers. The company decided to focus on the seed and, therefore, could see beyond its competitive environment. What happened at a first moment was the transfer of value from the agrochemicals to the seed. From the moment the farmer had a gene that made the plant resistant to insects, for instance, he ended up having seeds with a higher value, due to reduced insecticide applications.

At first, genetically modified seeds reduced the farmer’s expenses with production inputs, and at a second moment, they involved benefits that had not been previously offered to farmers, as a lower risk of toxicity and greater security, because the number of applications of pesticides and trips to the field for the applications had been reduced.

In addition to those benefits, society and the environment also benefited with the new products. By reducing the amount of pesticides there was a reduction in the amount of water used in the dilution and there was a reduction in the amount of CO_2 emitted due to the reduction of trips of the machines to the fields for pesticide applications. Another benefit is the reduction of toxic substances released into the environment.

Despite the benefits of transgenic crops, when the new product was launched in the U.S. market in 1996, Monsanto struggled to explain to the farmer that the research the company developed resulted in a new technology and in benefits, and that the company had the right to receive for the value delivered by those new seeds.

In Brazil, other strategic hurdles Monsanto faced with the development of GM seeds were related to the perpetuation of genetic information in the RR soybean seeds and the right of Brazilian farmers to save their own seed from one year’s harvest to the next.

If we focus on soybeans, the RR genetic trait, which makes the plant tolerant to the glyphosate herbicide that Monsanto inserted in the plant is a dominant gene. The patented glyphosate resistance is a genetic trait that is passed on from Roundup Ready seeds to the harvested soybeans. So, if the farmer saves his harvest, next year he can plant the saved seeds again, and consequently, Monsanto’s technology, without purchasing new seeds.

Therefore one of the strategic hurdles Monsanto faced was to solve the question of how to sell seeds that contained the RR technology if farmers did not have to purchase seeds every year.

The Brazilian Plant Cultivar Protection Law, Law 9.456 of April 28, BRASIL, 1997), enacted by Decree 2.366 of November 05, 1997 (BRASIL, 2007), establishes the right of farmers to store and plant seeds for their own use within their properties. In Brazil, under this Law the farmer has the right to save a portion of his harvested seeds to be planted in the future.

According to Bell and Shelman (2006), in 1997, Monsanto had applied for approval of Roundup Ready soybean seeds for commercial planting in Brazil. However, the company took seven years to start collecting on its technology. The battle for the release of transgenic crops began in 1998 with an injunction placed on the government forbidding RR soybean seeds based on the fact that no environmental impact report had been presented. Farmers in the south of Brazil ignored the law and aggressively adopted the RR soybeans. Those producers were facing severe competition from Argentina, which had already approved the RR seeds, causing a black market to arise in Brazil as the seeds were smuggled in from Argentina. The seeds began to be saved and used later in the year.

Faced with the lack of a permanent resolution about the sales of GM soybeans from 2002 and 2005, the Brazilian government had to issue temporary regulations legalizing the sale of the Roundup soybeans. Only in 2005 the Brazilian president signed a comprehensive biosafety bill that legalized genetically modified crops and regulated the biotechnology sector (BELL; SHELMAN, 2006).

In 2002 Monsanto considered the alternatives to collect for the technology. Once sales were not authorized in Brazil, the company could not sell seed and charge the technology fee. This strategic hurdle was even more complex because even if GM seed sales were legal, farmers would avoid it by planting saved seed.

In this context, Monsanto came up with an idea, which changed the revenue model building block (Figure 5) within the company's business model. Since every farmer who plants seeds, either using new seeds or saved seeds, has to sell his harvest to someone because soybean is not a product that is consumed *in natura*, the company's commercialization model could be split into two parts: those farmers who bought the seed, paid for the seed, those who did not buy it, would deliver their harvested seeds to someone else. By the time they delivered the crops, Monsanto would map those traders who buy soybeans in Brazil, such as ADM, Bunge, Cargill, Draifus and cooperatives.

There are about five hundred companies that buy soybean seeds at about three thousand different spots. But in every case the farmer delivers his harvested crops to one of those traders. So Monsanto realized that if the company established a commercial link with all of the soybean buyers, the problem would be solved.

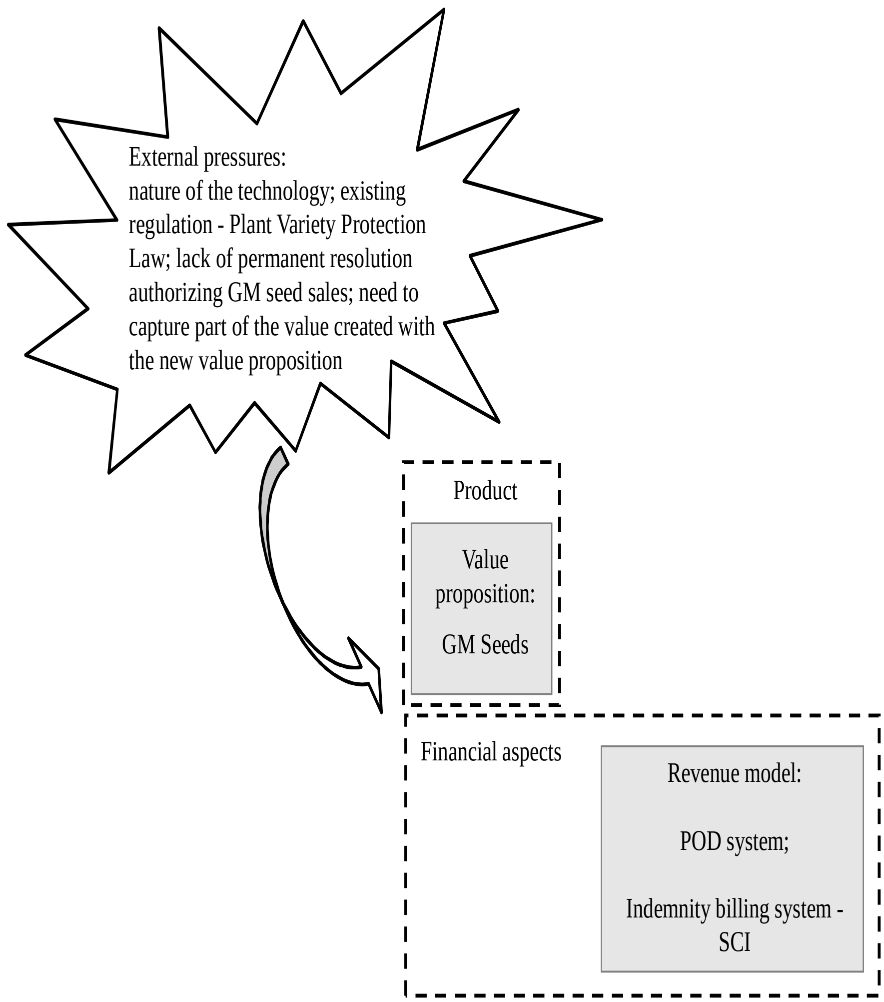

Figure 5 Changes observed in the Revenue model component of Monsanto's business model

In January 2004, Monsanto was ready to activate the system that received the name of 'Point of Delivery', (POD) in the south of Brazil.

In the POD system, when the farmer makes the decision to deliver his crops at a cooperative, the cooperative asks the farmer if that seed is genetically modified or not. If the farmer says that the seed is genetically modified, he assures that when he sells his harvest, he authorizes the payment of royalties.

The warehouses, in this system, became responsible by paying Monsanto, regardless of where those crops would be taken, either to be processed or to be exported.

In the case of the Bollgard cotton something similar occurred because the producer could also save his harvested seeds. The pricing model for cotton works the same way, but it has been called Indemnity Billing System (SCI in Portuguese) (Figure 5).

5 CONCLUSIONS

Willing to answer to the research question of how multinational companies succeed in creating and capturing value from innovation, we have approached the literature gaps of defining business model dynamics, and showing business model dynamics in real practice.

We have defined a firm's business model as the logic that exposes how the company creates and captures value from its value propositions and those business components related to the strategic choices employed to develop that task.

In this paper we argue that business models are continuously subject to external pressures obliging the company to adapt. Besides the business model static approach which can be used to evaluate the coherence between core business model components, the business model dynamics approach allows addressing change in the business model itself to enable adaptation when necessary.

Business model dynamics has been defined as the process of change in at least one of the components of a company's business model to address the necessary response by the company in face of strategic problems caused by pressures from the external environment, such as technological change, regulatory change, public acceptance, changes in customers' demand. The new business model rearranges strategic choices to allow new value creation and capture.

The case study that has been developed showed that external pressures forced Monsanto to implement changes and create new elements in some of its business model components. New technologies, such as the biotechnology tool, the need to respond to the customers' demand of information concerning the company's new value proposition, the nature of the technology, existing regulation, among other external pressures, leveraged business model change, allowing the company to capture part of the value that had been created with the new Roundup Ready seeds.

The present study shows that successful innovation depends on business model adaptation and evolution, especially if the innovative company has the intention to profit from a new technology. Sometime later Monsanto would realize that another good option to transform its new technology into value would be to start opening its business model so that other Brazilian seed companies would license and commercialize Monsanto's technology with their own brands, opening as many new markets and business opportunities as possible.

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CHAPTER 3 The concepts of open innovation and open business model and the dynamics of innovation processes in the genetically modified seed industry in Brazil

ABSTRACT

This study intends to answer to the research question of how the concepts of open innovation and open business model contribute to the understanding of the dynamics of innovation processes in the GM seed industry in Brazil. Data collection was based upon documental and bibliographical references, and in-depth interviews, analyzed through the content analysis technique, carried out with directors and managers from the six largest global agricultural biotechnology companies operating in Brazil: Monsanto, DuPont/Pioneer, Bayer CropScience, BASF, Syngenta, and Dow Agrosciences, as well as one research institution, Coodetec, and two seed companies, Riber *Sementes* and *Sementes* Farroupilha. Results showed that companies within the transgenic seed industry have taken steps towards creating more open business models, where companies have sought knowledge outside of their borders to create new products, or, other than that, technology that is developed within innovative companies is not taken to the market by the innovator, which might, instead, be done through IP licensing agreements.

1 INTRODUCTION

This chapter is part of a larger study that utilizes the concept and dimensions of open innovation to explain the composition of the business platform concept. Business platforms can be defined as the shared logic or the architecture of systems and subsystems that allow gathering the complementary competences necessary to facilitate innovation within firms as internal platforms, within supply chains, and between industries.

Agriculture is one of the world's oldest industries with a long history of innovation and adaptation as new practices and technologies are implemented.

In the end of the 20^{th} century, agricultural biotechnology emerged as a potential tool to solving social problems, such as the growing demand for food (world production will have to increase 50% until 2030), and the need for alternative energy sources (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS - FAO, 2006; LUTZ; KC, 2010; UNITED NATIONS, 2004, 2008; WOODS et al., 2010), once it allows farmers to increase crop productivity in more environmentally sustainable ways.

In that context, studies such as the one developed by Brookes and Barfoot (2010), show that genetically engineered, or genetically modified (GM) crops, enhanced with traits such as the Roundup Ready (RR) trait, and the Bacillus thurigiensis (Bt) trait, have contributed to a significant reduction in the environmental impact associated with insecticide and herbicide use on the areas devoted to biotech crops. For instance, from 1996 to 2008, the use of pesticides on the biotech crop area was reduced by 352 million kg of active ingredient (BROOKES; BARFOOT, 2010).

GM crops might indeed be considered revolutionary (WU; BUTZ, 2004), and the global area of biotech crops has grown every single year since its first commercialization in 1996, from 1.7 million hectares of GM crops in 1996 to 148 million hectares in 2010 (JAMES, 2010). Seeking to capitalize on the opportunities afforded by new biotechnology techniques, companies have accelerated their research and development programs, and developed new business models to commercialize their discoveries and profit from the results (KING; WILSON; NASEEM, 2002).

However, biotechnology is a complex business which involves high costs and high expectations towards continuous innovation, and large companies have acquired research firms and seed companies to expand their ability to develop and distribute genetically modified seed, taking industry merger and acquisition activity to rise sharply in the 1990s, peaking in 1996 (KING; WILSON; NASEEM, 2002). In addition, according to King, Wilson and Naseem (2002) firms have sought strategic alliances to better manage research and development and marketing costs.

Besides that, competition in the field of agriculture, which was based upon breeding programs until the 1970s, has also changed and become much more complex due to the fact that a single trait transgenic seed, for instance, has a number of different proprietary technologies that are not owned by a single company, generating many intellectual property rights issues (SEHGAL, 1996).

Changes in competition, witnessed in the transgenic seed industry, are characteristics of high technology industries, where companies willing to innovate will have to do more than outsource for external knowledge, they will have to open up their business models – the way a company creates and captures value (CHEBROUGH, 2006).

Open business models have enabled companies to create and capture value by letting more external ideas flow in from the outside and more internal knowledge flow to the outside, through intellectual property licensing, for instance (CHESBROUGH, 2006). In that sense, intense inter-firm alliance can be observed among agricultural biotechnology, seed, chemical, and a number of other companies not directly related to agriculture, willing among other things, to license and cross-license transgenic seed traits, and enhance competencies through business models that are more open.

This phenomenon can be observed in strategic partnerships, such as the one between Monsanto – a multinational agricultural biotechnology company – and Embrapa (*Empresa Brasileira de Pesquisa Agropecuária* / Brazilian Agricultural Research Institute) – a public research institution with plant breeding expertise and proprietary germplasm – where Monsanto is funding nine of Embrapa's research projects, involving popular crops in Brazil, such beans, rice and sugar-cane, with resources derived from the sharing of the intellectual property rights, payable as royalties, over the commercialization of Embrapa's soybean varieties containing Monsanto's RR technology (MONSANTO, 2013).

Regarding the changes in competition, such as the growing division of innovation labor, and the need of establishing collaboration agreements in order to deliver value to customers, this paper's main objective is to investigate the history, describe the most important features, and point future trends of the transgenic seed industry, willing to verify if firms' business models for creating and capturing value from the innovation shows a tendency to be more open, and if so, how the concepts of open innovation and open business models can be described in that sector and how they contribute to the understanding of the dynamics of innovation.

We believe that the evolution of agriculture and the changes in the competitive landscape caused by the application of biotechnology to agriculture force companies to pursue more open innovation strategies throughout time influencing strategies of firms in the GM seed sector.

For that reason, we have developed a qualitative study with a historical focus, aiming at observing business model evolution from closed to open models.

This paper has been divided into five parts. The second section presents the theoretical perspective which guided this study, approaching the transgenic seeds and business opportunities afforded by them, as well as the concept of open innovation and open business models. The third section presents the research methodology which was used for developing this paper. The fourth and fifth sections present the results and discussion and the main conclusions of this study.

2 THEORETICAL UNDERPINNING

This section defines genetically modified seeds and some business opportunities afforded by these products, as well as the concepts of open innovation and open business models through which companies can boost innovation in many industries.

2.1 Genetically modified seeds and business opportunities

With the application of new biotechnologies to agriculture, since the mid 1990s, genetically engineered, or transgenic, seeds have enabled companies to create new markets and redefine industry sectors.

The biotechnologies can be classified into three categories (NOSELLA; PETRONI; VERBANO, 2004): i) traditional biotechnologies – are thousands of years old, fermentation is an example; ii) modern biotechnologies – were developed after the industrial revolution, examples might be the biological processes used to obtain vaccines, enzymes and hybrids; and iii) new biotechnologies – have been developed since the 1970's, with the discovery of DNA recombination and cell fusion.

The application of biotechnology to agriculture created products that can not only benefit producers, but also offer benefits to processors and consumers (KRUEGER, 2001).

However, if on the one hand supporters of biotechnology and genetically modified organisms, such as GM crops, assert that those crops can revolutionize world agriculture, particularly in developing countries, in ways that would reduce malnutrition, improve food security, increase rural income, and in some cases, even reduce environmental pollutants (WU; BUTZ, 2004), on the other hand GM crops have engendered a lot of controversy and many social reactions from the public opinion (KLEBA, 1998).

Public acceptance of agricultural biotechnology was investigated by Oda and Soares (2001), who observed that in Europe, for instance, the introduction of biotechnology in the agricultural sector was followed by a strong reaction from end users and Non-Governmental Organizations (NGOs).

Despite the lack of public acceptance, the new biotechnologies applied to agriculture allow scientists to select a single gene for a desired trait, incorporate it into plant cells, and grow plants with that desired trait, and since the mid-1980s, researchers have been transplanting genes across species to produce engineered crops with pest or disease resistance, tolerance to drought, among other desirable features (WU; BUTZ, 2004).

Genetically modified crops can be classified into one of three generations (FERNANDEZ-CORNEJO, 2004). According to Kalaitzandonakes (2000), first-generation biotechnology products in agriculture have been crops with improved agronomic or input properties, such as herbicide tolerance and insect resistance. Second-generation bioengineered crops are those with enhanced quality or output traits, such as corn with high oil lysine content, developed to target feed and edible oil markets (KALAITZANDONAKES, 2000). Third generation biotech crops are crops that produce pharmaceuticals, bio-based fuels, and products beyond traditional food and fiber (FERNANDEZ-CORNEJO, 2004).

Vanhaverbeke and Cloodt (2006) argued that before the advent of agricultural biotechnology, agriculture was characterized by a standardized production of low-priced commodity-like food and feed, and that competition was based on price and economies of scale. Besides the benefits of the first-generation bioengineered crops, such as the productivity increases and farmers' profit from time and cost savings, those enhancements of agronomic traits did not change the commodity nature of crops like corn, and competition was still based upon price (VANHAVERBEKE; CLOODT, 2006).

On the other hand, according to the authors, genetically modified crops can lead to completely different ways to create value, depending on the firms' business models. Contrary to the first-generation of biotechnology products, second-generation products focusing on value enhanced traits, are designed for specific needs of end-users in industries that may not have been previously related to agriculture, some examples would be the intent of biotech companies to improve the fiber quality of cotton such as polyester-type traits with superior insulating qualities. In that sense, biotechnology has enabled agriculture to shift from low-priced commodity like food and feed to high-priced specialized plant-derived products that can be applied in a number of industries and enable companies to set up new value creating systems (VANHAVERBEKE; CLOODT, 2006).

Companies can create value from the application of biotechnology to agriculture if they implement business models that identify sources of value creation or 'value drivers', four of which might be efficiency, convenience, enabling properties, and complementary products (VANHAVERBEKE; CLOODT, 2006). Efficiency enhancements of agricultural biotechnology are, for instance, the purpose of the first-generation of engineered crops, to improve farm productivity. Considering convenience, insect resistant and herbicide tolerant crops have also increased convenience for farmers, as they reduced the need for tillage and spraying. The enabling property of biotechnology is important for customers once it enables them to have access to value propositions that were previously unknown, such as nutraceuticals that reduce the risk of health problems. Complementary products are value drivers because they allow companies to bundle complementary goods, especially when costs of bundled products are lower than when they are delivered separately.

One way companies within the transgenic seed industry could innovate and deliver new value propositions to customers would be through seeking open innovation and creating more open business models. The next section presents the concepts of open innovation and open business model.

2.2 Open innovation and open business model

Chesbrough (2006) argued that in the current competition environment we have been witnessing a shift in the innovation paradigm, from a “closed innovation” model to an “open innovation” model.

The logic of open innovation is based on a landscape of abundant knowledge, where knowledge that a company uncovers in its research cannot be restricted to its internal pathways to market, and similarly, its internal pathways to market cannot be restricted to using the company’s internal knowledge (CHESBROUGH, 2003a).

Examples of open innovation strategies would be licensing and cross-licensing technologies and patents, and generating or crafting the right business architecture, a modular architecture, for instance, where complementary innovations can be connected to each other enabling companies to manage interdependency (CHESBROUGH, 2003a; 2003b).

About the implementation of open innovation, some scholars have identified patterns, or different dimensions of open innovation, which they define as outside-in process, inside-out process, and coupled process or co-development (GASSMANN; ENKEL, 2004).

According to Gassmann and Enkel (2004) the outside-in process of open innovation enriches a company’s own knowledge base through the integration external knowledge. The inside-out open innovation process is the exploitation of external ideas in different markets, through licensing IP or multiplying technology by channeling ideas to the external environment. The coupled process of open innovation, links outside-in and inside-out by working in alliances with complementary companies and includes the joint development between partners of innovative products and services.

According to the new open innovation paradigm, a company willing to innovate has to do more than search externally for new ideas or license more of the ideas it has developed, it must also innovate its business model – the way a company creates value and captures a portion of that value (CHESBROUGH; ROSEMBLOOM, 2002).

A business model is a set of activities – articulating the value proposition, identifying a market segment, defining the structure of the value chain required to create and distribute the offering, estimating the cost structure and profit potential of producing the offering, describing the position of the firm within the value chain, and formulating the competitive strategy – through which a technology is transformed into value (CHESBROUGH; ROSEMBLOOM, 2002).

Without a business model, technology can't be translated into economic value (VANHAVERBEKE; CLOODT, 2006). Chesbrough and Rosembloom (2002) explained that new technological developments can only generate value if the firm is capable of commercializing it through a suitable business model, which is the tool that mediates the technology one the input side and the economic value on the output side.

The open business model approach can be better understood through the shift that can be observed in the process of industrial innovation, which despite working well during the 20^{th} century, assuming that corporations would be able to innovate by conducting basic research activities internally, and by carrying the results of that research to the market alone, has been considered obsolete in many industries (CHESBROUGH, 2003b).

Developments, such as the increasing ability of more actors to innovate, the rising cost of technology development in many industries, the rising quality of university research, the growth in quality and quantity of international research, as well as the complexity of products, which makes it impossible for firms to develop a new product alone, among other events, have rendered that closed innovation model obsolete (CHESBROUGH, 2003b, 2006, 2007; GASSMANN; ENKEL; CHESBROUGH, 2010; GAWER; CUSUMANO, 2002).

An open business model uses the new division of innovation labor, leveraging many more ideas to create value, due to the inclusion of a variety of external concepts, and captures greater value by using resources not only in the company’s own business, but also in other companies’ businesses (CHESBROUGH, 2006). The next section presents the methodology that was used for developing this study.

3 DATA AND RESEARCH METHODOLOGY

This study can be characterized as a qualitative research (STRAUSS; CORBIN, 1990). Data collection was based upon documental and bibliographical references, as well as in-depth interviews with semi-structured questionnaires (ALENCAR, 2003), and informal conversations carried out during 2010, 2011 and 2013, which were analyzed through a content analysis technique (BARDIN, 1979): the thematic analysis (MINAYO, 2000).

Fourteen (14) in-depth interviews were carried out with directors and managers from five of the six largest multinational agricultural biotechnology companies operating in Brazil: Monsanto (4); Syngenta (4); DuPont/Pioneer (1); BASF (1); Dow Agrosciences (1), as well as a Brazilian research cooperative, Coodetec (3). Five (5) informal conversations were carried out with managers and technicians from Bayer CropScience (2), Coodetec (1) and two seed Brazilian seed companies, Riber Sementes (1), and Sementes Farroupilha (1).

The selection of the interviewees was based on the need to understand the three different links of the genetically modified seed supply chain – biotechnology companies, breeding companies and seed companies – as well as the strategic position that the interviewees occupied within their companies, enabling us to access knowledge about the relevance of biotechnology to their companies' businesses, their companies' historical trajectory, strategic alliances to boost innovation, and conceptualizations of open innovation and open business models (Attachment C).

During the process of analysis and interpretation of the research data through the thematic analysis (MINAYO, 2000), the main categories identified were organized under the following topics: a) the history of the transgenic seed industry: evolution of agriculture and the emergence of agricultural biotechnology; b) impacts of agricultural biotechnology on companies' competitive landscape; and c) current and future trends of innovation processes in the genetically modified seed industry: open innovation and open business models.

The next section will present the study's results and discussion.

4 RESULTS AND DISCUSSION

Before approaching firms' innovation processes and their business models, and how the concepts of open innovation and open business model can be described in the GM seed sector, contributing to the understanding of the dynamics of innovation, we describe the evolution of agriculture, the emergence of agricultural biotechnology, and impacts of agricultural biotechnology on companies' competitive landscape.

4.1 The history of the genetically modified seed industry: evolution of agriculture and the emergence of agricultural biotechnology

The practice of agriculture emerged around ten thousand years ago (VIEIRA et al., 2004), and since then, it has undergone a number of significant changes. Over the past 80 years biological innovations embodied in the seeds, such as hybridization, and the new biotechnologies, especially genetic engineering, have led to unprecedented increase in crop yields (FERNANDEZ-CORNEJO, 2004).

Modernization process of agriculture owes much to the application of science to modern plant breeding (FERNANDEZ-CORNEJO, 2004), which is the science of improving plants to make them better suited to humankind, impelled along the 19th century with the development of fundamental knowledge such as Mendel's laws and plant selection (BORÉM et al., 2002).

It was Mendel's work on the laws of heredity that gave rise to scientific research into the inheritance of traits, focusing on corn and corn hybridization (FERNANDEZ-CORNEJO, 2004). With hybridization, a traditional breeding process in which inbred lines are crossed to create plant varieties with greater yield potential than exhibited by either parent, and the development of hybrid corn, in the United States in the 1930s, seeds and plants became objects of exchange and commercialization (FERNANDEZ-CORNEJO, 2004; KLOPPENBURG, 2004; PRINGLE, 2003).

Despite its major role in plant breeding, limitations of the hybrids – the development of hybrids through interbreeding may require up to 12 years to develop market seeds, and those hybrids may still generate only limited desired traits or, possibly, unwanted characteristics (FERNANDEZ-CORNEJO, 2004) – and limitations of the hybrids to certain species, assured the maintenance of the public sector's strategic position, where some crops unable to hybridize became the target of ambitious international breeding programs (KLOPPENBURG, 2004; PRINGLE, 2003).

Later on, other scientific discoveries in the field of genetics, beginning with Watson and Crick's postulate on the double helix model for DNA in 1953 and continuing with the development of the first genetically engineered plant in 1982, significantly reduced the unwanted characteristics that often resulted from traditional plant breeding crosses (FERNANDEZ-CORNEJO, 2004). In addition, the new biotechnologies could be applied to every type of crop (FERNANDEZ-CORNEJO, 2004; KLOPPENBURG, 2004; PRINGLE, 2003).

The transgenic seed industry emerged with the application of the new biotechnologies to agriculture, and since the mid 1990s, transgenic seeds have redefined companies and industry sectors.

Biotechnology is considered to be a toll of great relevance for the sustainability and strategic position of companies operating in the transgenic seed industry in the present, as we can observe from the next interviewee's opinion:

a) "Syngenta started working with biotechnology because we believe that the most important factor… The factor that will be decisive concerning sales will be the seed. The seed will be a decisive factor,

> and we truly believe that the market for seeds and biotechnology is a growing, promising market."

Agricultural biotechnology has had many impacts on companies, markets and products, once powerful technologies and valuable traits have led to linkages between agriculture and a broad spectrum of non-conventional sectors (SHIMODA, 1998), and also it has led to the restructuring of industries related to agricultural production processes, which will be discussed in the next section.

4.2 Impacts of Agricultural Biotechnology on Companies' Competitive Landscape

The emergence of agricultural biotechnology in the 1970s has influenced and dramatically changed competition rules among firms involved in the agricultural production processes for a number of reasons, among which are the following: a) companies realized that many sectors' core competencies could be complementary (KLOPPENBURG, 2004; PRINGLE, 2003); b) the introduction of legislation that enabled developers to privatize intellectual property rights (IPRs) in agricultural biotechnology, leading agricultural research to gradually shift from public to private institutions (BLAKENEY, 2010; MORRIS; EDMEADES; PEHU, 2006); c) complexity of products that have many proprietary technologies not owned by a single company and consequently the complexity of relationships among companies (SEHGAL, 1996); and d) companies became dependent on external knowledge and other companies' core capabilities in order to innovate (FREITAS et al., 2010; GAWER; CUSUMANO, 2002).

Regarding the perceived complementarities among companies from different industry sectors, it is relevant to keep in mind that biotechnology made it possible to have manipulative access to the basic molecular building blocks of life itself, and the practical utility, integrated into agricultural production processes was provided by the seed, that was the material link between research and the market (KLOPPENBURG, 2004). Therefore, control over the seed became a matter of considerable importance.

In that context, many studies have highlighted that the history of agriculture is marked by extensive structural change and transition (FERNANDEZ-CORNEJO, 2004; FULTON; GIANNAKAS, 2001; HAYENGA, 1998; KALAITZANDONAAKES, 2000).

Many companies engaged in mergers and acquisitions as we can observe in the following text of one of the interviewees:

b) "Syngenta was formed by the merger between Novartis and AstraZeneca's agribusinesses. Novartis and Zeneca themselves resulted from mergers of other companies. Zeneca had in its history the merger between ICI and Stauffer. And Sandoz and Ciba merged to form Novartis. When Syngenta was created Novartis and AstraZeneca separated the agribusinesses piece which originated Syngenta."

Fulton and Giannakas (2001) observed that in the 1990s, seed and chemical industries saw a substantial number of mergers and acquisitions and an increase in vertical as well as horizontal integration. Besides that, the major biotechnology companies increasingly purchased seed companies as a source of seed material in which to insert genes, seeking to gain knowledge from those companies in many countries that had, over the years, developed seed for specific geographical markets.

The next interviewee's text talks about the intense merger and acquisition activity in which many companies engaged in the mid 1980s:

c) “In the mid 1980’s many agrochemical companies acquired seed companies. Dow acquired Cargill in the United States, Monsanto acquired a number of different seed companies, and DuPont acquired Pioneer, and companies began to understand that in their chemical product portfolio, seeds, especially corn and cotton, were also good businesses.”

In that context, Monsanto led the way with massive investments in biotechnology research, and with seed and biotechnology company mergers and acquisitions (HAYENGA, 1998). According to next interviewee’s text, in the 1990s Monsanto acquired many seed companies so it could have the means to develop new products using the technologies it had discovered:

d) “In the 1990s Monsanto strengthened its activities within the biotechnology field and acquired a number of different companies such as Calgene, Asgrow, Braskalb and Agroceres.”

In addition, the seed industry has been much more concentrated since the second half of the 1990s, as a result of major chemical companies vertically integrating into the seed and biotechnology industries, willing to better capture profits from biotechnology innovations, which in some cases are also complementary to their chemical technology (HAYENGA, 1998).

Structural changes, mergers and acquisitions, resulted in industry consolidation and also in intense interfirm-alliance activity (KING; WILSON; NASEEM, 2002).

Interfirm alliances are a response from companies that have realized they can’t integrate every competency to produce every product internally, isolated from other companies as the following text of one of the interviewees:

e) "… Companies get specialized in specific areas, and they don't have resources to get specialized in every area. Therefore, I think doing partnerships with different suppliers is an alternative. There are companies that have seed and traits. Nevertheless, every day we see news such as: 'Company A engaged in a partnership or licensed its technology to company B', even among competitors, among the six largest companies in this area. For I am not going to have every solution!"

In order to deal with the complexity of products or the difficulty to profit from agricultural production and sustain competitive advantage, during the last twenty years, a growing number of strategic alliances and partnerships has taken place among the largest agricultural biotechnology companies and many other companies from different sectors, willing, among other things, to share risks and costs of research and development and regulatory approval, enhance competences, through licensing and cross licensing traits, access crop protection chemical treatment and quality germplasm, and create new markets (BJORNSON, 1998; HINTERHUBER, 2002; HOWARD, 2009; KING; WILSON; NASEEM, 2002).

The changes witnessed in industries related to agricultural biotechnology are in fact a common characteristic of a new competitive landscape, where high technology companies willing to innovate have implemented new business models. This trend will be approached in the next section.

4.3 Current and future trends of innovation processes in the genetically modified seed industry: open innovation and open business models

Biotechnology firms are very dynamic and their business models – or the logic of a company to create and capture value (CHESBROUGH;

ROSEMBLOOM, 2002) – attempting to respond to the rapidly changing scientific and commercial environment, tend to gradually evolve (WHITTLE, 2002). In that sense, agricultural biotechnology firms have gone through several transformations since the 1980s.

With the application of biotechnology to agriculture in the 90s, seeking to decrease costs or increase efficiency, companies started developing open innovation strategies, such as partnerships for licensing and cross-licensing technologies that enabled companies to share complementary competences**.**

As it is possible to observe in the following interviewee opinion, more than two companies might share their core capabilities to create new products, such as in the case of the 'stacked-trait' seeds. Trait stacking involves inserting multiple traits into a single plant variety:

a) "We [Monsanto] have a partnership of collaboration with Dow, and it's actually introducing a new generation of corn seeds called SmartStax®. What it does is it takes Monsanto's best insect resistance traits along with Roundup Ready, it takes Dow's best insect resistance traits along with the herbicide tolerance developed by Bayer to which Dow has a license, and it puts them together. We call it SmartStax technology. Both companies [Monsanto and Dow] have rights to it. But what it does is… It does two things. First, it increases the spectrum of disease resistance against pests that harm crop productivity. The second is it adds two different herbicide tolerances Roundup Ready and Liberty Link. So it gives growers more options, it provides a more sustainable agricultural system."

Biotechnology allows bundling a number of diverse enabling technologies (VANHAVERBEKE; CLOODT, 2006), or attributes together to create new value propositions.

In that sense, scientific discoveries such as the first and second generation of agricultural biotechnology crops have taken firms to seek strategic alliances as it can be seen in the inter-firm alliance which involves technologies from Monsanto, Dow Agrosciences, and Bayer CropScience (DOW AGROSCIENCES, 2008) (Figure 1).

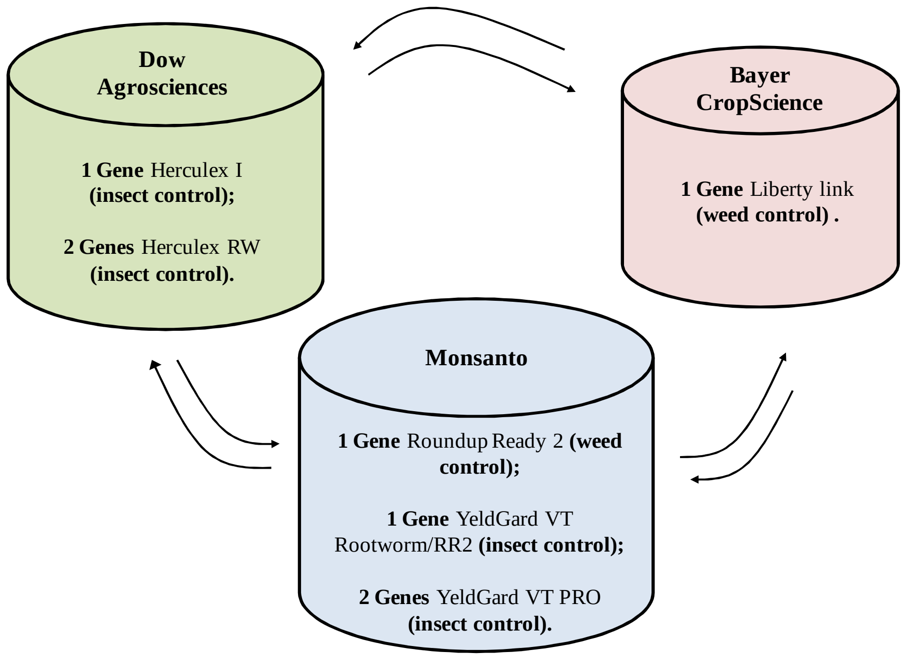

Figure 1 Core capabilities from Monsanto, Dow Agrosciences and Bayer CropScience shared in the strategic alliance for developing the SmartStax corn seed

Licensing and cross-licensing agreements to allow the access to traits the innovative company did not develop, or has proprietary ownership to, such as what happens in the SmartStax technology partnership can be understood as what Gassmann and Enkel (2004) call the outside-in process of open innovation.

The SmartStax partnership is one of the many collaboration agreements for cross-licensing seed traits observed in the agricultural biotechnology industry in the present. It has bundled technologies that have many ‘value drivers’: efficiency, convenience, enabling properties, and complementary products (VANHAVERBEKE; CLOODT, 2006).

Another partnerships relevant to this sector includes an strategic partnership between Monsanto and Embrapa for the research, development and commercialization of better adapted new varieties of Roundup Ready herbicide tolerant soybean to Brazilian regions, where Monsanto has benefited from plant varieties developed by Embrapa and the know-how on soybean varieties, while the partner has had access to Monsanto’s RR technology (Monsanto, 2013). Nevertheless, the RR trait developed by Monsanto will find its way to the market through Embrapa’s plant varieties. And, on the other hand, Embrapa’s customers can benefit from new value propositions.

There are many other examples of strategic partnerships such as the one shared by Monsanto and Embrapa between companies that have developed better adapted plant varieties and companies which have patented traits to license, or biotechnology companies. An example is the strategic alliance between Embrapa and BASF for the research, development and commercialization of the herbicide-tolerant soybean branded Cultivance® (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA, 2010). BASF collaborates with the herbicide-tolerant trait, and Embrapa collaborates with the plant variety, as shown by the interviewee’s text below:

b) “For instance, we [BASF] have a partnership with Embrapa for soybean... And we have other examples of partnerships around the world, where BASF collaborates with the gene and with our experience, and our partner collaborates with the genetics.”

In the mentioned partnership, between BASF and Embrapa, the two companies have created a new product that both companies license to seed growers, according to the interviewee's text:

c) "… For instance, COODETEC is a seed company located in Paraná, it has a license to our product. TMG, which is a another seed company, also has a license. So this is a model where two companies [BASF and Embrapa], have combined their expertise and created a commercial product. And then, COODETC and TMG they have their customers [farmers].

The strategic partnership between BASF Plant Science and Embrapa which created the herbicide-tolerant soybean branded Cultivance® illustrated in (Figure 2) can be identified as a coupled process of open innovation (GASSMANN; ENKEL, 2004), presenting an alliance with complementary companies (BASF and Embrapa) for the joint development of an innovative product.

We can also pose that such an alliance can be seen as an inside-out open innovation process (GASSMANN; ENKEL (2004), where other companies (COODETEC and TMG) can license and commercialize that technology.

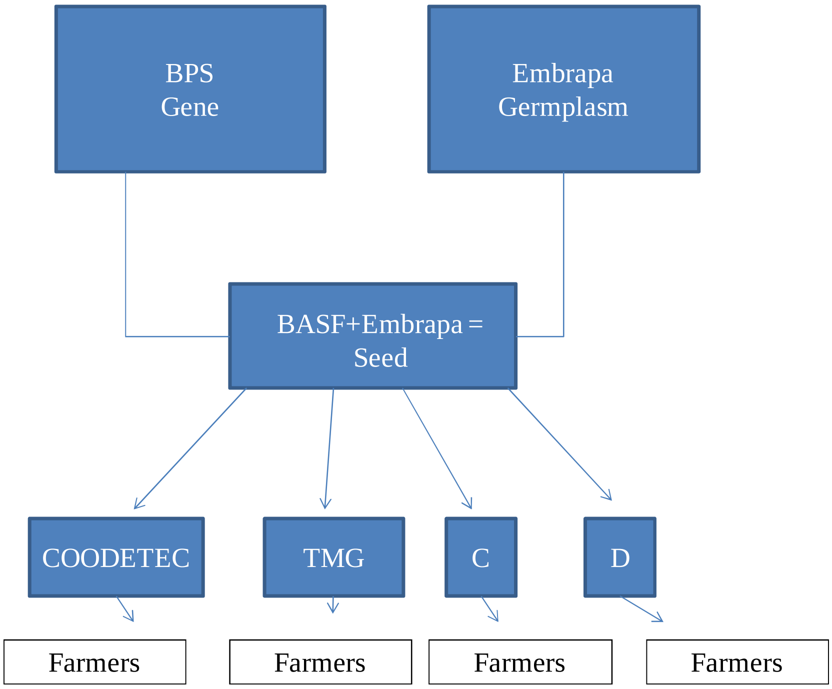

Figure 2 Strategic partnership between BASF Plant Science and Embrapa which enabled developing the herbicide-tolerant soybean Cultivance

Within the inter-firm alliance between BASF and Embrapa these two companies are not the ones to deliver the innovation (Cultivance) to the market. Other companies such as COODETEC and TMG are the ones who deliver the innovation.

So far we have seen strategic alliances that present different combinations of companies' expertise, such as the bundling of different traits within the same seed (SmartStax) for cross-licensing, or exchanging different technologies, agreements between agricultural biotechnology private and public companies (Monsanto X Embrapa) and (BASF X Embrapa), for accessing germplasm, or quality plant varieties, and high quality traits, and creating new value propositions for farmers (Cultivance). These examples seem to be proof that the complex solutions offered to customers in the present are not possible without sharing distinct capabilities within collaboration agreements, and that the context of growing innovation labor has taken companies to share their assets and competencies to innovate, or to take their new technologies to the market achieving as many markets as possible, through more open business models.

Analysis of the interviews that were carried out corroborates the fact that innovation in the present in high-tech industries such as the GM seed industry depends on collaboration and outsourcing of new ideas and technologies as shows the next two interviewees' perceptions:

d) "What we are trying to do is we are trying to avoid searching for things that already are part of Syngenta's core business… Our goal is to look for things that are linked to our businesses, because we have expertise in agriculture, we know our customer [the farmer]… We look for things that are not part of our core business and transform it into business, into integrated solutions."

e) "When BASF decided ten years ago to invest in biotechnology, it created a new company, BPS - BASF Plant Science, which is a research and development platform. So the idea was to create a gene platform and then look for seed companies."

The interviewees' opinions show that major players in the transgenic seed industry have found through strategic inter-firm alliances their means to access knowledge assets, generate innovation, and take new products to the market, and present some hints on how their business models will be, at least in the near future. They will certainly keep opening up their business models to create and capture value from their innovations.

5 CONCLUDING REMARKS

The literature review as well as the interviews carried out made it possible for us to analyze the evolution of agriculture and the impacts that the new biotechnologies applied to agriculture have caused in many industries involved with developing the transgenic seed.

As we could observe, GM seeds took competition to a new level that seems to highlight the relevance of collaboration, even with competitors for creating and capturing value.

In that context, the concept of open innovation, its dimensions, and open business models might help managers make sense of the competitive environment, and innovation processes within high-technology industries.

We believe that the renewed role of knowledge and the redefinition of competitive rules made companies involved with developing the GM seed implement new strategies, establishing partnerships to enable the value creation.

As we expected, having witnessed strategic alliances that present different combinations of companies' expertise, such as the bundling of different traits within the seed, and agreements between two companies for sharing expertise regarding quality traits and germplasm, willing to create complex solutions to customers, it is possible to observe that firms in the GM seed sector in Brazil have implemented different open innovation strategies and opened their business models, especially in the commercialization side.

Yet, we believe other studies may help analyze innovation processes in the GM seed industry through theoretical frameworks such as the value constellations, which in our view is another name for business platform, which are composed of the different dimensions of open innovation, allowing to manage the complexity of innovation, increasing interdependency between products and services, and the growing number of industry actors with the ability to innovate.

Other studies must be carried involving other major players, which are also relevant for the innovation process in the GM seed industry. In Brazil, for instance, public research institutions, and public universities are fundamental elements in the innovative environment of the agricultural biotechnology industry. We believe that seed growers must be heard, so that we can also have other points of view besides the ones from the world's largest multinational companies.

Our study may help researchers and managers understand that not only industries related to agriculture will experience restructuring or open business models, which allow corporate mosaics such as the one formed around agricultural biotechnology, with the bundling of products that help companies offer better value propositions to their customers, but also other sectors might change to better respond to the new challenges of competition.

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CHAPTER 4 The business platform theoretical concept and innovation processes in the genetically modified seed industry in Brazil

ABSTRACT

Drawing on developments that impact competition and adaptation rules in a number of different industries, and highlighting the relevance of the relational aspect in innovative processes, we question if the concept of business platforms helps explain innovation processes in the GM seed industry. Willing to understand how innovation processes are seen through the lenses of the business platform theoretical concept, and how that perception differs considering the different innovative agents in the genetically modified seed sector in Brazil, this study develops a qualitative analysis of partnerships to leverage innovation and defines the different contours business platforms present in the GM seed sector. The empirical evidences were collected from primary and secondary data of companies by in-depth interviews, pre-releases, specialized journals, and companies' web sites. Based upon the grounded theory, the content of collected data was analyzed qualitatively, utilizing the Atlas ti. software to illustrate relationships among codes corroborating our argument of business platform formation. Results show that Monsanto, for instance, has shifted its business models from closed models to open business models, proposing new solutions to farmers' crop productivity that allow external companies to develop complementarities to its products, boosting innovation.

1 INTRODUCTION

This chapter is part of larger study that aimed at developing a generic business platform theoretical framework for analyzing innovation processes in the genetically modified seed industry.

Over the past two decades, companies, especially those from high-tech industries, have faced new rules of competition and adaptation. In this competitive landscape, new organizational forms such as the business platform (GAWER; CUSUMANO, 2002) might help those companies shape their own competitive environment.

Even though the business platform approach (SUGANO, 2005) has been used to explain innovation processes within high-tech industries such as the computer and telecommunications industries, it might also be a helpful tool for understanding innovation within a number of other industries also producing complex products, such as the genetically modified seed industry.

Since the commercialization of the first genetically modified seeds in the 1990s, certain developments have dramatically changed the nature of competition of companies, causing the restructuring of seed and chemical industries, where large companies have acquired research firms and seed companies to expand their ability to develop and distribute genetically modified seed, taking industry merger and acquisition activity to rise sharply, resulting into the ‘Big Six’ (HOWARD, 2009) multinational agricultural biotechnology companies: Monsanto, DuPont/Pioneer, Syngenta, Dow Arosciences, Bayer CropScience, and BASF (KING, WILSON, NASEEM, 2002).

In addition, having in mind that in the present useful knowledge is widespread, and that companies are dependent on partners to innovate, a growing number of strategic alliances and partnerships has taken place among those six multinational agricultural biotechnology companies and many other companies from different sectors, willing, among other things, to share risks and costs of research and development and regulatory approval, enhance competences, through licensing and cross-licensing agreements, access crop protection chemical treatment and quality germplasm, and create new markets for complex products (BJORNSON, 1998; HINTERHUBER, 2002; HOWARD, 2009; KING; WILSON; NASEEM, 2002).

Competition has also been defined by other complementary products and services necessary for reaching better crop yields, such as better adapted plant varieties, and crop chemical treatments, which solve problems (specific insects and plant diseases) that the trait does not. In this situation, it is necessary to establish collaboration agreements among firms which have distinct competences to share.

In the 1990s, right after the first agricultural biotechnology product was commercialized, in the United States, multinational companies understood they were inserted in a new competitive environment – the plant genome – where the strategic battlefield was conquered with the definition by companies of portions of a seed's DNA – "seed traits", which became possible through genetic engineering. Soon after that, companies, especially knowledge-intensive companies, began to understand that to increase crop productivity to the largest, integrated solutions, based upon complementary products and services and the redefinition of innovation including services offered after products' commercialization, would be more profitable and more appealing to customers.

Complex products, consisting of interrelated components or technologies (GAWER; CUSUMANO, 2002), and inter-firm alliances are characteristics of today's growing division of innovation labor, where companies willing to innovate have to open up their business models (CHESBROUGH, 2006).

Monsanto, for instance shifted its business models from closed integrated models towards open models based upon the selection of strategic complementary partners to boost innovation.

Monsanto's strategy of selecting potential partner companies, based on specific criteria (HINTERHUBER, 2002), seem to purposefully seek to establish the business platform ecosystem – a system where developers can build applications on top of a platform (PARKER; ALSTYNE, 2008) – and achieve leadership positions.

Examples of inter-firm alliances within the GM seed industry in the present indicate that companies seem to deliberately bundle complementary technologies together to offer new revolutionary products to customers.

In that sense, considering this competitive landscape, agricultural biotechnology companies' strategies, and the characteristics of partnerships combining companies from different sectors around agricultural biotechnology, this study's objective is to analyze two elements we see as relevant for the understanding of platform organizing and building, focusing innovation: a) architecture – what is the platform is composed of? and b) platform leadership – can we perceive strategies firms pursue to maintain leadership position within platforms in the GM seed industry?

This paper analyzes the perception of the concept of business platforms in the GM seed industry by different agents operating in the sector, willing to understand how business platforms are built in the GM seed sector and if we can identify business platform leadership.

The present study can be characterized as a qualitative research. The empirical evidences were collected from primary and secondary data through eighteen in-depth interviews and informal talks with directors and senior managers from the six largest multinational agricultural biotechnology companies operating in Brazil: Monsanto, DuPont/Pioneer, Bayer CropScience, BASF, Syngenta, and Dow Agrosciences, as well as a research institution, COODETEC, and two seed companies, Riber Sementes and Sementes Farroupilha. Specialized journals, companies' web sites and annual reports were also analyzed. The content of each collected material was analyzed based upon the grounded theory approach with the help of the ATLAS ti. software.

This paper is structured into five parts. The second section presents a short literature review, approaching the concepts of business platform, business platform architecture, and business platform leadership. The third section presents the research methodology which was used for developing this paper. The fourth and fifth sections present the results and discussion and some conclusions of the study.

2 THEORETICAL REFLECTIONS

2.1 The concepts of business platform, business platform architecture, and business platform leadership

Knowledge and innovation have been widely recognized as keys to value creation and competitive advantage, as well as fundamental elements for firm survival and growth (CARAYANNOPOULOS; AUSTER, 2010; OEHMKE; PRAY; NASEEM, 2005).

Besides stating that companies that don’t innovate die, Chesbrough (2003a) argued that in the current competitive environment we have been witnessing a shift in the innovation paradigm, from a ‘closed innovation’ model to an ‘open innovation’ model. Open innovation strategies would be, for instance, licensing technologies and patents (CHESBROUGH, 2003b).

Significant developments, such as the globalization of innovation, causing decentralized innovation processes, as well as the complexity of products, making it impossible for firms to develop a new product alone, have rendered that closed innovation model obsolete (CHESBROUGH, 2003b, 2006; GASSMANN; ENKEL; CHESBROUGH, 2010; TEECE, 2000).

According to Chesbrough (2006), in the current competitive environment, a company willing to innovate has to do more than search externally for new ideas or license more of the ideas it has developed, it must also innovate its business model – the way a company creates value and captures a portion of that value (CHESBROUGH; ROSEMBLOOM, 2002).

In the open innovation world, firms must demonstrate that their management capability is highly flexible and responsive, favoring outsourcing and alliances to effectively redeploy organizational boundaries and allow the exchange of internal and external competencies (TEECE, 2000).

In such a new context of open innovation practices, business platforms can be seen as new organizational forms where firms create and capture value through the combination of interorganizational knowledge and competencies.

The business platform construct, which can be defined as an evolving system made of interdependent pieces that can each be innovated upon (GAWER; CUSUMANO, 2002), has become a ubiquitous feature of the information economy, where complex products, such as computers, cell phones and gaming systems allow developers to build applications that complement a core technology (GAWER; CUSUMANO, 2002; PARKER; ALSTYNE, 2008).

In recent years, many industries ranging from smart cell phones to one of the oldest industries in the world, agriculture, have become platform battlegrounds (CHESBROUGH, 2003a; GAWER; CUSUMANO, 2008; VANHAVERBEKE; CLOODT, 2006).

The business platform construct can be seen as an interorganizational network, as purposed by Vanhaverbeke and Cloodt (2006), who have argued that companies have to set up and manage interorganizational networks, linking firms with different competencies and assets in response to new market opportunities, in the agricultural biotechnology sector, in order to commercialize their innovations successfully. Partners in the network would be, for instance, biotech firms, seed producers, chemical companies, farmers, and also, manufacturing companies, retailers, among others (VANHAVERBEKE; CLOODT, 2006).

According to the authors genetically modified crops can lead to completely new ways of creating value if companies implement business models that identify sources of value creation such as the ‘complementary products’, which allow companies to bundle complementary goods, creating value especially when costs of bundled products are lower than when they are delivered separately.

Platforms can also be understood as an architecture created to combine internal and external innovations in ways that create value throughout the chain of activities that deliver a useful technology to the market (CHESBROUGH, 2003b).

An element that helps understand the business platform approach is the concept of modularity (GAWER, 2009).

Modularity emerged with the evolution of industries (GAWER; CUSUMANO, 2002; MUFFATTO; ROVEDA, 2000; PARKER; ALSTYNE, 2008; SUGANO, 2005), in which many firms not capable of producing all the components necessary for making their products, have specialized in developing certain components of specific products.

The modular architecture provides the kind of flexibility that enables business platforms to deal with issues firms face in high technology industries: the complexity of managing innovation; the increasing interdependency of various products and innovations; and the ability of an increasing number of industry actors to innovate (GAWER; CUSUMANO, 2002; MIKKOLA; GASSMANN, 2003; VOORDIJK; MEIJBOOM; HAAN, 2006).

Modularity can be defined as an approach for organizing complex products and processes by decomposing complex tasks into simpler activities, or ‘modules’, that can be managed independently (BALDWIN; CLARK, 1997; MIKKOLA; GASSMANN, 2003), where the module is a unit whose structural elements are powerfully connected to each other and weakly connected to elements in other units (GAWER; CUSUMANO, 2002).

According to Gawer and Cusumano (2002) many industries have evolved toward a modular architecture. The personal computer industry, for instance, is made of industry layers, such as the hardware at the base, or the operating system, and the applications, among others, which interact to deliver a complete PC capability (CUSUMANO; GAWER 2002; PARKER; ALSTYNE, 2008).

Baldwin and Woodard (2009) emphasized that, besides receiving little attention up to now, the relationship between platforms and architecture (the structure of modules) is crucial to understanding the nature of platforms and hence the dynamics of platform-based innovation and competition.

The fundamental feature of a platform architecture, in Baldwin and Woodard's (2009) view is that certain components remain fixed over the life of a platform, while others are allowed to vary or change over time.

In essence, according to the scholars, a platform architecture displays a special type of modularity, in which a product or a system is split into two sets of components, one with low reusability and the other with high variety. The first set is called 'the platform'. The second can be called 'the complements' of the platform. The combination of stability and variety in the architecture makes it possible to create novelty without developing a new system from scratch. This is why platform systems are evolvable.

According to Gawer (2009) platforms are building blocks (they can be products, technologies or services) that act as a foundation upon which an array of firms can develop complementary products, technologies or services. As we see it, different products, technologies or services can be different modules that work together to create a complex final product or solution to a customer.

We agree with Gawer's (2009) argument that a business platform can be understood as the shared logic or the architecture of systems and subsystems that allow gathering the complementary competences necessary to facilitate innovation within firms as internal platforms, within supply chains, and between industries.

Through a business platform, a leading firm provides a core technology, which becomes an infrastructure for the development of third parties' businesses. Third parties, or developers (PARKER; ALSTYNE, 2008), on the other hand, share complementary products or services, or interdependent modular capabilities, to deliver business results and value (CALKINS; SVIOKLA, 2006; GAWER; CUSUMANO, 2002; SUGANO, 2005; WEST, 2003).

In order to respond to the impacts that modular designs have on innovation, such as changes in the nature and stability of relationships between firms that make core products, and developers that make complements, companies have developed strategies which received the name of ‘platform leadership’ (GAWER; CUSUMANO, 2002).

According to Gawer and Henderson (2007), many high-technology industries offer products or services that can be described in terms of systems of interdependent components, built around or on top of platforms, or industrial ecosystems, where very large players seek to achieve platform leadership, being able to exercise considerable influence over developers of complementary products.

Platform leaders do not have all the capabilities or competencies to create complete systems and make every complement themselves (CUSUMANO; GAWER, 2002). Therefore, companies are dependent on research and development activities of partners and sometimes need to collaborate with competitors. In such platform environments, interdependency is an ongoing concern for platform leaders, and platform leadership can be defined as the ability of a company to drive innovation around a particular platform technology at the broad industry level (CUSUMANO & GAWER, 2002).

Cusumano and Gawer (2002) present the main levers of strategic action for managers who aim for platform leadership:

a) Scope – the amount of innovation the company does internally and the how much it encourages outsiders to do. Basically, it involves what to do inside the firm, and what to let external firms do.
b) Product technology – decisions about the system architecture, or how much modularity platform owners want, and decisions about interfaces, the degree of openness of interfaces and how much information to disclose to outsiders who might become complementors. Platform leaders have to establish standards concerning product architectures and architectural interfaces.
c) Relationships with external complementors – decisions about how collaborative and how competitive relationships between platform producers and complementors must be. This lever highlights the relevance of reaching balance between collaboration and competition.
d) Internal organization – How to organize the firm to support the first three levers. The right internal structure can help platform producers manage external and internal conflicts of interest.

Gawer and Cusumano (2008) have also recommended that companies follow one of two strategic approaches to become platform leaders: ‘coring’ or ‘tipping’. The coring strategy is related to the challenges of creating a new platform, where one does not exist. On the other hand, the tipping strategy is related to solving the problem of how to win platform wars by building market momentum.

According to the authors, successful coring and tipping involve both technology and business aspects of platform leadership. The technological aspects are related to designing the right architecture to facilitate third parties’ provision of complementary products. The business aspects of platform leadership include either making key complements or introducing incentives for third parties to create complementary products necessary to defeat competing platforms.

Gawer and Cusumano (2008) explain that coring can be described as the set of activities a company can use to design an element, such as a technology or a product, and make that element fundamental to a technological system and a market. A very successful company in coring is Qualcomm, which solved the problem of incompatible and inefficient wireless cell phone technologies in the early 1990s and licenses its patented technology (ship sets) to hundreds of companies producing complements for cell phones and other wireless devices (CHESBROUGH, 2006; GAWER; CUSUMANO, 2008).

Tipping can be defined as the set of activities that a company can use to shape market dynamics. An example would be a company that crosses its market boundary to extend its platform, which seems even more relevant in contexts of technological convergence, where tipping across markets by bundling new features, products or services, can leverage existing market power or reputation and help companies move into new markets (GAWER; CUSUMANO, 2008). The next section presents our research methodology.

We pose the question if platform leaders can be identified in the GM seed industry and what would the characteristics of platform leadership in this sector be?

In the next section we present the research method used to develop this study.

3 RESEARCH METHODOLOGY

This study can be characterized as a qualitative research (STRAUSS; CORBIN, 1990), based on the grounded theory (GLASER; STRAUSS, 1967). This study analyzes the perception of employees, most of them managers from companies we see as strategic agents, in terms of innovative capacity, operating in the GM seed industry in Brazil. We have carried out informal conversations and interviewed managers, directors, and technicians from the three supply chain links within the GM seed industry – biotech companies, breeding companies and seed companies, involving the six largest multinational agricultural biotechnology companies, one research, cultivar developing, institute and two seed companies, willing to understand what are the components within business platforms in the GM seed industry in Brazil, and how that perception differs considering the different innovative agents. We have also made an effort to explore what business platform leadership in the sector would be like.

The interest for this study is due to the fact that despite the number of studies which apply the business platform ideas to high-tech industries, there has been only a few studies uniting business platforms and the GM seed industry – the study developed by Vanhaverbeke and Cloodt (2006) analyzes open innovation within value networks in the agricultural biotechnology sector.

The grounded theory approach was chosen having in mind it would be an appropriate method given the novelty of the research theme and the fact that it would guide the researchers' analysis and interpretation of data through open, axial and selective coding processes (STRAUSS; CORBIN, 1990).

Grounded theory emerged with sociologists Glaser and Strauss' (1967) studies that developed systematic methodological strategies social scientists could adopt in many research fields. According to Charmaz (2006), to grounded theorists data forms the foundation of the researcher's theory and the analysis of those data generates the concepts that are constructed. In that sense, grounded theorists collect data to develop theoretical analyses from the very beginning of a project, without the need to have preconceived hypotheses. In that sense, the grounded theory can be seen as a method to test extant theories on new contexts and advance theory development.

The grounded theory might also be understood as a method to analyze processes. Charmaz (2006) explained that a process consists of unfolding temporal sequences that may have identifiable markers with clear beginnings and endings. Those temporal sequences are linked in a process and lead to change, demonstrating that single events are linked as part of a larger whole. Since the research process is not such a linear one, the grounded theory might help fill the gaps along the way.

Data collection was based upon documental and bibliographical references, as well as in in-depth semi-structured interviews and informal conversations. Fourteen (14) in-depth interviews were carried out with directors and managers from five of the six largest multinational agricultural biotechnology companies operating in Brazil: Monsanto (d); Syngenta (d); DuPont/Pioneer (a); BASF (a); Dow Agrosciences (1), as well as a Brazilian research cooperative, Coodetec (c). Five (e) informal conversations were carried out with managers and technicians from Bayer CropScience (b), Coodetec (a) and two seed Brazilian seed companies, Riber Sementes (a), and Sementes Farroupilha (a).

The research interviews were carried out in 2010, 2011 and 2013. The selection of the interviewees was based on the need to understand the relationships between the three different links of the genetically modified seed supply chain, as well as the strategic position that the interviewees occupy within their companies, enabling us to access knowledge about their companies’ historical trajectory and strategic alliances, as well as the relevance of biotechnology to their companies' businesses.

Interviews, which were recorded and transcribed, involved questions about the companies' understanding of innovation, most relevant products, the importance of open business models and inter-firm alliances to generating innovation and value, and the perception about internal, supply chain and industrial platforms, and platform evolution within the GM seed industry in Brazil (Attachment C).

Data was analyzed and interpreted using the Atlas ti software, which helped visualize the links among concepts, categories identified, and examine our question of how business platforms are seen by different agents.

4 RESULTS AND DISCUSSION

4.1 Understanding architecture and business platform components in the GM seed industry

The interviews carried out helped us find components, or building blocks, which first of all are relevant to companies that work in the GM seed industry and secondly, must be present in the transgenic seed industry business platforms. Different respondents from the different companies approached by this study understood the platforms formed in the GM seed industry innovative context differently.

They defined the business platforms in terms of: distinct parts that form a final product, focusing a GM seed as a final complex product; phases of development of a commercial product mastered by companies working with GM seeds; components within the GM seed product, which can also be bundled with other complementary products, sometimes from distinct industries; competencies that the companies must have access to, in order to be able to research, develop and commercialize a GM seed product.

4.1.1 Interdependent capabilities and modules within the transgenic seed industry business platforms

One of the business platform's characteristics is companies' dependency on other innovators for accessing fundamental proprietary technologies. Due to products' complexity no single company has all the necessary knowledge about either the product or the processes to completely design and manufacture everything in-house, as one of the respondents stated:

a) “Leading companies, or companies that have resources to invest in research and development, seeking to create innovative products, such as traits, genes, as much as they have means to invest, they do not have all the knowledge from every area of expertise”.

In high technology industries companies have specialized in developing certain components of complex products, that can be seen as modules. Having in mind that the business platform definition by interviewees approached by this study can be very broad, some of the interviewees defined business platforms within the GM seed industry in terms of areas expertise to generate GM seeds and deliver them to the market: seeds, or adapted plant varieties; traits; and crop chemical treatment.

Seen as three core competencies, these three modules, to some of the interviewees, are interdependently connected as we can observe in the following texts:

b) “It [the transgenic seed] starts with the germplasm. In the germplasm the company inserts the trait. After the trait, there is the seed care, the crop protection”.
c) “Today, there is the seed/seed genetics, there is the gene/the trait, and then, there is the last part, which is the crop chemical treatment. The crop chemical treatment protects the plant from the things the other two parts, genetics and traits, do not. Pioneer, for instance, owns the seed/genetics piece; it has agreements for accessing traits, and it buys the seed treatment. Consider Monsanto, for instance, our main competitor. It has the seed/genetics, it has traits, and it buys the seed treatment.”

The three modules (germplasm/seed genetics; traits; and seed chemical treatment) mentioned are complementary fundamental elements for innovating in the transgenic seed industry for some of the interviewees, according to the products they produce and their strategic positioning. For the respondent above, chemical treatment is as relevant as the other two pieces of the final GM seed product: germplasm and traits.

Uniting the components that are part of the seed product, the modules in which companies from the GM seed industry specialize, (Figure 1) illustrates the most important elements of the GM seed industry business platform for some of the respondents:

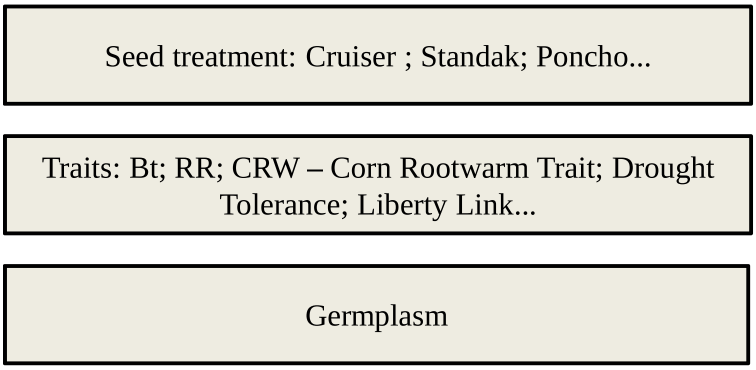

Figure 1 Relevant components of business platforms in the GM seed industry

Some of the respondents understand the platform in terms of phases of development of a commercial product mastered by companies working with GM seeds, or basically in terms of competencies developed within the three links in the GM seed industry supply chain: Biotechnoloy, germplasm and commercial production: as stated by the next respondent:

d) "After biotechnology we can divide the GM seed industry into three large blocks of activities: traits, germplasm and commercial

> production. Now if we think of types of companies… There are companies that own the trait stage; there are companies that own the germplasm plus the trait stages; there are companies that own the germplasm, the trait and the commercial production stages; there are companies that own germplasm and commercial production stages; there are companies that own only the germplasm stage and there are companies that own only the commercial production stage. BASF, for instance, has only the trait competence developed. Companies that own only the commercial stage would be seed companies, and companies which own all of these stages are Monsanto, Dow, Syngenta and Pioneer."

We could say that the three links of the supply chain mentioned or the competencies mastered by companies operating in each one of them are the elements that influence the establishment of partnerships for the development of the final product and the parts or modules within the business platform.

We could also observe that the definition of the many business platforms within the GM seed industry may depend on the way the companies address their customers' problems, or the way companies understand their organization with partners. For instance, Syngenta and Monsanto proposed terms such as: 'integrated solution platform'; or 'integrated platform', to define their global answer to the customer as we can observe in the next respondents' opinions:

e) "There was a change within our company and now this is Syngenta's global strategy. Now we create integrate solutions. The integrated solution is not only the seed offering, it means we offer solutions that are complete for including seeds and crop protection, but also adjacent technologies that can be related to irrigation, biotechnology, fertilizers, agricultural machinery…

f) ‘Last year Monsanto acquired a company called Precision Planting, and what does Monsanto want with this area od precision planting? It wants to unite precision agriculture – what is the best seed for this specific area with seed technology, trait and other areas outside Monsanto’s core competence, such as agricultural machinery and apps that can be downloaded into your iPad, for instance.

What we could observe through the data analysis is that the way respondents defined and elaborated on the business platforms definitions was in large part influenced by their companies strategic choices. BASF, for instance, calls its agricultural biotechnology firm, BASF Plant Science, ‘a gene platform’ and COODETEC names itself as ‘a germplasm window’.

According to the next interviewee’s perception, the GM seed research, development and production can be considered a business platform and the ‘know-how’ would be a key component within that platform as follows:

g) “Expertise, which is sort of knowledge-based or intellectual knowledge-based is certainly a key area [for agricultural biotechnology companies]… The intellect, human capital, knowledge skills, we sometimes call it know-how”.

In addition to that, another component, besides the know-how, would be ‘freedom to operate’, which can be defined as the legal access to all technologies involved in developing a new product (SEHGAL, 1996):

h) "Intellectual Property or the rights to use technology and license rights and ownership of technology, to where others cannot use that specific technology, is another. So, proprietary ownership, which is IP, it can be patents, it can be PVP (Plant Variety Protection) – the right for seeds… I think any multinational will value all of these things. IP, PVP, IP particularly, multinationals never underestimate this. You can call it freedom to operate, which also includes a certain amount of technology acceptance, and that includes both legal things and public acceptance".

Another important component for the formation of GM seed industry business platforms besides freedom to operate is 'infrastructure':

i) "Also, the buildings, the robots, DNA sequencers, the testing sites, are sort of another area. We pretty obviously have infrastructure, which is everything but the human capital, it is buildings, sites, equipment. And to produce seed, on R&D all these things fit. It fits across R&D, it fits across commercial and everything else".

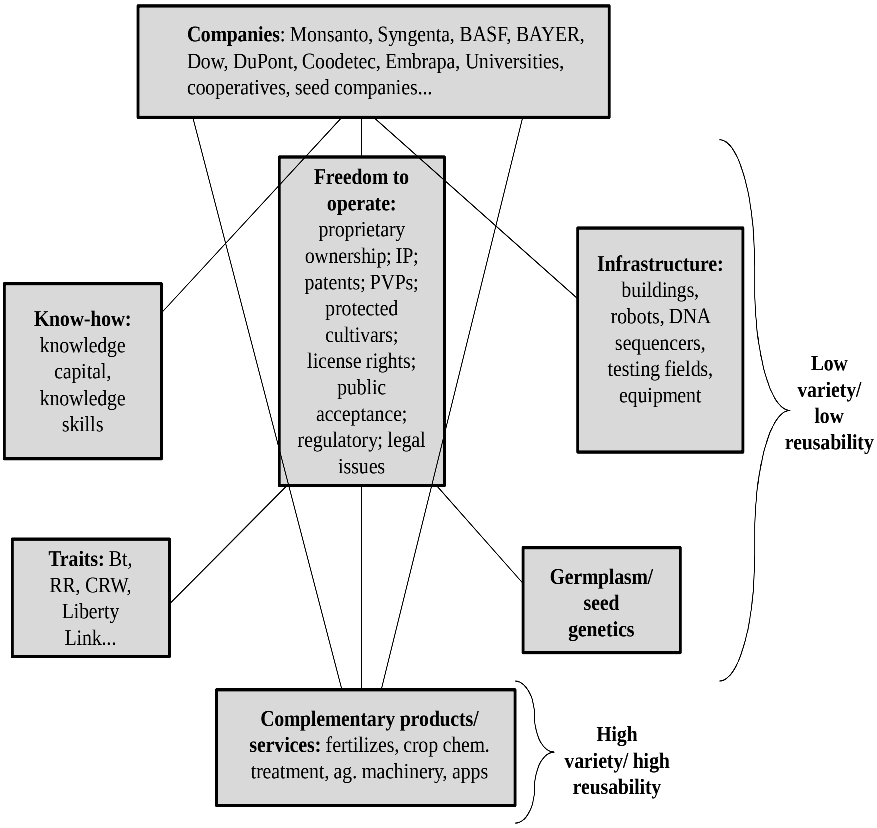

Figure 2 Main modules within the GM seed industry business platform

Analyzing the data, we observed that some components the interviewees described as elements composing platforms present higher variety if compared to the others. The distinct competencies that can be combined in the transgenic seed, along with the difficulty of having proprietary ownership of all the knowledge in every area of expertise, have made germplasm/seed genetics, traits, and the components necessary for companies to research, develop and commercialize solutions considering crop productivity: know-how, freedom to operate and infrastructure, present lower variety if compared to the complementary products. Accesses to the 2 modules described in (Figure 2), traits and germplasm increase the size of the module called (freedom to operate), which is the central component of the business platform for the fact that without access to some proprietary technologies it is not possible to innovate.

The three building blocks of the GM seed industry business platform (know-how, freedom to operate and infrastructure) are equally relevant to the six largest multinational agricultural biotechnology companies and to the other firms and research institutions working with innovation in this sector. However, freedom to operate might hold the key to platform leadership. All of the 'big six' have know-how and infrastructure, but they have different proprietary ownership, license rights over different technologies.

In this way of understanding the business platform, mergers and acquisitions, as well as almost every inter-firm alliance to access core competencies, including chemical treatment, traits and germplasm, or any other effort to control industry innovation, needs the freedom to operate building block to take place. That is also why it constitutes a central component within the transgenic seed industry business platform. That central category holds the most important assets, knowledge, regulatory expertise, and public acceptance, which are crucial to a company's ability to generate new products, exercise influence over developers, and develop leadership positions.

In addition, a company that develops a core technology crucial to other companies' innovative processes, or has the resources to obtain regulatory approval – which are part of the freedom to operate building block – might more easily achieve platform leadership.

Another way of understanding the platforms formed in the GM seed industry identified by respondents was related to the three links within the GM seed industry supply chain: Biotechnology companies, and their core competence, plant variety developing companies, and companies developing the commercial production.

For the interviewed people that identified platforms being formed from the sharing of these competencies, the companies that own the biotechnology or trait technology can capture the larger part of the profits generated from a GM product and depend less upon the other two links. The link within the supply chain that develops the adapted plant varieties, is a little more dependent on the trait developing company. As for the companies developing the commercial product or multiplying the seeds, they are the ones that depend the most on the other two links.

4.1.2 Strategies for establishing industry standards and achieving platform leadership

Since we have observed some evidence on the formation of leadership positions in the GM seed industry we might as we make an effort to answer to the question if there we can state that there is platform leadership strategies in the GM seed industry in Brazil.

The interviewees approached by this study did not agree with the term leader of a platform, especially those from the six multinational companies. Nevertheless, some scholars do identify leaders in the GM seed industry, such as the 'big six' (HOWARD, 2009). Business platforms are defined by open innovation dimensions and function as architectures where developers or complementors can innovate upon core technologies. According to Gawer and Cusumano (2002) managers who aim at platform leadership, or platform leaders, use 4 strategic levers to remain competitive. The following interviewee's opinion, which is related to the first lever of strategic action – 'scope' – is about how the company should decide on the amount of innovation to be done internally, and what outsiders should be encouraged to do:

j) “You must have heard of the Bts? That protein which can be found in some crops such as cotton, and corn that gives the plant a characteristic of insect resistance without the use of pesticides. This is a field of expertise, for instance, in which BASF is not going to get into. And ‘why is that?’ That is because there are companies that are light years ahead of us. I mean, they have already had that Bt research for years. So, for BASF to get into that, it will be in disadvantage. Therefore, you will choose what are the clusters in which you can be competitive, in which you have an expertise… ‘What is your core competence?’ So, for example, if your business is to seek for productivity genes, then that is a cluster where you should focus. Don’t go looking for Bt”!

The next interviewee opinion is about the second lever of strategic action – ‘product technology’ – which identifies how much modularity and how much information on the modules, on the platform, to disclose to outside firms:

k) “Nowadays, we [DuPont/Pioneer] have germplasm and we have traits. Only with the alliance we have established with Dow, it was possible for us to have access to those traits. We do not have the technology for developing the traits by ourselves, so we have to seek for partners”.

It is possible to infer from the previous interviewees’ texts that BASF, like other multinational agribiotechnology companies, such as Dow, follow the ‘coring’ strategic approach (GAWER; CUSUMANO, 2008), and set up their core technologies (high quality traits) as the basis for becoming a platform for the development of third parties’ business. Through the coring strategy multinational agribiotechnology companies establish inter-firm alliances allowing other companies to combine their germplasm/seed genetics to the traits commercialized by them.

The next interviewee's opinion regards also the second lever of strategic action – 'product technology' – and it focuses on Monsanto's expertise on regulatory processes and proprietary technologies, which might explain some of that multinational company's leadership position:

l) "We [Monsanto] have technology that is transferable, we also have know-how about Roundup Ready, insect resistance, how to test them, what to look for, we have global regulatory expertise... So, when you get a trait approved in Brazil, they [partner companies] understand that. And we have people and resources around the globe that can help or advise you. It is a pretty good mix"!

The previous interviewee talked about core competences that might explain Monsanto's leadership position within its platforms. Besides following the coring strategy leading the way in agricultural biotechnology, by setting up technologies such herbicide tolerance and insect resistance, crucial for other companies' innovative processes, Monsanto has also regulatory expertise, which the company can set up as basis for other companies business. In that context, other companies look forward to being part of strategic alliances with Monsanto to also obtain access to regulatory expertise.

The next text concerns the third lever of strategic action – 'relationship with external complementors' – which should reveal how collaborative or competitive the relationship with complementors should be:

m) “Nowadays and in the near future, we will be sharing within that organism which is the seed distinct desirable characteristics, such as herbicide tolerance, insect resistance, as well as high protein drought tolerance, among other things... And biologically, these traits have been developed by different research institutions, both public and private, or by large multinational corporations, such as Bayer. As an example, in the present, Bayer commercializes insect resistant and herbicide tolerant cotton seeds, sugar-cane varieties that produce more sugar... To share within a single seed (commercial brand) many different traits, we will have to license these traits within a conjoint collaborative work platform, consequently sharing the profits derived from seeds commercialized”!

The previous interviewee’s text is related to the tipping strategy (GAWER; CUSUMANO, 2008), implemented by companies when they cross their market boundary and bundle in a single product (transgenic seed) many different desirable features willing to leverage market power or create new markets and achieve platform leadership.

An example of a tipping strategy is the development of the stacked-trait seed called SmartStax by Monsanto and Dow, where different technologies bundled in a single corn seed allow those companies to move into new markets.

5 CONCLUSIONS

We believe the business platform theoretical concept, which can be seen as a methodology for analyzing the sharing of core competences from distinct companies to create complex products, might contribute to understanding of innovation processes in the GM seed industry.

To explain the many possibilities of business platform formation in the GM seed industry, different companies propose different definitions, as integrated solutions to customers, or as the integration of different competencies necessary to research, develop and commercialize GM seeds for instance. Through the investigation of the largest multinational companies' inter-firm alliances and perceptions of innovation and business platforms of these big companies, it was possible to unveil those companies' deliberate strategies to set up their technologies as architectures where other companies could build innovations upon.

Having in mind that the business platform construct can be understood as a network of relationships, or the architecture, that brings competences together to generate innovation, modularity – the decomposing of complex tasks into simpler activities – is a concept that helps the understanding of the transgenic seed industry business platform.

One way of looking into the architecture of business platforms formed in the GM seed industry is through the groups of expertise in which companies specialize in the GM seed industry: (germplasm/seed genetics; crop chemical treatment; and traits).

Besides this way of identifying business platform formation for the analysis architecture of business platforms in the GM seed industry, we identified three building blocks as main elements necessary to develop new products and platforms: a) know-how – human capital, knowledge skills; b) freedom to operate – proprietary technology, the rights to use technology and license rights; and c) infrastructure – buildings, testing sites, equipment.

The three building blocks of the GM seed industry business platform formation identified are equally relevant to the six largest multinational agricultural biotechnology companies. However, those companies have different proprietary technologies and license rights to use technology.

Two strategies established by the largest multinational agricultural biotechnology companies, seeking to achieve a leadership position within the GM seed industry, have been identified: a) the coring strategy; and b) the tipping strategy. Dow for instance, follows the 'coring' strategic approach to set up its core technologies (high quality traits) as the basis for becoming a platform for the development of other companies' business (DuPont). On the other hand, the stacked-trait corn seed called SmartStax is an example of the tipping strategy and the bundling in a single product (transgenic seed) of different desirable features willing to create new markets.

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ATTACHMENTS

Attachment A Information about the data collection process

Frame 1A Position of respondents and number of interviews or informal conversations carried out during the data collection process

Company	**Number of interviews or informal conversations**	**Position of respondent within company**
BASF	1 in-depth interview	-1 Biotechnology Manager – BASF Plant Science Brazil
Bayer CropScience	2 informal conversations	-1 Sugarcane Regional Manager; -1 Soybean, Corn and Beans Manager
COODETEC	3 in-depth interviews; 1 informal conversation	-1 Executive Director; -1 Research and Development Manager
Dow Agrosciences	1 in-depth interview	-1 Marketing, Seeds and Biotechnology manager
DuPont/Pioneer	1 in-depth interview	-1 Product and Technology Manager - Center/North DuPont Brazil – Pioneer Seeds
Monsanto	12 in-depth interviews; 2 informal conversations	-2 Soybean Team Business Managers; -1 Cotton Team Business Manager; -1 Corn and Sorghum Team Business Manager; -1 Agrochemicals Business Manager; -2 Public Affairs and CSR Managers; -1 Sales Manager for Minas Gerais; -1 South America Technology Strategy Lead; -1 Scientific Affairs Manager; -1 Product Management Director.
Riber Sementes	1 informal conversation	-1 Seed Analysis Laboratory Technician
Sementes Farroupilha	1 informal conversation	- Commercial Department Manager

“continues”

Frame 1A "conclusion"

Company	Number of interviews or informal conversations	Position of respondent within company
Syngenta	4 in-depth interviews	-1 Technical Market Development Manager; -1 Business Development Manager and Strategic Planning – Latam; -1 Manager of New Business – Latam; -1 Director of Integrated Planning and New Business – Latam.

Attachment B Questionnaires used in the data collection process for Chapter 2

Questionnaire 1

1. How would you describe Monsanto-World?			
2. How would you describe Monsanto-Brazil?			
About Monsanto's business model			
3. According to Sviokla et al. (2004), Monsanto's business model evolved as shown in the following table:			
4. Monsanto's Business components evolution			
Business components	Changes in the business unit		**Do you agree/disagree? Why is that so? Would you please explain?**
Business aspects	Chemical company	Biotecnology/ Agribusiness	
Business aspects	Chemical company	Biotecnology/ Agribusiness	
Economics	Based upon price	Based on value	
Core products	Chemical components and commodities	Bio-engineered innovative seeds	
Customers	Manufactures	Farmers	
Brand image	Based on price and services	Based on innovation	
Capabilities	Efficient manufacturer	Scientific leader	
Distributional channels	Direct	Distributors	
5. What was the company's identity before biotechnology, before the 1980s? What was the sentence that best described the company? / What can be seen as Monsanto's identity today? What is the sentence that best describes the company?			
6. Monsanto is seen as a pioneer in transgenic seed production. Being a pioneer is a risk for the organization?			
7. Right after the change, when Monsanto became a life sciences company, were there concerns about ethical matters and public acceptance matters considering the products generated from biotechnology?			
8. Did public knowledge about biotechnology influence Monsanto's business actions and the way the company developed and published its research & development results?			
9. What elements considering the company's business assets needed to be created or changed (distributional channels, human resources training...) to consolidate change when the company incorporated the biotechnology business?			
10. What is the influence of the Brazilian regulatory system to the company's businesses?			

Questionnaire 2

1- When Monsanto started working with biotechnology did it change its business model? Do you believe these changes can be seen as 'business model innovation'/ 'business model dynamics' in Monsanto Brazil? Would you please explain your answer?
2- How does biotechnology change the company's ways of commercializing and offering value to its customers?
3- According to Osterwalder (2006), there can be three types of business model change: a) the company does the same things in a different way; b) the company extends its business model; c) the company creates a business model that is completely new. How is agricultural biotechnology in Monsanto related to any of these ways of innovating?
4- What are the innovations based upon agricultural biotechnology that have been already commercialized by Monsanto in other countries and in Brazil? Can you please tell us about some new products that the company plans on launching in the Brazilian market within the next ten years?
5- According to Kalaitzandonakes (2000), products generated from agricultural biotechnology can be considered as first or second generation. Is Monsanto going to commercialize agricultural biotechnology second generation products in Brazil?
6- According to some scholars agricultural biotechnology first generation products do not represent such big changes at companies' business model. Do you agree with this?
7- In your opinion agricultural biotechnology products commercialized by Monsanto can be considered value innovations (those new products that offer value which is radically superior to customers, but at the same time price is lower if compared to substitute products), disruptive innovations (those new products that create new markets targeting non-customers or competing in the low end of an established market) or radical innovations (products entirely new)? Would you please explain your point of view?

Attachment C Questionnaire used in the data collection process for chapters 3 and 4:

Questionnaire

1- Our research group investigates the business platform concept. One of four colleagues has researched the sugar cane business platform, and another colleague has developed a study about the flex-fuel technology business platform. I am responsible for investigating what we see as the genetically modified seed business platform. We will be talking about it during our conversation. But before anything else I would like to ask you to tell me a little about your company, its story, main products and its importance for Brazil**.**
2- The business platform according to our understanding can be described as a form of organization and relationships of some companies in dynamic environments, such as hypercompetitive environments. Within a hypercompetitive environment, product life cycles are shortened and the trade-off cost-differentiation makes it difficult for companies to create new value to customers and capture part of the value created. Usually, information technology companies find themselves within hypercompetitive environments. In this context, we would like to know your opinion about agricultural biotechnology companies. What are the rules of competition for these companies?
3- We have been researching new business models and how companies adapt in the knowledge era. Within a business platform, one company produces a central core competence creating an infrastructure where other companies can participate and develop complementary competences and products. These complementary competences can originate from distinct firms within a same industry or from firms from distinct industries, aggregating value to a final complex product. What we are trying to figure out is if the genetically modified seed, which is composed of various fragmented knowledge and the complex relationships between companies to generate the final products could be understood as a business platform. Would you please explain your point of view?
4- Would you please give us your opinion about the future of the genetically modified seeds, output traits and quality traits? Does your company intend to invest more on those products?
5- Considering agricultural biotechnology, what happens? If a certain company ‘A’ has proprietary ownership of a good trait and another company ‘B’ has proprietary ownership of another good trait, these two companies can collaborate with each other to develop a better product together? Could the seed be seen as the architecture of distinct competences?
6- Could you please give us some examples of partnerships your company has with other companies for the development of genetically modified seeds? What is the importance for companies of establishing partnerships in the field of agricultural biotechnology?
7- Is there technology being developed in Brazil, or traits are developed in other countries and then brought to Brazil?

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"conclusion"

8- If we take a look at the partnerships established in the seed industry in the present, in your opinion, are they established in the initial, middle or final stages, taking the whole process, from research and development till product launch?
9- Within Intel's historical trajectory, the company developed the architecture that connected all the developers of complementary products to its product, and because of that it could connect and communicate its innovations to every complementary module and to its customers. This way Intel became leader of its platform. Such as the computer, other products, such as the automobile is organized into modules, or specialized parts of knowledge. Is it possible to think of modules within the production of genetically modified seeds?
10- In your opinion, is it possible to identify one or a few innovation coordinators, or leaders, of innovation within the genetically modified seed industry?
11- We have been researching cases of open innovation and open business models. The concept of open innovation can be observed when a certain company develops a new idea within the company's borders, but that company is not interested in taking that new technology to the market and allows other companies to develop that stage of the innovative activity, through licensing for instance. Or, another example of open innovation is when a certain company needs a piece of knowledge to complete the innovation process that it does not produce within borders, so that company partners with another company or research institution to access the necessary technology. And a third type of open innovation is the co-development innovation process, which is when two or more companies establish a partnership and develop a new product or service together. Does your company work with these concepts? Could you please give us examples of open innovation in which your company participates?
12- The concept of platform architecture is important to the understanding of business platform organization and evolution. The concept of business platform architecture works the following way: some components within the business platform, some technologies and components that remain fixed. These components do not change, or take longer to change throughout the life cycle of a platform. Some other components present higher variety, and can eventually due to changes of many kinds change and be replaced. I would like to ask you if in your opinion we can say there is architecture in the GM seed business platform and how it is characterized.